A study of some factors affecting reproductive traits in a small producer crossbred dairy cows in the Sudan.

Abu Eissa[a], H. I. and Atta[b], M.

[a] *Animal Production Research Centre, Kuku, P.O. Box 1355 Khartoum N., Sudan.*

SUMMARY

Three hundred and one records of Friesian × Kenana crossbred dairy cows during the period 1992 – 2000, were analyzed to evaluate the effect of parity order, calving season and sex of new born calves on some reproductive traits, including: days open, number of services per conception, gestation length and calving interval. The results documented insignificant effects of the investigated parameters on the reproductive traits measured. Values of days open, number of services per conception (NSPC), gestation length and calving interval (CI) were 99.1 ± 40.5 days, 1.8 ± 1.2, 279.0 ± 8.1 days and 379.0 ± 41.38 days, respectively. Male calves were found to spend in the uterus as gestation period significantly lower time than female calves (278.0 vs. 280 days). The heritability indices of these traits were estimated and they were 0.16 ± 0.03, 0.13 ± 0.02, 0.22 ± 0.02 and 0.11 ± 0.03, respectively, indicating that these traits could be improved substantially by sound management since the genetic impact is very low. Good management of crossbred cows under tropical conditions therefore can contribute greatly towards improving these traits to levels comparable with their exotic ancestors.

INTRODUCTION

Introduction of exotic breeds of cattle into semi-arid regions has been generally successful, since in most situations constrains to production are not genetic. The indigenous cattle in the tropics are known for their tolerance to hot environment but they generally exhibit low productive and reproductive performance (Ageeb and Hiller, 1991). Kenana and Butana cattle are considered as the main local dairy breeds in the Sudan. They are estimated to comprise a quarter of the total cattle population in the country (El Taher, 1999). Under improved feeding and management these two breeds yield about 1600 liters/lactation (Osman and Russel, 1974). Many attempts were made to improve the genetic potentials of these animals for milk production. Crossing between exotic and indigenous breed has been adopted in the Sudan since 1925 with Shorthorn breed, however, Friesian crossing was introduced in the year 1960 (Medani, 1996). The author also noted that Friesian crossbreds were the most suitable for their good adaptability to the tropical environment in addition to their high yielding capacity.

The continued production of any livestock commodity depends on reproduction, so reproductive efficiency is a major factor in both biological and economic efficiency. More factual knowledge is needed on reproductive performance before the breeds could be evaluated accurately for total merits. Deterioration in dairy cows' fertility has become a major problem in dairy cattle production to the point that it is becoming increasingly apparent that high yielding cows are more difficult to get in calf (Buckley *et al.*, 2000). Results of recent studies in a grass-based production system indicated that cows of high

genetic merit had a higher interval from calving to first service, poorer conception rate and higher number of services per conception compared to cows of medium genetic merit (Snijders *et al.*, 2001). They reported an infertility rate of 21% for high genetic merit cows compared with 6% for the medium merit cows. The authors also noted that the estimated margin after cost was about 0.02 US dollars per kilogram of milk higher in medium-merit cows compared with the high genetic merit cows after considering losses due to poor fertility. Economic losses due to poor fertility are generally due to the cost of a prolonged calving interval, increased insemination cost, reduced returns from calves born and forced replacement in the event of culling.

Age at first calving, calving interval, gestation period, days open, number of service per conception and conception rate are very essential reproductive indices to measure females' fertility. These indices are important indicators of the reproductive performance of a herd. Measures of fertility generally have a low heritability, indicating a strong influence of environmental factors such as seasonal parameters as well as management decisions taken by the breeder (Bath *et al.*, 1985). They noted that factors such as age of the animal have a strong influence on fertility. They also stated that fertility is highest in the coolest months of the year.

The day length was proposed to be the primary factor for the seasonal incidence of infertility in cattle specially when day length varies considerably (Montgomery, 1985), however, this may not be present when approaching the equator. So in the tropics the main seasonal component that may have effects on cow's reproduction is the ambient temperature. Thatcher (1974) reported a clear difference in conception rate between lactating dairy cows and heifers as maximum environmental temperature increased the day after insemination.

The objective of this study was to highlight the possible effects of factors such as calving season, parity order and sex of calf born on some reproductive traits of Friesian crosses in Khartoum and the heritability of these traits.

MATERIALS AND METHODS

The data used in this study were extracted from 301 records of Friesian × Kenana crossbred cows (body condition score ranging between 3 and 4) during the period between 1992 and 2000. Cows were kept in half shed free stall pens in a farm in Khartoum North at 15:37^{O} N, 32:35^{O} E and 392 m altitude. Pen floor was covered by earth. Clean drinking water was available all the time. Cows were fed on *Sorghum bicolor* (Abu70), *Medicago sativa* (Berseem) and a concentrate diet two times a day after milkings. Cows were milked by hand twice a day. Mastitis incidence was very low.

The records of days open, number of services per conception, gestation length, and calving intervals were arranged to test how they were affected by parity order, season of calving and sex of calf born. To test the effect of parity the cows were grouped into 7 groups as 1st, 2nd, 3rd, 4th, 5th, 6th and above 6th parities. To test the effect of season of calving cows were grouped according to the month of calving to three calving seasons. March to June were taken as the dry summer season, July to October represented the wet summer season, whereas,

November to February were considered as the winter season (Table **1** showed the average temperature, rainfall and relative humidity of these seasons during the experimental period). For the test of the effect of the sex of born calf on the reproductive parameters under study the cows were grouped into 2 groups, male and female calves.

Table (1). Metrological data of Khartoum during the experimental period (1992-2000).

Season	Rain fall (mm)		Max. temp. (°C)		Min. temp. (°C)		Re. humidity %	
	Aver	Range	Aver	Range	Aver	Range	Aver	Range
Dry Summer (Mar. to Jun.)	1.2	0.00-19.2	40.3	35.1-43.9	25.2	19.2-29.2	20.1	13-29
Wet Summer (Jul. to Oct.)	35.1	Tr-91.9	38.3	35.9-39.8	26.1	24.9-27.8	45.1	28-58
Winter (Nov. to eb.)	0.0	0.00-Tr	34.3	29.7-41.4	18.6	12.4-28.9	26.3	20-38

Tr =Trace.

Data of 55 daughters for 29 dams were extracted from the records to estimate the heritability of the reproductive traits by regression of daughters on dams as described by Falconer and Mackay (1996). The standard error of the estimated values was also calculated according to Falconer and Mackay (1996).

Taking the year of calving as a covariant, the data were analyzed to test the effect of cows' parity, season of calving and sex of born calf by analysis of covariance (Stat Soft 2001). The significance between means was tested by Duncan multiple range test. The significance of male ratio distribution was tested by χ^2 test.

RESULTS AND DISCUSSION

The age at first calving observed in the present study was 946.3 ± 91.6 days. Many researchers reported this age to be not less than 24 months of age; however, its excess is a problem facing the production orderliness and heifers not mated until 3 years of age frequently develop reproductive disorders (Bath *et al.*, 1985). The present value was lower than that reported for many crosses of Friesian in the tropics. Ageeb and Hiller (1991) found the crosses of Friesian with Kenana and Butana to calve for the first time at the ages 3.0 and 3.2 years, respectively. Ali *et al.*, (1988) reported the average age at first calving of Friesian × Kenana or Butana crosses of 50, 62.5 and 75% inheritance to be 42, 36 and 50 months, respectively. Bashir (1990) observed that the average age at first calving for crossbred cows having more than 50% Friesian blood was 1264.23 ± 445.55 days, whereas

those of less than 50% Friesian inheritance was 1404.08 ± 395.37 days. Nilforooshan and Edriss (2004) reported lower ages for pure Holstein (21 months), whereas for pure Kenana, Saeed *et al.*, (1987) reported a higher age at first calving (1502 ± 12.4 days).

A moderate heritability estimate (0.27 ± 0.17) was obtained for the age at first calving. Comparable values were reported by Ishag (2000) for Kenana × Friesian crosses (0.29 ± .42). For Kenana cattle, Khalafalla (1977) reported higher heritability estimates (0.332 ± 0.15).

The over all mean of days open period (DOP) was 99.1 ± 40.5 days. Very short DOP indicate good fertility, while long DOP may be due to poor fertility or to delayed breeding (Oseni *et al.*, 2003). Ahmed (2002) noted shorter periods for Friesian crosses in the Sudan. He noted that Days from calving to conception (days open) and calving interval were ($P<0.05$) longer for White Nile cattle (160.52 ± 53.2 and 445.0 ± 53.2 days) than the crossbred (88.53 ± 44.5 and 373.0 ± 44.0 days). However, Bashir (1990) reported longer days open period (178.9 and 200.4 days) for cows with 50% and >50% Friesian inheritance, respectively. Longer days open (120 ± 20 days) was also reported by Mansour (1992) for pure Friesian in Saudi Arabia.

Number of services per conception (NSPC) overall mean was 1.8 ± 1.2. This value was comparable to that reported by Mohammed *et al.*, (1985) for Friesian herd raised under a semi-arid environmental condition. They reported 1.9 ± 0.17 services for heifers and 2.6 ± 0.11 services for cows raised in Egypt. Lower NSPC values were reported for pure Friesian cows in the tropics. In Sudan, the imported Holstein Friesian cows kept at Dairy Land farm required 1.13 services and their locally born daughters required 1.23 (Bashir, 1990). In Saudi Arabia, Mansour (1992) reported 1.68 ± 0.4 inseminations. An average of 1.21 NSPC was reported by Saeed *et al.*, (1987) for Kenana at Um-Banein. Ahmed (2002) noted that NSPC of the local cows had higher values than crossbred ones however the difference was not significant.

DOP and NSPC were not affected by parity, calving season or sex of born calf (Table **2**). However, first and second calves tend to have shorter days open and this was consistent with Mohammed *et al.* (1985) and Bath *et al.*, (1985) who noted that heifers and first lactation cows were usually more fertile than lactating multiparous cows. Winter season calves tended to have shorter DOP and lower NSPC. Similar observations were reported by Ahmed (2002) who noted that seasonal effect on days open and calving interval was not significant, however dry summer calves showed the longest days to conception compared to wet summer and winter ones. This might have resulted from the effect of higher temperature on cows' fertility, high climatic temperature was found to depress ovarian activity, especially during dry season (Thatcher, 1974). The adverse effect of heat stress on ovarian activity, duration of estrus, uterine and endocrine status and conception rates resulted form its role as an inhibitory environmental stimuli that reduced the hypothalamic gonadotrophin releasing hormone secretion, lack of LH secretion and consequently lack of ovarian follicle development and ovulation (Gordon, 1997).

This adverse effect of heat stress on reproduction was confirmed in the present study by the higher number of calvings in dry summer 126 vs. 72 for wet summer and 103 for winter seasons. The higher number of calvings in the dry summer resulted from the higher conception rate in winter whereas the lower calvings of the wet summer season resulted from the lower conception rate during the dry summer.

When the seasonality of calving (SOC) was calculated according to Oseni *et al.*, (2003):

$$SOC = 1 - \left(\frac{\text{Number of calvings in season with the fewest calvings}}{\text{Number of calvings in the season with the most calvings}}\right)$$

it was found to be 0.43. This means that about 43% of calvings takes place in the dry summer. Oseni *et al.* (2003) reported a higher value of seasonality of calving (0.60) for the southeast states of the United States, whereas all other regions had SOC values less than 0.23. They added that the seasonality of 0.6 implies that about 60% of the cows bred during the spring season and calved in the hot season.

The overall mean of the gestation period was 279.0 ± 8.10 days. This value was consistent with that reported by Williamson and Payne (1978). They stated that the average gestation period of Friesian and Holstein-Friesian cows in the tropical and subtropical environments averaged 279 days. El Amin *et al.*, (1981) reported 275.6 days for the crosses of Butana with Friesian. An average of 286.5 ± 0.2 days was reported by Saeed *et al.*, (1987) for Kenana.

As shown in table 2, the parity as well as the calving season exerted insignificant effects on the gestation period; this result was consistent with that reported by Mohammed *et al.*, (1985), who reported 276.3 ± 0.6 and 275.8 ± 0.5 days for heifers and cows, respectively. The sex of born calf was found to have significant effect on this period, where males had shorter ($P<0.04$) gestation period than females. This could be attributed to the presence of testosterone hormone during the prenatal period in males, because it had an activating effect on growth and hence caused the gestation period to be shorter (Lawrence and Fowler, 1997; Gordon, 1997).

The overall calving interval of the present study was 379.0 ± 41.38 days, and it was within the range proposed by Bath *et al.* (1985) (12 – 13 months). The present values were comparable to that of the imported Friesian in Sudan (361.9 days vs. 360.7 days for their locally born daughters) reported by Bashir (1990), in Saudi Arabia (398 ± 2.0 days) reported by Mansour (1992) and in Egypt (381.9 ± 17.1 days) reported by Moharram (1988). On the other hand the present values were lower than 14.2 and 15.0 months reported by Ageeb and Hiller (1991) for Butana and Kenana crosses with Friesian, respectively.

Also lower than 485 ± 5.1 days reported for Kenana cattle at Um-Banein (Saeed *et al.*, 1987). Khalafalla (1977) reported 438.75 ± 4.70 days calving interval for Kenana cows with no significant influence exerted by season of calving.

The calving interval was not affected by cows' parity, calving season or sex of born calf (Table **2**). Similar data were reported for Friesian – Kenana crosses (Ishag, 2000) and Friesian – Sahiwal crosses (Gurcharan Singh *et al.*, 1980). The latter authors reported that the average calving interval to be 462 days and there was insignificant gradual decrease in the calving interval with the increase in lactation number. However, Jadan *et al.*, (1991) reported calving interval of 459.0 ± 4.0 days for indigenous and crossbred cows of Ethiopia, with significant effects of breed, year of calving and lactation number, whereas season of calving had no significant effect.

Most of the reproductive traits tested here have low heritability estimates (Table **2**). The moderate estimate of the gestation period was consistent with that reported by Forbes and Robinson (1967), who stated that the gestation period was stable within breeds and was not affected by environmental factors. The lower heritability of the other traits was consistent with most of the literature reviewed which noted that the reproductive traits generally have low heritability. Higher estimates for the calving interval were reported for Friesian crosses by Ageeb and Hiller (1991) (0.467 ± 0.312) and Ishag (2000) (0.29 ± 0.35). Lower estimate was reported by Khalafalla (1977) for Kenana cows (0.022 ± 0.054). The variation in estimations might be explained by what stated by Falconer and Mackay (1996), who stated that for the same character, heritability was not constant and might show a wide variation, depending on the herd in which it was measured and the method of estimation.

The male calves born ratio is 50.8%. Neither cow's parity nor calving season exerted any effect on this ratio. Smith (1980) stated that the sex ratio at birth in most organisms tended towards 1:1 ratio, however in mammals it was often weighted toward males. Similar to this ratio was reported by Atta and El Khidir (2005) for Nilotic sheep (range between 47% and 59%).

The study concluded that the present crossbred dairy cows have satisfactory reproductive performance because of their good management. The factors as cows' parity, season of calving showed no significant effect on the characters studied. The environmental factors seemed to have larger burden than the animals' genotype on the phenotype of these characters. This indicated that good management of Friesian crosses in the tropics will enable them to have reproduction efficiency comparable to that of their foreign ancestors and higher than that of their local ones.

REFERENCES

Ageeb, A. G. and Hiller, J. K. (1991). Effect of crossing local Sudanese cattle with British Friesian on performance. Bulletin of Animal Health and Production in Africa. 39(1) 69-76.

Ahmed, S. E. H. (2002). A comparative reproductive and productive study of crossbred and local White Nile cattle under two husbandry systems. Ph. D. thesis Faculty of Animal Production, University of Khartoum.

Ali, T. E., Ahmed, F. A. and Ombabi, Y. A. (1988). Productivity of crossbred Zebu cattle with different levels of Friesian blood. Sudan J. Anim. Prod. 4(2) 69-79.

Atta, M. and El Khidir, O. A. (2005). The effect of age and diet on the reproductive performance of Sudan Nilotic ewes. Journal of Agricultural Science, Cambridge, 143(5), 421 – 426.

Bashir, I. E. (1990). Reproductive performance of Holstein-Friesian dairy cows with indirect comparison to different crossbred grades in the Sudan. M. Sc. Thesis, University of Khartoum.

Bath, D. L.; Dickerson, F. N; Tucker, H. A. and Appleman, R. D. (1985). Dairy cattle: Principle, Practices, Problems, Profits. 3rd edition. Lea and Febiger. Philadelphia.

Buckley, F., P. Dillon, M. Rath, and R. F. Veerkamp. (2000). The relationship between genetic merit for yield and live weight, condition score and energy balance of spring calving Holstein Friesian dairy cows on grass based systems of milk production. J. Dairy Sci. 83:1878–1886.

El Amin, F. M.; Simerl, N. A. and Wilcox, C. J. (1981). Breed and environmental effects on reproductive performance of crossbred dairy cows in the Sudan. Anim. Breed. Abstract, 52, abst. No. 6458.

El Taher. H. A. (1999). Effect of pre-partum Energy levels on some production traits of Exotic dairy breeds in Butana Dairy Farm. M. Sc. Thesis Faculty of Animal Production, University of Khartoum.

Falconer, D. S. and Mackay, T. F. C. (1996). Introduction to quantitative genetics. 4th edition. Longhman group Ltd England.

Forbes, T .J. and Robinson, J. J. (1967). The effect of source and level of dietary protein on the performance of in-lamb ewes. Animal Production 9, 521–529.

Gordon, I. (1997). Controlled Reproduction in Sheep and Goats. Vol. 2, Wallingford: CAB International.

Gurcharan Singh, R. S.; Chillar, R. R.; Patil, M. P. and Ram, P. (1980). Note on performance of crossbred (Friesian × Sahiwal) cows at the Indian Agricultural Research Institute, New Delhi. Indian J. Anim. Sci. 50(12) 1126-1128.

Ishag, I. A. (2000). Impact of genetic and non-genetic factors on production and reproduction traits of crossbred cows raised under Sudan conditions. M. Sc. Faculty of Animal Production, University of Khartoum.

Jadan, K. L.; Tripathi, V. N.; Taneja, V. K. and Kale, M. M. (1991). Performance of various Holstein × Sahiwal Grades for First lactation reproduction and production traits. Indian J. Dairy Sci. 44(3) 209-216.

Khalafalla, A. M. (1977). The reproductive performance of a herd of Kenana cattle (a North Sudan Zebu). M. V. Sc. Thesis University of Khartoum.

Lawrence, T. L. J. and Fowler, V. R. (1997). Growth of farm animals. 1st edition, CAB INTERNATIONAL Walling ford UK.

Mansour, H. (1992). Some reproductive performance parameters of Friesian and Holstein-Friesian cattle in Kingdom of Saudi Arabia. Annals of Agric. Sci. (Ain Shams University) 37(1) 85-93.

Medani, M. A. (1996). Animal resources and animal production in the Sudan. 1st edition. University of Khartoum press.

Mohammed, A. A.; Abdel-Aziz, A. S. and Badran, M. H. (1985). Some reproductive aspects of Friesian cattle under semi-arid environment. AlAzhar J. Agric. Res. 3, 137-149.

Moharram, A. A. (1988). Reproductive and dairy performance of Holstein-Friesian cattle in Egypt. Dairy Sci. Abstract. 52(2), abstract No. 693.

Montgomery, G. W. (1985). An interaction between season of calving and nutrition on the resumption of ovarian cycle in postpartum beef cattle. Proceeding of the N. Z. society of Anim. Prod. 45, 43-48.

Nilforooshan, M. A. and Edriss, M. A. (2004). Effect of Age at First Calving on Some Productive and Longevity Traits in Iranian Holsteins of the Isfahan Province. J. Dairy Sci. 87:2130-2135

Oseni, S.; Misztal, I.; Tsuruta, S. and Rekaya, R. (2003). Seasonality of days open in US Holstein. J. Dairy Sci. 86, 3718-3725..

Osman, A. H. and Russel, W. S. (1974). Report on comparative performance of different grades of European Zebu cross-bred cattle at Ghurashi Dairy Farm, Sudan. Trop. Agric. (Trinidad) 51(4) 549-558.

Saeed, A. M.; Ward, P. N.; Light, D; Durkin, J. W. and Wilson, R. T. (1987). Characterization of Kenana cattle at Um Banein, Sudan. ILCA Research report, No. 16.

Smith, R. L. (1980). Ecology and field biology. 3rd edition, Harper & Row, Publishers, New York, pp835.

Snijders, S. E. M., P. G. Dillon, K. J. O'Farrell, M. Diskin, A. R. G. Wylie, D. O'Callaghan, M. Rath, and M. P. Boland. (2001). Genetic merit for milk production and reproductive success in dairy cows. Anim. Reprod. Sci. 65:17–31.

Stat Soft, Inc. (2001). *STATISTICA* (data analysis software system), version 6. www.statsoft.com.

Thatcher, W. W. (1974). Effects of season, climate, and temperature on reproduction and lactation. J. Dairy Sci. 57:360–368.

Williamson, G. and Payne, W. J. A. (1978). An introduction to animal husbandry in the tropics. 3rd edition. Longman group. U. K.

Authors:

HUSSEIN IBRAHIM ABUEISSA
MUZAMIL ATTA ALI

دراسة العوامل التي تؤثر علي الخصائص التناسلية لابقار اللبن الهجين في السودان

حسين إبراهيم أبو عيسي[1] ومزمل عطا علي [2]

[1] مركز بحوث الإنتاج الحيواني- حلة كوكو، [2] كلية الموارد الطبيعية والبيئية بجامعة جوبا

ملخص البحث

سجلات 301 بقرة هجين كنانة × فريزيان في الفترة بين الأعوام 1992 و2000 تم تحليلها لتقييم أثر عدد الولادات وموسم الولادة ونوع المولود علي بعض الخصائص التناسلية تشمل فترة الايام المفتوحة, عدد التلقيحات للحمل, فترة الحمل, والفترة بين الولادتين. سجلت النتائج أثر غير معنوي للعوامل تحت الدراسة علي الخصائص التي تم قياسها. كانت قيم فترة الايام المفتوحة, عدد التلقيحات للحمل, فترة الحمل, والفترة بين الولادتين 99.1 ± 40.5 يوم, 1.8 ± 1.2 تلقيحة, 279.0 ± 8.1 379.0 ± 41.38 يوم علي التوالي. وجد ان المواليد الذكور تقضي في الرحم كفترة حمل أقل من الإناث (278.0 ضد 280.0 يوم) وقد كان الفرق معنويا. المكافئ الوراثي لهذه الخصائص تم حسابه وقد كان0.16 ± 0.03 , 0.13 ± 0.02, 0.22 ± 0.02, 0.11 ± 0.03 , علي التوالي. ويوضح ذلك ان هذه الخصائص تحت تاثير العوامل المناخية والإدارية بالمزرعة اكثر من ان تكون تحت تاثير جينات الحيوان وقد أمكن ذلك من استنتاج ان الادارة الجيدة لهجين الفريزيان في المناطق المدارية تمكنها من اظهار خصائص تناسلية يمكن مقارنتها بخصائص أصولها الأجنبية.