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A Study of Some Factors Affecting the Age at First Calving and the Calving Interval of Different Sudan Zebu Breeds

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Abstract: One thousand one hundred and four primiparous Butana, Kenana and ½ Friesian x ½ Kenana cross-bred heifers born during the years 1953 to 1986 at three Research Centre in North Sudan (Atabara) and Central Sudan (Nisheishiba and Um-Banein) were studied for age at First Calving (AFC). Also 4230 calving interval (CI) records covering the years from 1957 to 1986 were studied. The overall means of age at first calving of Butana, Kenana and ½ Friesian x ½ Kenana crosses were 43.20±0.11 (SE), 53.60± 0.13 and 42.30±0.34 months, respectively. The breed effect between the AFC of Kenana and their crosses to Friesian was found highly significant ($p<0.001$). The heifers' own season of birth had no major effect. But their own year of birth was found highly significant ($p<0.001$) source of variation upon age at first calving. Kenana breed located at Nisheishiba was found significantly ($p<0.01$) younger at first calving (52.70 months) when compared to those at Um- Banein (55.00 months). On the other hand, the result on calving interval revealed overall means of Butana, Kenana and ½ Friesian x ½ Kenana- crosses as 12.60±0.06, 15.20± 0.04 and 14.80±0.12 month, respectively. Unlike AFC, the effect of breed on CI was not found a major one in comparing Kenana and their crosses. But the effects of season and year of calving were found to have major sources of variation upon calving interval. The effect of herd location on CI was not found significant for the Kenana breed at Nisheishiba (15.30 months) and Um-Banein (15.20 months) centres. The longest mean CI was found to occur between the first and second parities in all genotypes studied except for Butana where the sixth CI had the highest mean. This effect of parity was found highly significant. Sex of calf affected neither age at first calving nor calving interval.

Key words: Age at first calving, calving interval, Butana, Kenana, Friesian x Kenana crosses, Sudan

INTRODUCTION

Age at First Calving (AFC) and Calving Interval (CI) are the most important reproductive economical traits. The average productive life-time of a cow is a direct function of these traits. As well, they determine collectively with the other reproductive traits, the fertility of animals and success of livestock enterprises.

Both Butana and Kenana cattle (Northern and Central Sudan) are breeds of the Large East African short-horn Zebu as described by Renge and Tawah[1]. They resulted from the incursions of the Western Asiatic zebu (*Bos indicus*) with the older original wild long- horned cattle of Africa (*Bos africanus*) as reported by Bennet *et al.* [2] Atabani[3] pointed to Kenana cattle as a breed and Saeed *et al.* [4] reported full characterization for this genotype. Butana on the other hand is comparable to Kenana as regards descent, size and performance. The major phenotypic difference is the brownish colouration of the Butana instead of the greyish outer coat of Kenana. Butana breed however; inhabit the Butana plain which is a triangle covering parts of the Northern, Central and Eastern regions of the country while Kenana prevalence is the Fung Area (South East Central Sudan). The two breeds constitute about 24% of the total cattle population of the country. Crossbreeding of Kenana females by Friesian concerning calf performance and milk production traits was shown by Ahmed *et al.* [5].

The specific objective of the studies reported in this study was to determine the effects of dam breed ; season and year of dam own birth ; herd location and sex of calf on age at first calving and also the effect of dam breed; parity sequence ; season and year of calving, herd location and sex of calf on calving interval.

MATERIALS AND METHODS

Source of data: The data were collected from three Animal Production Research Centres namely Atbara (Butana breed), Nisheishiba (Kenana breed and ½ Friesian x ½

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Kenana crosses) and Um-Banein (Kenana breed). Atbara is situated in the eastern bank of the River Nile northern to River Atbara at latitude 17° 40 ' N, longitude 33° 58' E and altitude 345 meters above sea level. Nisheishiba and Um-Banein are located at the western bank of the Blue Nile river at altitude 14° 24′ N and 13° 04' N; longitude 33° 29' E and 33° 57' E and attitude 407 and 435 meters above sea level, respectively.

The climate at Atabara is mainly of the semi- desert. The annual rainfalls registered during the study period ranged from 1.1 to 238.9 mm with annual average of 90.1 mm. The highest and minimum means daily temperature were 42.8 and 14.4°C registered in June and January successively. However, Nisheishiba lies in the poor Savannah zone, with annual rainfalls range of 147.2 to 589.1 mm and an average of 307.9 mm. The highest mean daily maximum temperature of 41.5°C occurred in May while the lowest mean of 14.7°C was registered in January. On the other hand the climate at Um-Banein is mainly of Savannah zone. The annual rainfall ranged from 323 to 631 mm with a total annual average of 481 mm. The respective highest and lowest daily means temperature of 44.4 and 14.3°C occurred in April and January. Hence, the only drastic difference on the climate of the above centres was the quantity of rainfalls available. Some areas in each centre were artificially irrigated.

The major forages cultivated in the three centres were Abu-70 (*Sorghum bicolor*), Sudan grass (*Sorghum sudanense*), Lubia (*Dolicus Lablab*), Clitoria (*Clitoria ternatea*) and recently a sorghum hybrid forage (Pioneer 988). Also there was some limited area of Berseem (*Medicago sativa*) available for the herd of Atbara Centre. These fodders were mainly fed to the milking cows and the preweaned livestock in addition to some high quality roughages and hays of the abovementioned fodders. The herd of Um-Banein also had an access to sorghum stubbles and stover and cotton stubbles during early winter and natural grazing during the wet summer and early winter[4]. The dry livestock at the three Centres were fed low quality roughages and different types of hay added to any surplus of green feeds and concentrate premixes[4]. The concentrate rations were composed of wheat bran, crushed durra (sorghum) and/or wheat grains, oil seed cakes and recently molasses with some mineral salts and urea. This was fed according to milk production during and after milking. Steamed dams and peweaned stock had enough concentrates while other growing and dry stock had limited access to concentrates.

The animals at Atabara and Nisheishiba Centres were housed in metallic fences but those at Um-Banein were housed in fences made from local material of wood.

Hand milking was applied twice a day. Machine milking was tried over the three Centres.

Breeding was controlled using the best bulls selected according to the high merit of their dams milk productivity. For limiting inbreeding, sires from the surroundings were also introduced. An Artificial Insemination (AI) programme was applied using Friesian and limited semen of other breeds at Nisheishiba Centre since 1976. Heifers were normally introduced to the breeding stock at the age of 20 to 24 months. The milking cows were dried-off 60-days prior delivery. In the early days of the calves, natural suckling was allowed but later on artificial feeding of whole milk was the trend used at the centres at the rate of 10-12% of the calf's birth weight. Early weaning began during 1959 to 1976 in 6-months-age. Later a 2-months-age weaning was the routine, with the allowance of some concentrate supplementation. Calf mortality was negligible but increased afterwards due to bad hygienic measures. The culling programme applied enable 10 to 15% of the herd to be disposed off[4].

The records used in the analysis of variance consisted of cow identification number, breed, parity number, dam birth date and date of calving. Age at first calving in months, was calculated by computing the period between cow birth date and the date of its first calving. Computing the period between any two successive calvings derived calving interval. Three seasons namely winter (November to February), dry summer (March to June) and wet summer (July to October) were considered. Also the years of study were divided to three year- intervals due to the limited number of available records especially on records of age at first calving.

The total number of records consisted of 1104 first calving heifers of which 459 Butana from Atbara herd, 352 Kenana and 77 ½ Friesian x½ Kenana-crosses from Nisheishba herd and 216 Kenana from Um-Banein herd. These heifers were born during the years 1953 to 1986 inclusive. Calving interval was analyzed using 4230 records comprised of 1691 Butana, 1230 Kenana and 308 ½ Friesian x ½ Kenana-crosses from Nisheishiba herd and 1001 Kenana from Um-Banein herd. These data covered the period from 1957 to 1986.

Statistical analysis

Age at First Calving (AFC): Age at first calving was investigated using three different statistical models in the analysis of variance as follows:

- Butana (Atbara herd)

$$Y = \mu + F + G + FG + H + E_{ijkln\ i\ j\ k\ L\ ijkln}$$

Where:

Y = Age at first calving of nth heifer born during ijkln *i* th season; *j* th year interval and *k* th season x year-Interval interaction that calving *l* th sex of calf.

μ = Overall mean AFC common to all observations.

F*i* = Effect of i th heifers own season of birth (*i* = 1 for witer, 2 for dry summer and 3 for wet summer.
G*j* = Effect of *j* th heifers own year - interval of birth (*j* = 1,.,...., 11 year-interval).
FGk = Effect of k th heifers own season x year Interval of birth interaction (*k* = 1,..., 33 interaction subclass).
Hl = Effect of l th sex of calf (*l* = 1 for male and 2 for female).
E = *ijkln* th random error term.
Ijkln

- Kenana (Nisheishiba and Um-Banein herds):

$Y = \mu + F + G + FG + H + X + E$

ijklmn i j k l m ijklmn

In this model the herd effect (Xm) was added and the other effects are same to the first model.

- Kenana and ½ Friesian x ½ Kenana-crosses (Nishieshiba herd):

$Y = \mu + F + G + FG + H + B + E$

ijklmn i j k l m ijklmn

In this model the breed effect (B*m*) was added in place of herd effect and the other effects are the same in the second model.

Calving Interval (CI): On the other hand calving interval was also investigated using three different statistical models to analyze variance with the same arrangements followed in age at first calving as follows:

- Butana :

$Y = \mu + F + G + FG + H + X + E$

ijklmn i j k l m ijklmn

Where:
Y = Calving interval of nth cow gave birth during *ijklmn* the *i* th season, *j* th year-interval and *k* th season x Year-interval interaction, having *l* th sex of calf born in *m* th parity.
μ = Overall mean CI common to all observations.
F*i* = Effect of i th season of calving (same season as in AFC).
G*j* = Effect of *j* th year - interval of calving (*j* = 1,..., 10).
FG*k* = Effect of k th season x year-interval interaction (*k* = 1,...., 30).
Hl = Effect of l th sex of calf.
Xm = Effect of m th parity (*m* = CI between 1 and 2,..., 6 and 7+ parities).
E = *ijklmn* th random error term.
Ijklmn

- Kenana ((Nisheishiba and Um-Banein herds):

$Y = \mu + F + G + FG + H + X + A + E$

ijklmbn i j k l m b ijklmbn

In this model the herd effect (Ab) was added, all other effects are same as in the first model.

- Kenana and ½ Friesian x ½ Kenana- crosses:

$Y = \mu + F + G + FG + H + X + C + CX + E$

ijklmdrn i j k l m d r ijklmdrn

In this model the herd effect was replaced by the breed effect (Cd) and the breed x parity interaction (CXr) was added (r = 1,., 12 sub-classes). Other effects are same as in the second model.

In each of the abovementioned statistical models the effects included were fixed except for the error term, which is considered random with zero mean and variance sigma. These model were fitted using least squares methodology[6] with the aid of a 386 IBM compatible personal computer using SAS programme for the analysis of variance. Duncan's Multiple Range Test[7] reformed by Krammer[8] was also used for mean separation.

RESULTS

Age at First Calving (AFC): The overall means AFC±SE of Butana ; Kenana ; Kenana and their crosses to Friesian and ½ Friesian x½ Kenana were 43.20±0.11; 53.60±0.13; 50.9±0.14 and 42.30±0.34 months, respectively (Table 1). The difference between means of Kenana and their Friesian-crosses was highly significant ($p<0.001$). The heifers' own season of birth had effect on AFC of Kenana and Kenana added to their crosses. But the Butana heifers born during the dry summer (42.60 months) and wet summer (42.8 months) were significantly ($p<0.05$) younger at first calving compared to those delivered during the winter (44.90 months) season (Table 1).

The effect attributed to heifers own year-interval of birth on AFC was found to follow an inconsistent trend over the herds studied and found to had a major effect ($p<0.001$).

The interaction of season x year-interval was not significant source of variation upon AFC except for the Nisheishiba herd ($p<0.01$).

The effect of breed location (Table 1) was found significant ($p<0.01$) source of variation on Kenana first calving heifers. The overall means found for the two herds were 52.70 (Nisheishiba) and 55.00 (Um-Banein) months. Sex of calf was not found a significant factor on age at first calving.

Calving Interval (CI): The overall means CI±SE of Butana; Kenana; Kenana and their crosses to Friesian; and ½ Friesian x ½ Kenana-crosses were found to be

Table 1: The Effect of some Factors on Age at First Calving (AFC) of Butana ,Kenana and ½ Friesian x ½ Kenana-crosses (½Fx ½ K) at three different locations in the Sudan

	Butana (Atbara herd)	Kenana (Nisheishiba and U-Banein herds)	Kenana and ½Fx½ K (Nisheishiba herd)
Herd factor	Mean AFC±SE (months)	Mean AFC± SE (months)	Mean AFC±SE (months)
Breed			
Butana	43.20±0.11 (459)		
Kenana		53.60 ±0.13 (568)	
Kenana and ½ Fx½ K-crosses			50.9±0.14 (429)[a]
Kenana			52.70±0.16 (352)[a]
½ Fx½ K-crosses			42.30± 0.34 (77)[b]
Average SE			0.25***
Season[1]			
Winter	44.90 (155)[a]	54.20 (191)[a]	51.70 (146)[ab]
Dry summer	42.00 (195)[b]	52.70 (210)[ab]	49.40 (171)[ab]
Wet summer	42.80 (109)[b]	53.10 (167)[ab]	52.10 (112)[a]
Average SE	0.20*	0.23[NS]	0.25[NS]
Year [1]			
1953-56	56.30[a] (8)	-	-
57-59	44.60[e] (4)	-	-
60-62	49.20[b] (48)	54.5[ab] (53)	54.50[ab] (53) Kenana only
63-65	45.00[bc] (24)	54.30[ab] (42)	53.00[ab] (40)
66-68	38.5[d] (66)	49.80[e] (84)	52.00[b] (64)
69-71	39.00[d] (60)	56.40[a] (167)	56.20[a] (84)
72-74	37.00[d] (84)	55.00[ab] (62)	46.00[e] (34)
75-77	48.40[bc] (60)	52.40[b] (116)	44.70[e] (94)
78-80	45.10[bc] (24)	49.30[e] (38)	49.00[bc] (46)
81-83	48.00[bc] (40)	53.20[b] (6)	51.40[b] (12)
84-86	44.50[e] (41)	-	-
Average SE	0.49***	0.7***	0.74***
Location			
Um-Banein		55.00[a] (167)	
Nisheishiba		52.70[b] (352)	
Average SE		0.19**	

1= The heifers´ own season and year of birth . Values between brackets are the No. of heifers . * =p<.0.05,** = p< 0.01,*** = p<0.001. NS= Not Significant. Means followed by same script are not significantly different

Table 2: The effect of some factors on Calving Interval (CI) of Butana ,Kenana and ½ Friesian x ½ Kenana-crosses (½Fx ½ K) at three different locations in the Sudan

	Butana (Atbara herd)	Kenana (Nisheishiba and U-Banein herds)	Kenana and ½Fx½ K (Nisheishiba herd)
Herd factor	Mean CI±SE (months)	Mean CI± SE (months)	Mean CI±SE (months)
Breed			
Butana	12.60±0.04 (1691)		
Kenana		15.20 ±0.04 (2231)	
Kenana and ½ Fx½ K			15.00±0.06[a] (1309)
Kenana			15.20±0.06[a] (1001)
½ Fx½ K			14.80±0.12[a] (308)
Average SE			0.09[NS]
Season			
Winter	12.60[ab] (618)	15.10[b] (816)	15.00[b] (423)
Dry Summer	12.50[b] (643)	14.70[b] (832)	14.70[b] (527)
Wet Summer	12.90 (430)	16.10[a] (583)	15.70[a] (359)
Average SE	0.07*	0.07***	0.10**
Year			
1957-59	12.40[de] (65)	-	-
60-62	13.50[bcd] (100)	16.10[b] (11)	16.10[a] (11) Kenana only
63-65	12.00[e] (158)	13.70[d] (111)	13.70[a] (111)
66-68	11.80[e] (193)	13.70[d] (363)	13.30[d] (165)
69-71	12.50[cde] (215)	14.30[cd] (565)	13.80[cd] (174)
72-74	12.30[e] (269)	15.60[bc] (534)	15.30[bc] (266)
75-77	13.70[a] (130)	17.70[a] (289)	17.40[a] (163)
78-80	13.30[ab] (131)	16.30[b] (183)	17.10[ab] (150)
81-83	13.10[abc] (160)	16.20[b] (175)	15.20[bc] (203)
84-86	13.00[bcd] (270)	-	13.30[d] (66)½ Fx ½ K only
Average SE	0.13***	0.19***	0.2***

Table 2: Continued

Herd factor	Butana (Atbara herd) Mean CI±SE (months)	Kenana (Nisheishiba and U-Banein herds) Mean CI± SE (months)	Kenana and ½ Fx½ K (Nisheishiba herd) Mean CI±SE (months)
Location			
Um-Banein		15.20[a] (1001)	
Nisheishiba		15.30[a] (1230)	
Average SE		0.06[NS]	
Parity			
CI between			
1st and 2nd	12.90[a] (402)	15.90[a] (712)	16.00[a] (391)
2nd-3rd	12.10[b] (313)	15.30[ab] (521)	15.30[ab] (297)
3rd-4th	12.30[b] (226)	15.10[b] (354)	14.80[b] (219)
4th-5th	12.50[ab] (226)	14.70[b] (249)	14.70[b] (174)
5th-6th	12.80[a] (154)	14.80[b] (203)	14.40[b] (125)
6th-7th +	13.00[a] (411)	14.00[c] (192)	13.10[c] (103)
Average SE	0.10**	0.11***	h0.15***

Values between brackets are the No. of heifers . * =p<.0.05,** = p< 0.01,*** = p<0.001. NS= not significant. Means Followed by same script are not significantly different

Table 3: Effect of cow breed x parity-interaction on CI of Kenana and Friesian x Kenana-crosses at Nisheishiba herd

Parity No. CI-Between	Kenana (Mean±SE months)	½ Friesian x ½ Kenana (Mean±SE months)
1st and 2nd	15.70±0.12 (309)	17.30±0.23 (82)
2nd-3rd	15.50±0.15 (225)	14.50± 0.25 (72)
3rd-4th	15.10±0.17 (158)	14.10±0.24 (61)
4th-5th	15.20 ±0.19 (119)	13.50±0.24 (55)
5th-6th	14.20 ±0.19 (112)	13.60±0. 54 (13)
6th-7th +	14.50±0.19 (78)	12.20 ±0.30 (25)

** Overall Average SE = 0.23,-Values between brackets are the Number of CIs

12.60±0.04; 15.20±0.04; 15.00±0.06 and 14.80±0.12 months, respectively (Table 2).

The difference between Kenana and their ½ Friesian x ½ Kenana-crosses was not found significant, hence exclude any breed effect on this trait (Table 2).

Season of calving was found a significant source of variation upon CI over the herds studied. Table 2 shows that cows delivering during the dry summer had least calving intervals compared to those calved during the other seasons.

The effect of year–interval of calving however, found inconsistent and represented a major source of variation ($p<0.001$) on calving interval (Table 2).

The interaction of season x year-interval of calving was found a significant factor on CI of Kenana ($p<0.001$) and Kenana added to their ½ Friesian x ½ Kenana-crosses ($p<0.01$) but not on CI of Butana.

Unlike AFC, the effect of breed location on Kenana was found not significant on calving interval (Table 2).

The parity sequence was found to have a major effect ($p<0.001$) on calving interval. The longest mean CI found over the genotypes under discussion occurred between the first and second parities and between the sixth and seventh parities especially for the Butana breed (Table 2). However, the longest mean CI found was that of ½ Friesian x ½ Kenana crosses (17.30+0.23 months) occurred between the first and second parities (Table 3).

The effect of breed x parity interaction (Table 3) was found a significant ($p<0.01$) source of variation on CI of Kenana and their ½ Friesian x ½ Kenana-crosses at the Nisheishiba herd. Like age at first calving the effect of sex of calf had no effect on calving interval.

DISCUSSION

The management and husbandry of the herds at the three centres was generally the same. However due to the different ecological zone and the differences in climate, the availability and types of feeds, agricultural residues and natural grazing conditions affected the body conditions of the herds.

In order to make unbiased results and discussion each herd was investigated in its prevalence ecological zone represented by the three mentioned Centres except for Kenana breed (Nisheishiba and Um-Banein) which was furtherly studied so as to know the effect of breed location on the traits under discussion.

Age at First Calving: The mean age at first calving (AFC) of Butana (43.20 months) found in this study was close to the findings of Alim[9] who reported a mean of 44.0 months and slightly higher than that reported by Kalafallah and Khalifa[10] for a sample of the same herd (40.6 months) but, Khalifa and Shafei[13] reported a higher mean (50.3 months).

The overall mean of Kenana breed found (53.6 months) however, is higher than the averages reported by Atabani[3] and Saeed *et al.* [4] Their respective values were 51.0 and 50.1 months. Other authors reported shorter means[9,11-14]. The means of AFC found for the two indigenous breeds (Table 1) suggest that Butana breed are early maturing animals compared to Kenana. Age at first calving is a lowly heritable trait[15-17] and can be improved by selecting the appropriate local Sudanese breeds under discussion with an improved system of feeding[14]. The highly significant ($p<0.001$) effect of breed obtained on comparing AFC of Kenana (52.7 months) and their ½ Friesian x ½ Kenana-crosses (42.3 months) at the Nisheishiba genetic group (Table 1) indicates a successful positive heterosis which permit an interest also in genetic upgrading for this trait.

The results on heifers own season of birth had a minor effect on AFC (Table 1) and that was well supported by the results on season x year interaction found in this study and that of Khalafallah and Khalifa[10] and Elkhidir *et al.* [4] on Butana and Kenana breeds, respectively. But Wilson and Willis[18] and El-Said *et al.* [17] reported significant effect for this parameter successively in Brahman and Santa Gertrudis cattle studied in hot and humid ecological zone and also Holstein-Friesian in Temperate Zone (Hungary). Hafez and Dyer[15] however, attributed the effect of season to the environmental reflection upon heifers' performance, maturity and fertility.

The in between year-interval highly significant ($p<0.001$) differences found (Table 1) represent a year variation in management and in climatic condition which matches the result of El-Said *et al.* [17]

The significant ($p<0.01$) result of the effect of location (Table 1) on AFC of Kenana at Nisheishiba (52.7 months) and that of Um- Banein (55.0 months) was well supported[19]. The result found indicates full adaptation of Kenana breed between the poor and rich Savannah in concern to this trait.

The insignificant effect of calf sex excludes any correlation between this factor and age at first calving.

Calving Interval: The mean calving interval (C1) of Kenana breed found (15.2 months) lies between the figures reported by Khalafallah and Khalifa[20] and Saeed *et al.* [4] Their respective means were 14.4 and 16.1 months. Other authors reported shorter means[3,12,21].

On the other hand the mean CI of Butana breed found (12.6 months) supports well the value reported by Khalafallah and Khalifa[10], but differ from that reported by Alim[9]. Their, respective means were 12.5 and 13.8 months. These results on CI of Sudanese local genotypes (Table 2) also like AFC suggest that the Butana breed is superior in this trait compared to its homologous Kenana, each under their environment of location. And also their superiority extended up to their Holstein crosses if we compare the results shown by El Amin *et al.* [16] (441d decreasing by -25 to -31 for 50% Holstein cross-breds).

The insignificant breed effect found in the results of CI trait (Table 2), indicates that cross-breeding between Friesian and Kenana was not a successful genetic tool for upgrading. Since the trait was lowly heritable[20,15,16,] so, any variation in CI means could be attributed to a non-genetic factor and could be improved likewise AFC by improving the management systems.

The significant effect of season of calving (Table 2) on CI reflects the influence of nutrition and heat stress[15]. Most cows delivering through the dry summer will be expected to conceive during the wet summer; where there is some available green feeds added to the comparative low temperatures prevail. This would consequently shorten the service and so on CI period. But most cows delivering during the wet summer and winter seasons are expected to conceive respectively during winter and dry summer, the seasons of green feeds scarcity and the temperature stress during the dry summer. This would elongate the service and CI periods. The results on season effect were in line to those reported by Wilson and Willis[18]. However Khalafallah and Khalifa[20] reported insignificant effect of the factor on CI of Kenana breed.

Like AFC the in between year- interval differences found in CI (Table2) represented a year to year differences in management and climatic variations[18,20]. This was supported by the results found here in this study on the effect of the different seasons that interacting throughout the course year-interval.

The insignificant effect due to breed location (Table 2) on CI permit to adopt that Kenana breed tended to be adapted to the Fung area where the breed dominates and more over to Central Savannah zone (poor and rich) of Sudan considering the results on the two traits under discussion.

The highly significant ($p<0.001$) effect of parity and breed x parity interaction on CI (Table 2 and 3) was obviously observed in the first calving interval obtained means for the three genotypes under discussion. This could be attributed to the continuous concomitant growth of heifers after their first deliveries[15] versus the demands of heifers' fertility and lactation. Butana have also recorded longer CI means in late parities which matches the findings of El Amin *el al.* [16] which may be due to their early maturing and late performing tendency.

The insignificant effect of calf sex on CI had the same contribution discussed over age at first calving trait.

CONCLUSION

Age at first calving was found to be affected significantly by cow breed (Kenana and their crosses at Nisheishiba), cow year of birth and breed location (Kenana at Nisheishiba and Um-Banein). Cow season of birth was not an important factor and sex of calf had no effect on the trait.

Calving interval was found to be influenced significantly by season and year of calving and parity sequence, but the breed, breed location and sex of calf were not significant.

Butana breed was found superior to Kenana on both traits, considering that they were statistically investigated each on its natural location. Furthermore, Butana had shorter CI and a close mean AFC compared to ½ Friesian x½ Kenana-crosses each on its location (North and Central Sudan).

Cross-breeding between Friesian and Kenana had resulted in a highly significant improvement of the first hybrid (1st filial generation = F_1) concerning AFC. This would suggest an interest to continue genetic upgrading this trait collectively with the other important traits in dairy industry.

Future research programmes should be designed and applied in a way that should represent breeds with same purposes under same environments and management systems to explore their maximum potentialities and to measure traits under discussion and the other economical traits (reproductive and productive) added to improvement of the production environment aiming at increase performance efficiency. This can be applied and tied to molecular genetics programmes that complete a full database to begin improving not only dairy cattle but also all livestock genotypes.

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