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Factors affecting reproductive performance of crossbred dairy cattle at the Bambui regional centre of the institute of agricultural research for development Cameroon

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Abstract
The present study focused on identifying some of the factors which may be a significant source of variation for the duration between calving and first insemination (CFAI), the postpartum period also known as open days (OD) and calving intervals (CI) of crossbred dairy cattle in the western highlands of Cameroon. The crossbred cattle involved in this study were Jersey-White Fulani crosses, Holstein-Gudali crosses and their back crosses. Information on an interval of 7 years (1987-1993) from the database of IRAD Bambui Research Center were used in this study to distribute animals according to their reproductive performances. The General Linear Models procedures of SPSS 23 for windows were used to statistically analyze the data. Genetic and non-genetic factors such as germplasm, sex of the calf, parity of the dam, month of calving and service, season of calving and service, year of calving were found be a significant source of variation for the traits under analysis. Means for CFAI, OD and CI in this study were 72.23 ± 7.53 days, 76.18 ± 11.74 days and 345.60 ± 10.46 days (approximately 11.52 months) respectively. The average OD and CI recorded in this study for crossbred cattle were respectively lower than the 85-120 and 356 days researched in France. These observations showed that, it is possible to obtain inter-calving periods below or close to 365 days with crossbred dairy cattle with the condition to improve nutritional, reproductive and health management of animals. Holstein-Gudali crossbred dairy cattle had a better reproductive performances with crossbred dairy cattle having 50% and 75% of Holstein exotic blood (50%Hx50%G and 75%Hx25%G crossbred) recording the best performances. Thus, 50%Hx50%G recorded the best performances of 77.97 ± 9.69 days for CFAI. Moreover, 75%Hx25%G crossbred recorded the best performances of 102.54 ± 27.32 and 234.60 ± 28.56 days for OD and CI respectively. 12.6% of crossbred dairy cattle in this study had a CI length between 365 to 400 days, 58.3% had an earlier CI length below 365 days while 29.1% of this crossbred cattle had a late CI higher than 400 days. These results could be attributed to the performances observed with CIFAI and DO. 64.8% of crossbred dairy cattle involved in this study were inseminated before 60 days after calving and 62.2% of them conceived before 85 days postpartum. The high potential of Holstein crossbred dairy cattle observed trough good performances in CFAI, OD and CI as compared with Jersey crossbred in this study might be due to the better capacity of Holstein and thus their crossbred to adapt in difficult environment as in the tropics where exotic dairy cattle have a low resistant capacity to harsh conditions.

Keywords: Factors, crossbred cattle, reproductive performances, western highlands, Cameroon

1. Introduction
About 12 to 14% of the world population is estimated to live on dairy farms or within dairy farming households [1] The Cattle production sector is the main sector of the animal industry in Cameroon and plays an important socio-economic role. Approximately 10% of domestic products come from the livestock sector [2] of which cattle represent over 60%. In Cameroon, local zebu breeds are Red Fulani, White Fulani, and Gudali. These non-specialized breeds are used commonly as dual-purpose animals providing milk and meat [3]. Cross-breeding native cattle, often of *Bos indicus* type, with exotic *Bos taurus* cattle is now a widely used method of improving reproduction and production of cattle in the tropics [4].

Although indigenous cattle are well adapted to local production conditions, they are characterized by low growth rate and low productivity.

To improve the low productivity, high performance exotic dairy cattle (*Bos taurus*) were introduced in the early seventies [5]. This resulted in improved hybrids (exotic x local) produced at Wakwa in the Northern Highlands and at Bambui in the Western Highlands known for their harsh climate.

Duration between calving and first insemination (CFAI), the duration of postpartum interval also known as open days (DO) and the calving interval (CI) are the most important traits in cow-calf operations and significantly affects cattle breeding and production. Postpartum interval has some prospects for selection to reduce calving intervals as it has moderate to high heritability [6]. Furthermore, selection for reasonable postpartum periods will decrease the rearing period and the calving interval for cattle. Tropical cattle breeds generally have prolonged anoestrous (parturition to first observed oestrus or first service) periods. These lead to extended calving-to-conception intervals, which in turn cause long inter-calving periods [7]. Duration between calving and first insemination, postpartum interval also known as open days and the calving interval of crossbred dairy cattle Bambui regional centre of the Institute of Agricultural Research for Development of Cameroon have so far received little or no attention.

The aim of the present study was to contribute to the characterization of the Bambui Regional Centre of the Institute of Agricultural Research for Development crossbred dairy cattle, by determining its duration between calving and first insemination, the duration of postpartum interval also known as open days and the calving interval, as well as some of the genetic and non-genetic factors that could significantly affect this trait.

2. Materials and methods

2.1 Description of the study area

The study was carried out at the dairy cattle research section at the Bambui Regional Centre of Institute of Agricultural Research for Development. The Bambui Regional Centre is located at latitude 5°20' and 7°N, longitude 9°40' et 11°10' E. Research activities of the Centre cover the West and North West regions which form the Western highlands of Cameroon. The Western highlands of Cameroon also known as Western High Plateau cover an area of 31,150 km2, which is equal to 6.6% of the national territory. It is a hilly complex with altitudes ranging from 300 m for the lowest areas to above 3000 m above the sea. Weather is described as tropical. Annual rainfall varies from1500 to 3000 mm with a mean of 2000 mm per year. Mean relative humidity for the dry season is 52% and 70% for the rainy season, with an absolute minimum of 22%. The rainfall has a unimodal pattern and runs from mid-March to October. The dry season is fresh from November to December, then hot until mid-March. Soils are largely volcanic [8]. The Centre has managed pastures with natural or improved (exotic) areas of vegetation. Natural vegetation is made of elephant grass (*Pennisetum purpureum*), Kikuyu grass (*Pennisetum clandestinum*), *Hyperrhenia* sp. and *Sporobolus africanus*, which are common. *Leguminosae* include *Stylosanthes guyanensis*, *Stylosanthes scabra* and *Desmodium* sp. Among exotic *Gramineae* species introduced are: *Brachiaria ruziziensis*, *Panicum maximum* and Guatemala grass (*Trypsacumlaxum*).

2.2 Experimental Animal Management

The farming system was semi-intensive and breeding was done by artificial insemination (AI). The six animal genotypes used in this study were the results of crosses between exotic males Jersey (J) and Holstein (H) breeds with local White Fulani (WF) and Gudali (G) female breeds as follows: Jersey-White Fulani (50%Jx50%WF) and Jersey-White Fulani backcrosses (75%Jx25%WF); Holstein-Gudali (50% Hx50 % G) and Hostein-Gudali backcrosses (75%Hx25%G). During the rainy season (mid-March to October) animals were put on natural or improved pastures while in the dry season (November to mid-March), alongside grazing they were mainly fed silage made of Guatemala grass and *Pennisetum*, together with *Brachiaria* hay. Milking was essentially performed with milking machines twice a day, at 6 AM and 5 PM. During milking and immediately after, cows received 4kg (2kg in the morning and 2kg in the evening) of concentrate diet.

2.3 Data collection

The data used for analysis were collected over a 7-years period from (1987 -1993). Open days were estimated from the group of females who calve at least once. Each female was identified such that female records would give complete information on calf sex, dam parity, service and calving date. Calving first artificial insemination (CFAI) were calculated from date of last parturition to the first artificial insemination, while open days (OD) were calculated from date of last parturition to the next successful mating or conception date. CI were calculated from date of last parturition to the next parturition.

2.4 Data analysis

The effects of genetic and non-genetic factors affecting open days were subjected to analysis of variance of fixed effects using the General Linear Model (GLM) procedures of SPSS version 23. Turkey's multiple range test was used for testing the differences between least squares means.

The following models were used:

Model used for CI was:

$$Y_{ijklmn} = \mu + B_i + S_j + M_k + Y_l + P_m + e_{ijklmn}$$

Where Y_{ijklmn} is the observation on CI, µ is the overall mean, B_i is the fixed effect of dam blood level (i=50%Jx50%WF, 75% Jx25%WF, 85.5%Jx12.5%WF, 50%Hx50%G, 75% Hx25%G) S_j is the fixed effect of sex of the calf born (j=female, male), M_k fixed effect of calving month (k=January to December), Y_l is the fixed effect of the year (n=1987 to 1991), P_m fixed effect of dam parity (k=1 to 7) and e_{ijklmn} is the residual effect assumed to be independent and randomly distributed with a mean of zero and variance σ^2.

Model used for CFAI and OD was:

$$Y_{ijklmno} = \mu + B_i + S_j + M_k + MS_l + Y_m + P_n + e_{ijklmno}$$

Where Y_{ijkl} is the observation on CFAI and OD, µ is the overall mean, B_i is the fixed effect of dam blood level (i=50%Jx50%WF, 75% Jx25%WF, 85.5%Jx12.5%WF, 50%Hx50%G, 75% Hx25%G) S_j is the fixed effect of sex of the calf born (j=female, male), M_k fixed effect of calving month (k=January to December), MS_l fixed effect of service month (l=January to December), Y_m is the fixed effect of the year (n=1987 to 1991), P_n fixed effect of dam parity (k=1 to

7) and $e_{ijklmno}$ is the residual effect assumed to be independent and randomly distributed with a mean of zero and variance σ^2.

3. Results

Results of least square means (± SE) for CFAI and OD (days) of crossbred dairy cattle at the Bambui Regional Centre of Institute of Agricultural Research for Development of Cameroon represented in table 1 were 72.23 ±7.53 days and 76.18 ± 11.74 days respectively. While the overall mean for calving interval recorded in this study was 345.60 ± 10.46 days which is approximately 11.52 months.

There were no significant differences (p>0.05) in the open days (OD) between the different crossbred dairy cattle. However, results showed a significant difference (p<0.001) for CFAI between the various genetic groups of cattle involved in this study, with a linear increase of CFAI corresponding with an increase of exotic blood level. The genetic group of crossbred dairy cattle having Holstein exotic blood had a higher CFAI than the genetic group with Jersey blood. Crossbred dairy cattle with 75% of Holstein blood had the higher CFAI (113.92 ± 17.56 days) while cows with 50% of Jersey inherited blood had the lowest CFAI (51.99 ± 7.28 days). CI was ranged between 234.60 ± 28.56 days, the shortest calving interval registered and recorded by the 75%Hx25%G crossbred dairy cattle, and 390.83 ± 20.69 days, the longest period registered by 87.5%Jx12.5%WF crossbred dairy cattle with a significant (p<0.0001) difference of 156.23 days (approximately 5 months) between these two values.

Calf sex did not significantly (p>0.05) affect the duration of CFAI, OD and CI even though Cows that calved males had a CFAI of more than 1.26 days (72.96 ± 8.34 days) compared with cows that calved females (71.70 ± 8.30 days). Similarly, OD was 17.67 days longer (85.02 ± 12.60) after a male calf's birth than a female calf's birth (67.35 ± 13.29), and CI was 5.83 days longer (348.51 ± 11.99 days) after a male calf's birth than a female calf's birth (342.68 ± 11.63 days).

Month of calving and month of service had a highly significant (p<0.0001 and p<0.001) effect on CFAI, OD and CI of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle while. About the calving months, CFAI increased in January (178.61 ± 29.45days), March (140.52 ± 14.58 days), April (126.10 ± 21.69 days) and May (93.38 ± 15.82 days). This CFAI was relatively low during the mid-raining season (p<0.0001) and high during the early raining season (March, April and May) and mid-dry season (January). Similarly, OD was relatively short (24.05 ± 28.09, 83.30 ± 21.23, 37.50 ± 18.43 and 7.19± 19.38 days) during the mid-raining months (from June to August, and October respectively). It was also short during the mid-dry months December (71.60 ± 41.34 days) to January (70.06 ± 31.48 days). The month of October had the shortest (11.20 ± 13.81 and 7.19 ± 19.38 days) CFAI and OD respectively while the month of January had the longest (178.61 ± 29.45 and 70.06 ± 31.48 days) CFAI and OD respectively. Table 1 shows that, dry season tended to reduce CI contrary to rainy season or end of the rainy season. CI increased from April with 361.12 ± 22.77 days to November (389.88 ± 19.74 days) before decreasing from December (352.56 ± 26.41days) to March (294.07 ± 20.94 days). Therefore, the shortest (279.82 ± 24.11 days) CI was recorded in February while the longest (389.88 ± 19.74 days) was recorded in November.

Concerning the months of service, CFAI started increasing from September (105.44 ± 17.22 days) to February (121.64 ± 38.34 days) with the month of February having the highest value. CFAI decreased from March (73.61± 20.00 days) to August (74.37 ± 13.82 days) with the month of June showing the lowest value (13.62 ± 20.78 days) of CFAI. In the same way, OD started increasing (111.14 ± 15.85, 106.26 ± 22.33, 115.96 ± 28.18 and 158.09 ± 25.08 days) when rains started becoming infrequent (October, November, December and February respectively). The February month had the longest (158.09 ± 25.08 days) of OD meanwhile the month of June showed the shortest OD value (11.88 ± 24.73 days).

The effect of year was not a significant (p>0.05) source of variation for CFAI and OD of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle. With OD having a negative trend across years. Calving intervals varied significantly (p<0.05) over the years, with a clear negative trend in the calving interval over time (Table 1). During this period, the calving intervals remained constantly below 400 days with the longest CI (399.32 ± 19.60 days) observed in 1987. Results revealed a difference of 49.09 days (1.64 months) and 112.07 days (3.74 months) between the period of 1987 and 1992, and the period of 1987 and 1993 respectively.

Parity did not significantly (p>0.05) affect the duration of CFAI and OD. Whereas CFAI tended to increase with parity, OD tended to decrease as the cows got older. Inter-calving periods were significantly affected by the lactation rank (p<0.001). CI was reducing with the increase in the parity, with young females (heifers and cows at their second parity) tending to have a CI longer (362.38 ± 19.17 and 393.33 ± 13.71 days respectively) than multiparous cows. Thus, a difference of 68.82 days (2.3 months) was observed between the second parity which registered the highest CI value and the seventh parity (324.5 ± 24.83 days), although the shortest CI (321.21 ± 15.38 days) was observed at the parity 3.

Table 1: Least square means (± SE) for CFAI, OD and CI (days) of crossbred cattle

Source of variation	N	CFAI (days)	N	OD (days)	N	CI (days)
Overall	125	72.33 ± 7.53	119	76.18 ± 11.79	199	345.60 ± 10.46
Genetic group		**		NS		***
50%Jx50%WF	38	51.99 ± 7.28[a]	29	66.90 ± 14.95	72	361.92 ± 12.03[b]
75% Jx25%WF	41	54.54 ± 7.94[ab]	35	78.97 ± 16.00	56	370.54 ± 14.50[b]
87.5%Jx12.5%WF	8	63.22 ± 16.98 [abc]	8	48.23 ± 22.56	17	390.83 ± 20.69[c]
50%Hx50%G	27	77.97 ± 9.69[bc]	36	84.27 ± 14.24	38	370.10 ± 13.99[b]
75%Hx25%G	11	113.92 ± 17.56[c]	11	102.54 ± 27.32	16	234.60 ± 28.56[a]
Sex		NS		NS		NS
Male	56	72.96 ± 8.34	54	85.02 ± 12.60	100	342.68 ± 11.63
Female	69	71.70 ± 8.30	65	67.35 ± 13.29	99	348.51 ± 11.99
Calving month		***		***		**
January	3	178.61 ± 29.45	6	70.06 ± 31.48	7	342.17 ± 30.24
February	5	86.90 ± 24.01	6	97.49 ± 24.96	12	279.82 ± 24.11
March	14	140.52 ± 14.58	18	129.81 ± 18.87	18	294.07 ± 20.94
April	8	126.10 ± 21.69	10	104.83 ± 23.62	14	361.12 ± 22.77

May	19	93.38 ± 15.82	15	74.64 ± 23.90	22	326.76 ± 19.35
June	7	58.82 ± 18.92	7	24.05 ± 28.09	10	357.3 4 ± 25.73
July	12	53.60 ± 15.39	8	83.30 ± 21.23	17	369.67 ± 20.65
August	20	37.07 ± 14.81	16	37.50 ± 18.43	18	356.18 ± 20.13
September	14	45.47 ± 14.35	12	94.84 ± 18.07	18	357.64 ± 20.26
October	14	11.20 ± 13.81	14	7.19 ± 19.38	36	360.00 ± 15.10
November	6	59.59 ± 19.50	5	118.89 ± 28.93	18	389.88 ± 19.74
December	3	64.20 ± 29.23	2	71.60 ± 41.34	9	352.56 ± 26.41
AI month		***		***		
January	6	104.99 ± 23.10^{d}	4	36.23 ± 30.44	-	-
February	1	121.64 ± 38.34^{d}	6	158.09 ±25.08	-	-
March	4	70.63 ± 24.13^{c}	7	91.27 ± 23.78	-	-
April	8	73.61± 20.00^{c}	8	43.86 ± 25.66	-	-
May	9	70. 16 ± 17.83^{c}	7	40.13 ± 24.79	-	-
June	8	13.62 ± 20.78^{a}	9	11.88 ± 24.73	-	-
July	15	41.87 ± 14.79^{b}	14	86.74 ± 21.30	-	-
August	14	74.37 ± 13.82^{c}	11	95.43 ± 20.97	-	-
September	10	105.44 ± 17.22^{d}	5	66.54 ± 26.17	-	-
October	25	114.55 ± 12.91^{d}	27	111.14 ± 15.85	-	-
November	12	108.76 ± 15.88^{d}	13	106.26 ± 22.33	-	-
December	13	117.64 ± 14.51^{d}	8	115.96 ± 28.18	-	-
Year of calving		NS		NS		*
1987	17	66.19 ± 14.86	27	103.38 ± 17.17	20	399.32 ± 19.60^{c}
1988	24	77.17 ± 10.63	29	99.05 ± 12.57	30	381.09 ± 16.01^{c}
1989	31	74.37 ± 10.94	30	75.23 ± 12.60	31	351.84 ± 15.44^{b}
1990	39	77.36 ± 9.70	28	57.63 ± 14.50	50	367.10 ± 12.28^{b}
1991	14	66.55 ± 11.40	5	33.69 ± 27.91	40	350.88 ± 14.02^{b}
1992	-	-	-	-	12	350.23 ± 22.53^{b}
1993	-	-	-	-	16	287.25 ± 34.73^{a}
Parity		NS		NS		**
1	25	67.24 ± 8.45	24	94.35 ± 15.26	23	362.38 ± 19.17^{b}
2	25	86.01 ± 9.94	25	73.78 ± 16.08	44	393.33 ± 13.71^{c}
3	23	79.05 ± 9.67	23	54.27 ± 16.27	40	321.21 ± 15.38^{a}
4	23	70.54 ± 9.11	21	81.09 ± 13.95	34	339.22 ± 16.47^{a}
5	19	68.44 ± 10.86	13	77.19 ± 18.20	27	332.33 ± 18.04^{a}
6	8	76.57 ± 15.34	9	64.29 ± 22.17	17	346.22 ± 22.17^{a}
7	2	58.44 ± 27.70	4	88.31 ± 31.44	14	324.51 ± 24.83^{a}

a, b, c, d, e: Values carrying different superscripts within the cell are significantly different
N=number of observations, J= Jersey, WF=White Fulani, H=Holstein, G= Gudali, CFAI= calving first artificial insemination, OD=open days, CI=calving intervals
*** = Very highly significant (*P*<0.0001); * Significant (*P*<0.05); NS = Non-significant (*p*>0.05)

The means of CFAI for Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle were 39.02 ± 2.85, 69.29 ± 5.01 and 137.97 ± 4.13 days for the early (<60 days), recommended days (60-90 days), and the late days (>90 days) respectively. 64.8% of crossbred dairy cows recorded an average CFAI which were below the recommended interval of 60-90 days, 19.2% had an average above 90 days while only 16% fell within the recommended average range of 60 and 90 days (Table 2). 81.6%, 68.3%, 63.6% of 50%Jx50%WF, 75%Jx25%WF and 75%Hx25%G crossbred respectively were inseminated for the first time less than 60 days after calving. 36.4% and 75% of cows having respectively 75% of Holstein blood (75%Hx25%G) and 75% and 87.5% of Jersey exotic blood (87.5% Jx12.5%WF) were being inseminated for the first time above 90 days after calving. None (0%) of these cows were inseminated for the first time between 60 and 90 days after calving.

Table 2: Percentages distribution for CFAI, OD and CI ranges of crossbred cattle

Parameters ranges			Genetic groups					
			50%Jx50% WF	**75% Jx25% WF**	**87.5%Jx12.5% WF**	**50%Hx50% G**	**75%Hx2% G**	**Total**
CFAI Range (days)	Early (<60)	%	81.6	68.3	25.0	48.1	63.6	64.8
		Means ± SE	39.02± 2.85					
	Recommended (60-90)	%	10.5	22.0	0	25.9	0	16.0
		Means ± SE	69.29 ± 5.01					
	Late (>90)	%	7.9	9.8	75.0	25.9	36.4	19.2
		Means± SE	137.97 ± 4.13					
OD Range (days)	Early (<85)	%	79.3%	65.7%	50.0%	47.2%	63.6%	62.2%
		Means ± SE	49.24 ± 3.74					
	Recommended (85-120)	%	6.9%	14.3%	25.0%	8.3%	0	10.1%
		Means ± SE	97.07 ± 8.30					
	Late (>120)	%	13.8%	20.0%	25.0%	44.4%	36.4%	27.7%
		Means ± SE	167.89± 5.28					

CI Range (days)	Early (<365 days)	%	58.3	48.2	47.1	60.5	100	58.3
		Means ± SE	326.11± 4.16					
	Recommended (365-400)	%	12.5	17.9	23.5	5.3	0	12.6
		Means ± SE	367.68 ± 8.63					
	Late (>400)	%	29.2	33.9	29.4	34.2	0	29.1
		Means ± SE	482.64 ± 5.99					

N=number of observations, J= Jersey, WF=White Fulani, H=Holstein, G= Gudali, CFAI= calving first artificial insemination, OD=open days, CI=calving intervals

Percentages distribution for open days ranges represented in the table 2 revealed that 62.2% of crossbred dairy cattle in this study had a postpartum interval of 49.24 ± 3.74 days which was below 85 days, while 27.7% had an interval (167.89 ± 5.28 days) of more than 120 days, and only 10.1% of these cows had an interval (97.07 ± 8.30 days) between 85-120 days. The percentage (27.7%) of crossbred dairy cattle conceiving above 120 days was more than the recommended 10% suggested by Weaver [9].

The means of CI ranges recorded in this study were 326.11 ± 4.16, 367.68 ± 8.63 and 482.64 ± 5.99 days for the interval considered as early (<365 days), recommended interval (365-400 days) and the late interval (>400 days) respectively. 58.3% of calving intervals recorded in this study for Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle were lower than the 365 days recommended. Inter-calving length of more than 400 days was frequent and represented 29.1% of all the calving intervals recorded. While calving intervals comprised between 365 and 400 days were small and represented only 12.6% of all calving intervals recorded in this study. 50%Hx50%G and 75%Hx25%G crossbred dairy cattle had the highest (60.5% and 100% respectively) percentages of CI lower than 365. The highest (33.9%) percentage of crossbred dairy cattle having CI of more than 400 days was recorded with 75%Jx25%WF cattle, while the lowest (29.2%) percentage in this particular interval was recorded with 50%Jx50%WF crossbred.

Means for CI ranges of crossbred dairy cattle ranged between 298.87 days and 526.6 days. In the interval considered as early (<365), 75%Hx25%G crossbred dairy cows obtained the shortest (298.87 days) CI, meanwhile in the recommended interval (365-400 days) the shortest and more closer (368.5 days) to the early range was obtained in cows with 87.5% (87.5%Jx12.5%WF) of Jersey exotic blood. In the same way, crossbred cattle having 50% of Holstein exotic blood (50%Hx50%G) obtained the shortest CI which was closer (472.54 days) to the recommended interval, while the longest (526.6 days) CI observed after 400 days was obtained in crossbred dairy cows having 87.5% (87.5%Jx12.5%WF) of exotic Jersey blood.

4. Discussion

The overall least square mean estimated for CFAI in this study was 72.23 ± 7.53 days. This value was similar to finding of Bouzebda *and al.* [10] in Algeria, Ghoribi [11] in Algeria, and correspond to finding (68 to 79 days) observed in Tunisia by Bensalem *and al.*, [12] with Holstein cattle. The mean (76.18 ± 11.74 days) obtained for the open days (OD) is shorter than the means (248±6.02 days, 105.70 ± 7.31 and 266 ±7.40 days) obtained by Messine *et al.*, [13] with Gudali Zebu Cattle of the Adamawa Highlands of Cameroon, by Doko *et al.*, [14] with Girolando cattle in Benin and Bayou *et al.*, [15] with Sheko cattle in Southwest Ethiopia respectively. While the CI recorded in this study (345.60 ± 10.46 days approximately 11.52 months) was lower than the results obtained by Tawah and Mbah [16] with Gudali and White Fulani cattle; Kamga *et al.*, [4] and Djoko *et al.*, [17] with the same breeds, Kumar *et al.*, [18] with indigenous and Holstein crossbred dairy cows in Ethiopia, Mfopit *et al.*, [19] with Gudali cattle at Wakwa Regional Centre for Agricultural Research in Cameroon and Bayou *et al.*, [15] with Sheko cattle in Southwest of Ethiopia. CI was significantly (P<0.01 to P<0.0001) affected by all variables considered such as animals germplasm, month and year of calving, and the parity while the sex of calf was found to not significantly affect the CI. The average CI recorded in this study for crossbred cattle was below 400 days and was lower than the 365 days (12 months) researched in France. This result was similar to the finding of Galukande *et al.*, [20] and was therefore 1.5 time lower than the CI of local breeds. These observations showed that, it is possible to obtain inter-calving periods below or close to 365 days with crossbred dairy cattle with the condition to improve nutritional, reproductive and health management of animals.

Though no statistical difference (p>0.05) of OD between the different crossbred dairy cows. Was found, results showed a significant difference (p<0.001) for CFAI between the various groups of cattle involved in this study, with a linear increase of CFAI with the increase of exotic blood level. Genetic group of crossbred dairy cattle having Holstein exotic blood had CFAI higher than the genetic group with Jersey blood with crossbred dairy cattle. Crossbred dairy cattle with 75% of Holstein blood had the higher CFAI (113.92 ± 17.56 days) while cows with 50% of Jersey heritance blood had the lowest CFAI (51.99 ± 7.28 days). In fact, in climatic environment with good sanitary conditions, crossbred cattle having a high blood percentage of exotic dairy cattle could reduce considerably their intervals between calving and first mating. But, in a difficult environment as in the tropics where exotic dairy cattle have a low resistant capacity to harsh conditions [21], their reproduction was low as compared with crossbred cattle having low exotic blood. The results revealing a statistical difference (P<0.0001) among the various genetic groups involved in this study were different from the finding of Kamga *et al.*, [4] and Djoko *et al.*, [17] with the same breeds and Doko *et al.*, [14] with Girolando crossbreds, which revealed no significant difference between crossbreds. Thus, the shortest inter-calving length registered between two calving (234.60 ± 28.56 days) was performed by 75%Hx25%G crossbred dairy cattle meanwhile the longest period registered (390.83 ± 20.69 days) was performed by 87.5%Jx12.5%WF crossbred dairy cattle. These crossbred dairy cattle CI were lower than the CI (539.7 ± 0.6 days, 603 ± 227 days and 522 days) obtaining by Messine *et al.*, [22] with Gudali cattle in Ngaoundéré, Mfopit *et al.*, [19] with Gudali cattle at Wakwa Regional Centre for Agricultural Research in Cameroon and Bayou *et al.*, [15] with Sheko cattle in Southwest of Ethiopia respectively. Thus the longest CI characteristic of African cattle could be reduced trough crossbreeding programs coupled with the improvement in animals' management such as nutrition, reproduction and health. This could be also due to the fact that environmental conditions such as the climate on the Cameroon Western

Highlands favored a better expression of certain potentials compared to other zones of studies.
Although calf sex did not significantly ($p>0.05$) affect CFAI, OD and the inter-calving period, these periods were longer after a male calf's birth than a female calf's birth. Male calves are usually heavier at birth [23] and tend to grow faster than female calves. The faster growth of male calves is then accomplished through a larger intake of milk, which increases the nutritional stress on the cow, resulting in additional inhibitory action on the resumption of the ovarian activity and therefore lengthens the opened day's length which is related to CI.
Month of calving and month of service had bot a highly significant difference ($p<0.0001$) effect on CFAI and OD of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle. Lowest values (11.20 and 13.62 days in October and June respectively) of CFAI were observed in the mid-raining season while highest values (178.61 and 121.64 days in January and February respectively) were observed in dry season months in this case both for calving and service months. Similarly, lowest values (7.19 and 11.88 days in October and June respectively) of OD were observed in the raining months while highest values (129.81 and 158.09 days) were observed during the late dry season in March, and in the dry month of February respectively, this for both calving and service months. Crossbred dairy cattle that were bred at the middle of rainy season calved at the end of the onset of the rainy season (April to May). These crossbred dairy cattle were thus be lactating when feed excess was at its peak (rainy season), and did not need a longer time to restore their body reserves. This could explain why these crossbred dairy cattle had the shortest CFAI and OD, compared to crossbred dairy cattle conceiving later in the rainy season. Crossbred dairy cattle that were actually bred later in the rainy season or earlier in the dry season (March, April, November or December) started calving from the end of August to the end of January. They then had low chance of being rebred during the same mating season, as pastures are not available in quantity and when the nursing, cows are at their peak of production. The season, through its effect on the availability of feed, plays an important role in postpartum interval in cattle. It has been reported that, dairy cows are in a phase of negative energy balance during the first few weeks following calving as the feed consumption does not meet the nutritional needs of lactation [24]. This negative energy balance would be aggravated with Jersey-White Fulani and Holstein-Gudali crossbred dairy cows calving late in the rainy season or at the beginning of the dry season, when forage from natural pastures turn out to be less available and the dam is losing weight [25]. Nutritional management during the transition period if possible 3 weeks before and 3 weeks after parturition, is thus of great importance as it may have significant carry-over effects on reproductive efficiency during the subsequent mating season.
Month of calving was found to significantly ($p<0.001$) affect the CI. The dry season tended to reduce CI contrary to rainy season or end of the rainy season (Table 1). The calving period despite the fluctuation across months, increased from April (361.12 ± 22.77 days) to November (389.88 ± 19.74 days) before decreasing from December (352.56 ± 26.41days) to March (294.07 ± 20.94 days). Therefore, the shortest (279.82 ± 24.11 days) CI was recorded in February while the longest (389.88 ± 19.74 days) was recorded in November. These findings are similar to those obtained by Mfopit *et al.*, [19]. This reduction of CI during the dry season months could be due to the fact that, cows that calved in the rainy season and earlier in the dry season (from April to November), when the breeding season arrive, they were not yet ready and waited for the next season. While those that calved in the middle of dry season and later in the dry season (December to March) were ready as they could benefit from the growth of grass with the beginning of rains and were also complemented with good quality forage as soon as weather conditions became difficult.
Year was found to be a non-significant ($p>0.05$) source of variation for CFAI and OD of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle. This observation was contradictory from the findings of Doko *et al.*, [14] reporting a significant difference of OD across years with Girolando cattle in Benin. CI varied significantly ($p<0.05$) over the years. This finding was similar to result obtained by Djoko *et al.*, [17] and Doko *et al.*, [14] who found a significant effect of years on CI. Results revealed a clear negative trend in the calving interval over time (Table 1), with a difference of 49.09 days (1.64 months) and 112.07 days (3.74 months) between the period of 1987 and 1992, and the period of 1987 and 1993 respectively. Interannual variations observed with CI could be attributed to fluctuations in feed (pastures) availability and quality through the seasons, to changes in the quality and availability of concentrate supplements and maize silages offered to animals over the years, or to variations in the genetic structure of the herd from one year to another. In addition, these decrease of CI across years might be associated with changes in temperature and relative humidity across years.
Parity was found to non-significantly ($p>0.05$) affect CFAI and OD and significantly ($p<0.001$) affect CI. OD and CI reduced when parity rank increased, with young females (heifers and females at their second parity) tending to have a longer OD and CI than multiparous cows. Same results were obtained by Kamga *et al.*, [4] with the same breeds, Demeke *et al.*, [26] with indigenous and crossbred cows in Ethiopia, Doko *et al.*, [14] with Girolando crossbreds in Benin, Kumar *et al.*, [18] with indigenous and Holstein crossbred dairy cows in Ethiopia, Mfopit *et al.*, [19] with Gudali cattle at Wakwa Regional Centre for Agricultural Research in Cameroon and Bayou *et al.*, [15] with Sheko cattle in Southwest of Ethiopia. According to Bulman and Wood [27], the general declining trend of OD and the length of CI with the advance of parity and the incidence of silent estrus was highest in the primiparous cows and decreased with the increase of parity could be attributed to the lower energy balance as young cows or heifers are notable to consume more for their own growth, production, reproduction and maintenance, thus lower energy balance delays the onset of postpartum heat and increase the CI. The shortest calving interval in 7th parity might be due to their physiological maturity that contributed to have shorter CI.

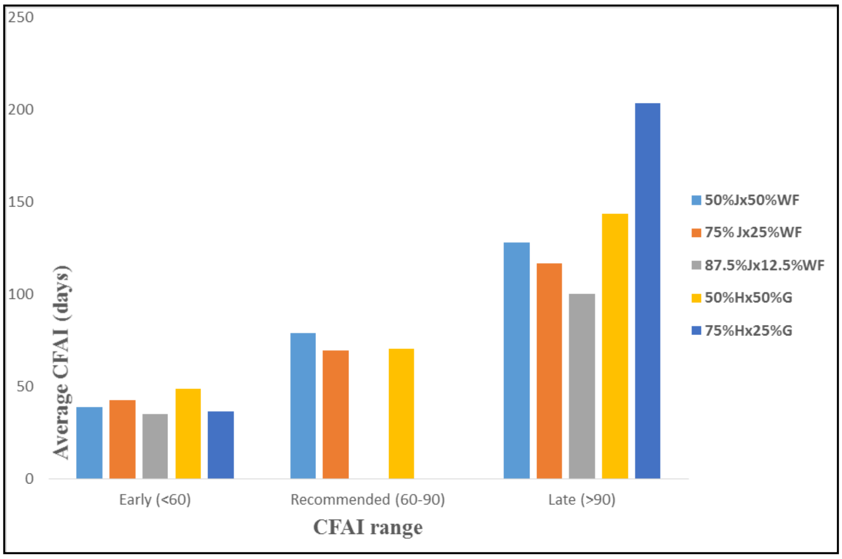

Fig 1: Average distribution for calving intervals first AI (days) ranges

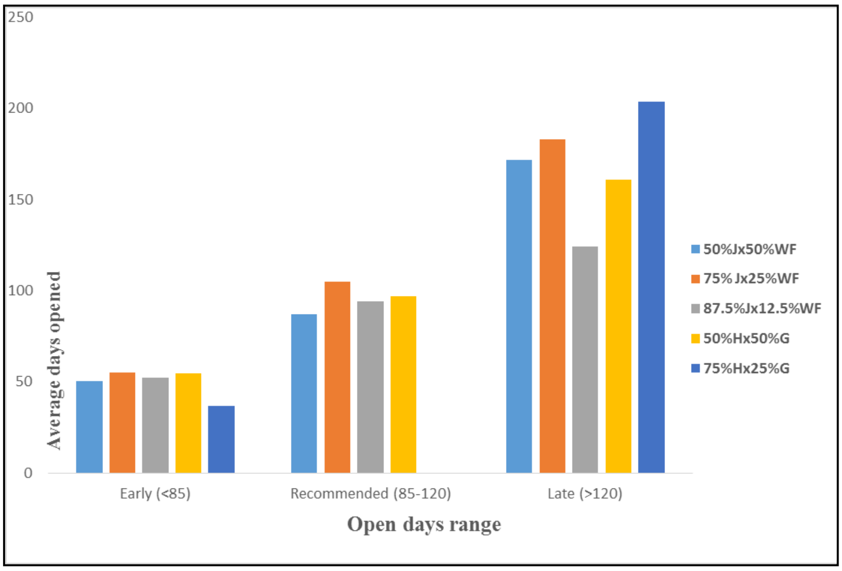

Fig 2: Average distribution for OD (days) ranges

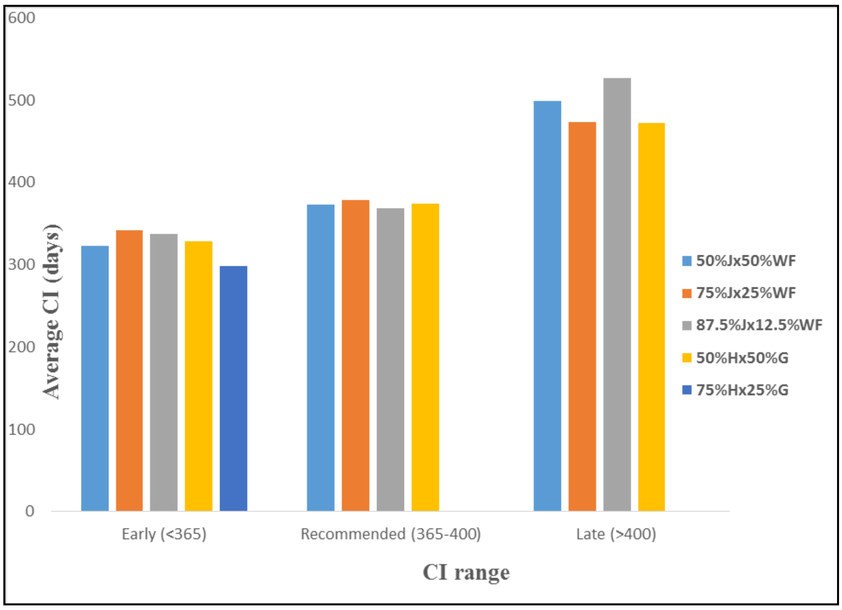

Fig 3: Average distribution for CI (days) ranges

The percentage (16%) of crossbred dairy cattle being inseminated in the 60 days post-partum was low compared with finding of Gilbert *et al.,* [28] (more than 90%), but, was closer to the findings of Ghoribi [11] with Holstein cattle. 62.2% of crossbred dairy cattle had an OD mean (49.24 ± 3.74 days) shorter than the 85-120 days recommended, while 10.1% of crossbred dairy cattle had a OD mean (97.07 ± 8.30 days) included in the recommended value, and 27.7% had a OD mean (167.89 ± 5.28 days) longer than the recommended value. According to Ghozlane *et al.,* [29], the high percentage (>50%) of cows having CFAI period lower than the 60-90 days recommended and the short OD observed in this study could be the consequence of an early reproduction onset which could be due to the improvement in herd management processes and incorporation of feed supplementation. This may also be attributed to short oestrous cycles that in some cases follow parturition with normal ovulations and ova release in thus to pregnancy in case of any insemination. The percentage (27.7%) of crossbred dairy cattle which were not successfully inseminated after 120 days was more than the 10% recommended by Weaver [9] gives an idea on the failure of reproduction. Table 2 revealed that 12.6% of crossbred dairy cattle in this study had a CI length between 365- 400 days. 58.3% had an earlier CI length below 365 days while 29.1% of this crossbred cattle had a late CI higher than 400 days. These results could be attributed to the decrease observed previously with CIFAI and DO. 64.8% of crossbred dairy cattle involved in this study were inseminated before 60 days after calving and 62.2% of them conceived before 85 days postpartum. But, according to Seegers *et al.,* [30], an inter-calving of more than 400 days should not extend 15 percent (15%). This CI (29.1%) above 400 days could be attributed to problems related with reproductive management coupled with the non-respect of dry off (milking all over the year) increase the postpartum period.

5. Conclusion

Factors identified which considerably influenced the duration between calving and first insemination (CFAI), the postpartum period also known as open days (OD), the gestation length (GL), and calving intervals (CI) of crossbred dairy cows were the genetic groups, seasons, months of service and calving, years of calving and parities. The crossbreeds of Jersey and Holstein cattle, were characterized by different adaptability capacity at the Bambui Regional Centre of Institute of Agricultural Research for Development of Cameroon, which like most of the tropical environment are characterized by marked seasonal variations in rainfall, resulting in a large variation in the quantity and quality of feed available for grazing animals.

Genetic groups significantly affected CFAI of crossbred dairy cattle involved in this study. A linear increase of CFAI and OD with the increase of exotic blood level was observed. Crossbred dairy cattle having Holstein exotic blood had higher and better CFAI and OD than the genetic group with Jersey blood.

The overall mean for CI of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle recorded in this study (345.60 ± 10.46 days approximately 11.52 months) was lower than CI obtained with indigenous breed in Cameroon. Thus the longest CI characteristic of African cattle could be reduced trough crossbreeding programs coupled with the improvement in animals' management such as nutrition, reproduction and health. Month of calving, years and parities were found to significantly affect the CI. The dry season tended to reduce CI contrary to rainy season or end of the rainy season. A variation in the ideal calving season (rainy or dry) has been noted with month of calving and service having bot a highly significant effect on CFAI and OD of Jersey-White Fulani and Holstein-Gudali crossbred dairy cattle. There should be a determination of the ideal breeding season. The corresponding mating season should be planned in such a way that both the reproduction of the cow and the well-being of the calf are warranted.

OD and CI was reduced with increasing number of parity with young females (heifers and females at their second parity) tending to have a longer OD and CI than multiparous cows with the shortest calving interval in 7th parity. 12.6% of crossbred dairy cattle in this study had a CI length between 365 to 400 days, 58.3% had an earlier CI length below 365 days while 29.1% of this crossbred cattle had a late CI higher than 400 days. These results could be attributed to the decrease observed previously with CIFAI and DO. 64.8% of crossbred dairy cattle involved in this study were inseminated before 60 days after calving and 62.2% of them conceived before 85 days postpartum. Holstein-Gudali crossbred dairy cattle had a better reproductive performances. According to this study, Gudali is preferable than white Fulani for the local breed and Holstein as the exotic breed for crossbreeding programs. Values obtained with Holstein crossbred dairy cattle confirmed the high potential of these crossbreeds and their adaptability in tropical milieu.

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