Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 1639-1645
Received: 01-09-2019
Accepted: 05-10-2019

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Reproductive performance of FG GIR Halfbred

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Abstract
The data on reproduction and production traits of FG crosses of Gir maintained at R.C.D.P. on cattle, M.P.K.V., Rahuri (Maharashtra) were collected from year 1972 to 2014. The overall least squares means of AFC for FG genetic group were 971.07±16.41days. In FG, half-bred the DMRT indicated that the heifers born during P2 (1980-1985) (883.17±16.97) and P6 (2004-2009) (903.75±30.17) had significantly lower AFC (days), than born in P4 (1992-1997) (1095.17 ± 31.79) and P3 (1986-1991) (1051.50±40.08). The variation due to season of birth in AFC was non-significant in FG genetic group. Although the lowest AFC was observed in heifers born during Rainy season (965.36±21.61 days). Significantly lowest AFC was noticed in G1 generation cows (816.53±14.16). The overall least squares mean of OP, it was 76.55±2.08 days. The non-significant effect of period of calving, season of calving, lactation order and AFC group on OP observed.
The overall LSQ means of SP in FG genetic group cows was 133.26±1.84 days. The variation due to SOC, LO and AFC group on SP was non-significant. The effect of generation was significant on SP. In FG group the lowest SP observed in G_8 (98.00±18.87) while highest in G_4 (150.14±4.67). The overall least squares means of CI in FG, group cows were 409.28±2.67 days. The Generation wise least squares means for highest CI in FG group observed in G_8 (435.63 ± 23.63), days. While the lowest CI observed in G_5 (402.57 ± 7.37) days, respectively. The effect of genetic group was significant on CI of group.

Keywords: GIR crossbred, age at first calving, open period, service period, calving interval

Introduction
India ranks first in milk production accounting for 18.5% of world production, achieving an annual output of 165.4 million Tones during 2016-17. The average daily milk yield for crossbred cattle is better at 7.1 kg per day, but still significantly lesser than the best of global standards *viz*. UK, US and Israel having 25.6, 32.8 and 38.6 kg per day, respectively. India's estimated demand for milk is expected to be about 155 MT by 2016-17 and 200 MT in 2021-22 (Anonymous, 2014) [6]. With the increasing population in worldwide and need to increase milk production, the introduction of high-yielding breeds plays an important role in protein needs supplying.
One of the best methods for solving this problem could be crossbreeding. Gir cows had been used as foundation stock to produce a breed of cow which should have minimum milk production of 2000 kg per lactation with a herd average of 3200 kg per lactation and fat content in milk should not be less than 3.5 per cent. Gir cows were bred with frozen semen of progeny tested Jersey, Holstein Friesian and Brown swiss bulls to generate half-breeds.

Methods and Material
The data were collected from the history and pedigree sheets maintained at Research Cum Development Project on Cattle, M.P.K.V., Rahuri, Dist. - Ahmednagar (MS), for the period of 43 years (1972 to 2014) on reproduction traits of Gir crosses.

Reproductive traits - Age at first calving (days), Open period (days), Service period (days) and Calving interval (days). The data were classified according to genetic group, generations, season of birth / calving, period of birth / calving, age at first calving and lactation order. The details as below

1. Generation under study: The following generations were considered for estimation of least square means for production and reproduction traits.

Genetic group	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8	G_9
FG: 50% HF + 50% Gir	FG	IH	3IH	4IH	5IH	6IH	7IH	8IH	9IH

2. Season of birth/calving: As per climatic conditions of the farm the data of each year were divided into three seasons as under

Season	Months	Code
Rainy	June- September	S_1
Winter	October-January	S_2
Summer	February-May	S_3

3. Period of birth: The data pertains to 43 year from 1972 to 2014 were divided into different groups according to period of birth as under

Periods Genetic groups	P_1	P_2	P_3	P_4	P_5	P_6	P_7
FG	1972-77	1978-83	1984-89	1990-95	1996-01	2002-07	2008-13

4. Period of calving: The data generated from 1974 to 2014 were divided into different groups according to period of calving as under

Periods Genetic groups	P_1	P_2	P_3	P_4	P_5	P_6	P_7
FG	1974-79	1980-85	1986-91	1992-97	1998-03	2004-09	2010 -2014

5. Lactation order: The parity wise data were collected up to 7th lactation of animal maintained at the farm and coded as below

Lactation order	Code
First Lactation	L_1
Second Lactation	L_2
Third Lactation	L_3
Fourth Lactation	L_4
Fifth Lactation	L_5
Sixth Lactation	L_6
Seventh Lactation	L_7

6. Age at first calving: The age at first calving was classified into following groups

Sr. No.	AFC (days)	Code
1	< 800	A_1
2	801 to 850	A_2
3	851 to 900	A_3
4	901 to 950	A_4
5	951 to 1000	A_5
6	1001 and above	A_6

Analysis was carried out by using least squares analysis method for non-orthogonal data as described by Harvey (1990). The following mathematical model was used.

Model I

$$Y_{ijk} = \mu + P_i + S_j + e_{ijk}$$

Where,

Y_{ijk} = Observations on age at first calving of k^{th} animal belonging to i^{th} period of birth and j^{th} season of birth
μ = Overall population mean
P_I = Effect of i^{th} period of birth (i =1, 2,----,n)
S_j = Effect of j^{th} season of birth (j = 1, 2 and 3)
$e_{ij\,k}$ = Random error associate with NID (0, $\delta^2 e$)

The DMRT as modified by Krammer (1957) was used for testing differences among least squares means. The differences were considered significant if

$$X_i - X_j = SQRT\,[\,2/(C_{ii} + C_{jj} + 2C_{ij})] > 6eZpn_2$$

Where

X_i and X_j were the least square means for i^{th} and j^{th} treatment, and C_{ii}, C_{jj} and C_{ij} were diagonal and off-diagonal elements in the inverse of coefficient matrix in the least squares normal equations.

Results and Discussion

Reproduction traits

The data pertaining to FG genetic group reproduction traits consists of age at first calving (AFC), open period (OP), service period (SP) and calving interval (CI) were analyzed by least squares technique tostudy the effect of non-genetic factors *viz*., period of birth / calving, season of birth / calving and lactation order on the traits under study.

1. Age at first Calving (AFC)

The age at first calving is an important economic trait in dairy cows. The results pertaining to the least squares means according to season of birth, period of birth, generation and genetic group are presented in Table 1.

The overall least squares means of AFC for FG genetic group was 974.48 ± 8.31days. These results were in close agreement with Jadhav (2009) [19] in FG, However higher values reported by Mhasade (2010) [24] and lowest AFC days reported by Garudkar (2015) [16] and Kamble (2015) [22].

2. Effect of period of birth (POB)

In the present study, AFC was significantly (P<0.01) influenced by period of birth in FG group of cows. These results were in consonance with Zol (2007) [21] and Ambhore *et al.* (2016) [3] in Phule Triveni, Jawale (2015) [20] in 5/8 Gir crossbred.

In FG, halfbred the DMRT indicated that the heifers born during P_1 (1974-1979) (892.74 ± 7.41) and P_2 (1980-1985) (876.47 ± 7.80) had significantly lower AFC (days), than born in P_3 (1986-1991) (1026.97 ± 10.24), P_4 (1992-1997) (1056.16 ± 16.51), P_5 (1998-2003) (989.10 ± 26.82), P_6 (2004-2009) (1016.88 ± 40.47) and P_7 (2010-2014) (963.03 ± 23.48). The differences in AFC among heifers born during P_3, P_5, P_6 and P_7 were at par with each other.

3. Effect of season of birth (SOB)

The variation due to season of birth in AFC was non-significant in FG group these results were in agreement with Zol (2007) [21] in Phule Triveni, Jadhav (2009) [19] in Gir crossbred, Garudkar (2015) [16] in Gir crossbreds and Mote (2017) [25] in FG, IFG, FJG and IFJG groups.

Although the effect of season of birth on AFC was non-significant the lowest AFC was observed in heifers born during winter season (960.38 ± 10.24 days) in FG.

4. Effect of generation

The analysis of variance showed that generation had highly significant effect (P<0.05) on AFC of FG genetic group of Gir crossbred cows (Table 2). As pertains to AFC significantly lowest AFC was noticed in G_1 generation cows of both FG (819.91 ± 6.24) However, in FG group the highest AFC noticed in G_8 (1037.18 ± 44.17).

5. Open period (OP)
Open period is an important economic trait in dairy cows. The results pertaining to the least square means according to non-genetic factors, generation are presented in Table 4. The overall least squares mean of OP in FG group was 76.55 ± 2.08 days.
These results corroborated with Chavhan (2010) [26] in FG and Kamble (2015) [22] in FG and FJG and their *inters*e.

6. Effect of period of calving (POC)
Open period of cows calved in P_6 (67.33 ± 11.56) period of calving it was lowest and in P_3 (84.58 ± 2.52) it was highest in FG group.

7. Effect of season of calving (SOC)
The non-significant effect of season of calving on open period in FG genetic group. It showed that the year round climatic conditions were similar. Similar results were reported by Kamble (2015) [22] in FG, FJG and their *interse*. However in FG lowest OP observed in S_3 (Feb-May) 75.52 ± 2.40 while highest OP in S_2 (Oct-Jan) 78.50 ± 2.46 days.

8. Effect of lactation order (LO)
In FG lowest OP observed in L_7 (68.92 ± 5.15) while highest OP observed in L_5 (80.45 ± 3.71).

9. Effect of AFC group
In FG lowest open period observed in A_6 (1001 and above) 72.96 ± 2.51, while highest open period observed in A_3 (850 to 900) 80.46 ± 3.75 days.

10. Effect of generation
In FG the lowest OP observed in G_1 (67.66 ± 1.98), G_7 (68.06 ± 4.20), G_8 (65.73 ± 6.48) and G_9 (62.40 ± 9.76) which were at par with each other while significantly higher open period observed in G_6 (82.77±4.02) Similar results were reported by Kamble (2003) in Gir crossbreds.

11. Effect of genetic group
The DMRT revealed that the mean open period (days) in FG (78.25 ± 0.96) was significantly higher and similar results were reported by Chavhan (2010) [26] in FG and Kamble (2015) [22] in FG, FJG and their *interse.*

12. Service period (SP)
Service period as a component of calving interval, it influences reproductive efficiency and thus has a bearing on lifetime production of dairy animals. The least squares means according to season of calving, period of calving, lactation order, generation are presented in Tables 5.
The overall least squares means of Service period in FG genetic group cows were 133.26 ± 1.84 days. The present results resembled with Jadhav (2011) [18] in FG (144.51± 8.45) and Kamble (2015) [22] in FG (141.67 ± 4.81) and in *interse* of FG (138.65 ± 4.76).

13. Effect of period of calving (POC)
The overall least squares means of Service period in FG group cows was 137.56 ± 3.78 days. The cows calved during the period P_7 shows lowest (126.05 ± 7.86) SP while P_3 shows highest SP (149.50 ± 4.57).
The non-significant effect of period of calving on service period was reported by Garudkar (2015) [16] in FG, IFG, FJG and IFJG and Kamble (2015) [22] in FG, FJG and their *interse*.

14. Effect of season of calving (SOC)
In FG group the lowest service period was observed in cows calved during S_1 (Jun – Sept) (133.73 ± 4.65) rainy season followed by S_2 (Oct – Jan) winter (138.98 ± 4.47) and summer season (139.99 ± 4.35) days. Similar, results were reported by Zol (2007) [21] in 'Phule Triveni' cows and Jadhav (2011) [18] in Gir crossbreds.

15. Effect of lactation order (LO)
The analysis of variance revealed that lactation order had non-significant effect on service period in FG group. These results corroborated with Jadhav (2009) [19] in HF x Gir halfberds. Whereas, contradictory result was reported by Kamble (2015) [22] in FG, FJG and their *interse*

16. Effect of AFC group
The analysis of variance revealed that the age at first calving had a non-significant effect on service period in FG group. These results corroborated with Kamble (2015) [22] in FG, FJG and their *interse.*

17. Effect of generation
Analysis of variance revealed that the effect of generation was significant on service period in FG genetic group. In FG group the lowest SP observed in G_8 (98.00 ± 18.87) while highest in G_4 (150.14 ± 4.67) while G_1, G_3, G_5 and G_7 are at par with each other. The results were in consonance with Kamble (2015) [22] in FG, FJG and their *interse.*

18. Calving interval (CI)
The least squares means for CI are depicted in Table 6. The overall least squares means of calving interval in FG group cows was 409.28 ± 2.67days. These results corroborated with Kamble (2015) [22] in FG, FJG and their interse and Mote (2017) [25] in Gir crossbreds.

19. Effect of period of calving (POC)
In FG group, DMRT showed that the cows calved during P_5 (1998-2003) (398.13 ± 9.37) and higher CI in the cows calved during P_3 (1986-1991) (419.54 ± 5.73). The non-significant effect of POC on CI was supported by Mallick and Ghosh (2011) [23] in Red Sindhi cattle and Jawale (2015) [20] in 5/8 Gir crossbred R.

20. Effect of season of calving (SOC)
The influence of season of calving on calving interval was non-significant in all three genetic groups (Table 6). The non-significant results were reported by Deokar *et al.* (2005) [11, 12] in Gir crossbreds, Ahmed *et al.* (2007) [1] in HF X Zebu cows, Kamble (2015) [22] in FG, FJG and their interse,
DMRT of FG group show highest CI in S_3 (Feb – May) 413.52 ± 5.46 and lowest CI in S_1 (Jun – Sept) 402.03 ± 5.84 days.

21. Effect of lactation order (LO)
In FG group, the highest CI observed in L_5 (414.25 ± 8.45) while lowest CI was in L_7 (393.93 ± 11.73) days. The non-significant results were agreement with Jadhav (2009) [19] in HF x Gir halfbreds.

22. Effect of AFC group
The non-significant results were agreement with Kamble (2015) [22] in FG, FJG and their *interse.* In FG group, the highest calving interval (CI) observed in A_2 (801 to 850)

412.35 ± 6.62, while lowest CI was in A_3 (850 to 900) 402.67 ± 8.64 days.

23. Effect of generation
The Generation wise least squares means for significantly higher calving interval in FG group observed in G_8 (435.63 ± 23.63) days. While the significantly lowest CI observed in G_5 (402.57 ± 7.37). The significant results were in confirmation with the results reported by Bhoite (1996) [8] in Gir halfbreds and triple crosses.

Summary and Conclusion
To assess the magnitude of different factors along with genetic, phenotypic and environmental trends affecting the reproductive traits. This investigation also aimed at studying the association between age at first calving, open period, service period and calving interval on reproduction performance of FG genetic group of cow.

Reproductive traits: The data on pre-partum and post-partum reproductive traits consists of age at first calving, open period, service period, calving interval were analyzed by least squares technique to study the effect of non-genetic factors *viz*., period of birth / calving, season of birth / calving and lactation order on the traits under study.

Age at first calving (AFC)
The overall least squares means of AFC in cows of FG genetic group cows were 974.48 ±8.31 days.

Effect of period of birth (POB)
In FG the heifers born during P_2 (876.47 ± 7.80) had significantly lower AFC (days), than born in P_4 (1056.16 ± 16.51), P_3 (1026.97 ± 10.24) and P_6 (1016.88 ± 40.47). The differences in AFC among heifers born during P_3, P_4 and P_6 were at par with each other.

Effect of season of birth (SOB)
Although the effect of season of birth on AFC was non-significant the lowest AFC was observed in heifers born during winter season (960.38 ± 10.24 days) in FG.

Effect of generation
The generation overall mean for AFC was 983.65 ± 7.26 days in FG group. The AFC significantly lowest age at first calving was noticed in G_1 generation cows of FG (819.91±6.24) group. However, in FG group the highest age at first calving noticed in G_8 (1037.18±44.17).

Open period (OP)
The overall least squares mean of open period in FG group it was 76.55± 2.08 days.

Effect of period of calving (POC)
Analysis of variance showed non-significant effect of period of calving on cows of FG group. Open period of cows born in P_6 (67.33 ± 11.56) period of calving it was lowest and in P_3 (84.58 ± 2.52) it is highest in FG group.

Effect of season of calving (SOC)
Analysis of variance showed non-significant effect of season of calving on open period in FG genetic group under study.

Effect of lactation order (LO)
The analysis of variance revealed that the lactation order had non-significant effect on OP in FG genetic group.

Effect of AFC group
In FG lowest open period observed in A_6 (1001 and above) 72.96 ± 2.51, while highest OP observed in A_3 (850 to 900) 80.46 ± 3.75.

Effect of generation
In FG genetic group the least square means of open period was days in FG group was 79.29 ± 1.69days.

Service period (SP)
The overall LSQ means of SP in FG group cows was 133.26±1.84 days.

Effect of period of calving (POC)
The overall least squares means of SP in FG group cows was 137.56± 3.78 days. The cows calved during the period P_7 shows lowest (126.05±7.86) SP while P_3 shows highest SP (149.50± 4.57).

Effect of season of calving (SOC)
In FG group the lowest service period was observed in cows calved during S_1 (Jun - Sept) (133.73 ± 4.65 days) rainy season followed by S_2 (Oct - Jan) winter (138.98 ± 4.47 days) and summer season (139.99 ± 4.35 days).

Effect of lactation order (LO)
The analysis of variance revealed that lactation order had non-significant effect on service period in FG genetic group under study.

Effect of AFC group
The analysis of variance revealed that the age at first calving had a non-significant effect on service period in FG genetic group under study.

Effect of generation
Analysis of variance revealed that the effect of generation was significant on service period in FG genetic group. In FG group the lowest SP observed in G_8 (98.00 ± 18.87) while highest in G_4 (150.14 ± 4.67) while G_1, G_3, G_5 and G_7 are at par with each other.

Calving interval (CI)
The overall LSQ means of CI in FG group cows was 409.28±2.67 days.

Effect of period of calving (POC)
The analysis of variance revealed that the influence of period of calving period of calving had non-significant effect on CI in FG genetic group. In FG group, DMRT showed that the cows calved during P_5 (398.13 ± 9.37) and higher CI in the cows calved during P_3 (419.54 ± 5.73).

Effect of season of calving (SOC)
The influence of season of calving on calving interval was non-significant in FG genetic group. DMRT of FG group show highest CI in S_3 (Feb - May) 413.52±5.46 and lowest CI in S_1 (Jun - Sept) 402.03 ± 5.84 days.

Effect of lactation order (LO)
Analysis of variance indicated that lactation order had non-significant effect on calving interval in FG genetic group under study. In FG group, the highest CI observed in L_5 (414.25 ± 8.45) while lowest CI was in L_7 (393.93 ±11.73)

Effect of AFC group
Analysis of variance indicated that age at first calving had a non-significant effect on calving interval in all genetic groups under study. In FG group, the highest CI observed in A_2 (801 to 850) 412.35±6.62, while lowest CI was in A_3 (850 to 900) 402.67±8.64.

Effect of generation
The overall generation CI in FG genetic group was 414.34±3.88 days. The Generation wise least squares means for highest calving interval in FG group observed in G_8 (435.63 ± 23.63) days, while the lowest CI observed in G_5 (402.57 ± 7.37) days.

Table 1: Least squares means for AFC (days) in FG genetic group

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**974.48**	**8.31**
Period of Birth			
P_1 (1974 – 1979)	478	892.74[a]	7.41
P_2 (1980 – 1985)	428	876.47[a]	7.80
P_3 (1986 – 1991)	248	1026.97[bc]	10.24
P_4 (1992 – 1997)	95	1056.16[c]	16.51
P_5 (1998 – 2003)	37	989.10[bc]	26.82
P_6 (2004 – 2009)	16	1016.88[bc]	40.47
P_7 (2010 – 2014)	47	963.03[b]	23.48
Season of Birth			
S_1 (Jun – Sept)	459	980.47	10.89
S_2 (Oct – Jan)	472	960.38	10.24
S_3 (Feb – May)	418	982.59	10.20

Means under each class in the same column with different superscript differed significant

Table 2: Generation wise least squares means for AFC (days) in FG genetic group

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**983.65**	**7.26**
	Generation		
G_1	551	819.91[a]	6.24
G_2	175	967.72[b]	11.06
G_3	154	1019.37[bc]	11.80
G_4	179	1042.29[c]	10.95
G_5	113	1000.46[bc]	13.78
G_6	72	1032.58[bc]	17.26
G_7	75	969.37[b]	16.91
G_8	11	1037.18[c]	44.17
G_9	19	963.94[b]	33.61

Means in the same column with different superscript differed significantly.

Table 3: Least squares means for open period (days) in FG genetic group

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**76.55**	**2.08**
Period of calving			
P_1 (1974-1979)	426	76.37	2.16
P_2 (1980-1985)	389	79.21	1.89
P_3 (1986-1991)	219	84.58	2.52
P_4 (1992-1997)	162	78.97	2.93
P_5 (1998-2003)	76	77.34	4.11
P_6 (2004-2009)	9	67.33	11.56
P_7 (2010-2014)	68	72.06	4.33
Season of calving			
S_1 (Jun - Sept)	416	75.64	2.56
S_2 (Oct - Jan)	465	78.50	2.46
S_3 (Feb - May)	468	75.52	2.40
Lactation Order			
L_1	384	80.12	2.65
L_2	318	77.21	2.70
L_3	240	76.12	2.91
L_4	169	75.36	3.19
L_5	112	80.45	3.71
L_6	77	77.69	4.24

L_7	49	68.92	5.15
AFC group			
A_1 (< 800)	338	73.68	2.74
A_2 (801 to 850)	239	74.22	2.88
A_3 (850 to 900)	113	80.46	3.75
A_4 (901 to 950)	150	78.74	3.24
A_5 (951 to 1000)	132	77.83	3.52
A_6 (1001 and above)	377	72.96	2.51

Table 4: Generation wise least squares means for open period (days) in FG halfbreds

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**79.29**	**1.69**
Generation			
G_1	551	75.80 [a]	1.45
G_2	175	76.26 [a]	2.57
G_3	154	85.37 [a]	2.74
G_4	179	81.83 [a]	2.55
G_5	113	79.66 [a]	3.20
G_6	72	82.77 [a]	4.02
G_7	75	69.70 [a]	3.93
G_8	11	80.63 [a]	10.28
G_9	19	81.57[a]	7.827

Means in the same column with different superscript differed significantly.

Table 5: Least squares means for service period (days) in FG genetic group

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**137.56**	**3.78**
Period of Calving			
P_1 (1974 - 1979)	426	128.37	3.93
P_2 (1980- 1985)	389	138.69	3.43
P_3 (1986 - 1991)	219	149.50	4.57
P_4 (1992 - 1997)	162	137.31	5.32
P_5 (1998 - 2003)	76	136.10	7.47
P_6 (2004 - 2009)	09	146.94	20.98
P_7 (2010 - 2014)	68	126.05	7.86
Season of Calving			
S_1 (Jun – Sept)	416	133.73	4.65
S_2 (Oct – Jan)	465	138.98	4.47
S_3 (Feb – May)	468	139.99	4.35
Lactation Order			
L_1	384	128.89	4.80
L_2	318	134.77	4.89
L_3	240	131.56	5.27
L_4	169	143.64	5.79
L_5	112	143.76	6.74
L_6	77	130.92	7.70
L_7	49	149.40	9.35
AFC group			
A1 (< 800)	338	133.45	5.03
A2 (801 to 850)	239	147.14	5.28
A3 (850 to 900)	113	141.53	6.89
A4 (901 to 950)	150	138.85	5.95
A5 (951 to 1000)	132	129.03	6.46
A6 (1001 and above)	377	135.39	4.61

Means in the same column with different superscript differed significant.

Table 6: Generation wise least squares means for service period (days) in FG genetic group

Sources of variation	FG		
	N	Mean	S.E.
µ	1349	127.05	3.10
Generation			
G_1	551	130.88[c]	2.66
G_2	175	123.06[b]	4.73
G_3	154	137.41[c]	5.04
G_4	179	150.14[c]	4.67
G_5	113	138.69[c]	5.88
G_6	72	122.88[b]	7.37
G_7	75	140.84[c]	7.22
G_8	11	98.00[a]	18.87
G_9	19	101.52[a]	14.35

Means in the same column with different superscript differed significantly

Table 7: Least squares means for calving interval (days) in FG halfbreds

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**408.29**	**4.74**
Period Of Calving			
P_1 (1974 - 1979)	426	402.28	4.92
P_2 (1980 - 1985)	389	407.36	4.30
P_3 (1986 - 1991)	219	419.54	5.73
P_4 (1992 - 1997)	162	410.58	6.67
P_5 (1998 - 2003)	76	398.13	9.37
P_6 (2004 - 2009)	9	410.55	26.31
P_7 (2010 - 2014)	68	409.60	9.86
Season of calving			
S_1 (Jun – Sept)	416	402.03	5.84
S_2 (Oct – Jan)	465	409.32	5.61
S_3 (Feb – May)	468	413.52	5.46
Lactation Order			
L_1	384	412.73	6.02
L_2	318	409.64	6.14
L_3	240	408.09	6.62
L_4	169	411.80	7.26
L_5	112	414.25	8.45
L_6	77	407.60	9.66
L_7	49	393.93	11.73
AFC group			
A_1 (< 800)	338	405.16	6.31
A_2 (801 to 850)	239	412.35	6.62
A_3 (850 to 900)	113	402.67	8.64
A_4 (901 to 950)	150	420.65	7.47
A_5 (951 to 1000)	132	404.47	8.10
A_6 (1001 and above)	377	404.45	5.78

Table 8: Generation wise least squares means for calving interval (days) in FG halfbred

Sources of variation	FG		
	N	Mean	S.E.
µ	**1349**	**414.34**	**3.88**
Generation			
G_1	551	403.68[a]	3.33

G_2	175	413.58[a]	5.92
G_3	154	410.14[a]	6.31
G_4	179	423.94[b]	5.85
G_5	113	402.57[a]	7.37
G_6	72	407.87[a]	9.23
G_7	75	407.42[a]	9.05
G_8	11	435.63[c]	23.63
G_9	19	424.21 [b]	17.98

Means in the same column with different superscript differed significantly

Conclusions

In view of the above findings the following conclusions were drawn:

1. The FG Halfberds performed better for reproduction traits.
2. Most of the reproduction traits under study were affected by non- genetic factors indicating the importance of feeding and management for enhancing performance.

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