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Evaluation of Kankrej cattle for lifetime calf production traits in an organized herd

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Abstract

The present investigation was undertaken on 251 Kankrej cows maintained at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat over 15 years (2001-2015) to determine the effect of genetic and non-genetic factors on lifetime calf production traits. The study revealed that averages of the number of calves born per cow, number of female calves born per cow and number of female calves reaching milking herd per cow were 3.17 ± 0.15 , 2.01 ± 0.99 and 1.79 ± 0.10 respectively. The number of calves born per cow, number of female calves born per cow, number of female calves reaching milking herd per cow were significantly affected by period of first calving, first lactation milk yield and season of first calving except number of calves born per cow which is not affected by season of first calving.

Keywords: Calf production, selective value, replacement value

Introduction

The genetic contribution from a cow to the next generation depends upon several traits, viz. number of calves born per cow, number of female calves born per cow and number of female calves reaching milking herd per cow. The lifetime production of calves and their survival until the age of first calving are important traits of dairy animals that are associated with a better replacement of old and low-producing animals over time. Information on these traits is essentially required for planning, operating and evaluating the breeding programme for genetic improvement of a dairy herd. Therefore an investigation was undertaken to study the effects of non genetic factors (periods of first calving, season of first calving, age at first calving, first lactation milk yield group) on lifetime calf production traits in Kankrej cattle.

Materials and Methods

The relevant data for the present investigation generated over a period of 15 years (2001-2015) were collected from the history sheets and pedigree sheets maintained at Livestock Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat which was initially set up to evaluate production potential of Kankrej cattle, a native breed of Gujarat state.

Least square mean for the above traits were estimated across different period of first calving, season of first calving, age at first calving groups and first lactation milk yield groups. The data were classified into five periods of three year each according to the year of first calving, as P1, P2, P3, P4 and P5. Season of calving was classified as S1 (March-June), S2 (July-October) and S3 (November-February). Age at first calving was classified into five groups with a class interval of 150 days, A1 (Less than 100days), A2 (1001 to 1150days), A3 (1151 to 1300 days), A4 (1301 to 1450 days) and A5 (Above 1451). First lactation milk yield was classified into seven groups on the basis of first lactation 305 days milk yield as follows L1(Less than 1001 kg), L2 (1001 to 1400 kg), L3 (1401 to 1800 kg), L4 (1801 to 2200 kg), L5 (2201 to 2600 kg), L6 (2601 to 3000 kg) and L7 (Above 3000 kg).

Life Time Calf Production

The number of calves born to each cow, number of female calves born to each cow during its lifetime and the number of number of female calves reached to the milking herd that is survival to their age at first calving from each cow in its lifetime were included.

Results

(A) Life time calf production traits

The mean for number of calves born per cow was 3.17 ± 2.41 , C.V. being 76.0 per cent (Table 1). The mean for number of female calves born to a cow was 2.01 ± 1.37 C.V. 68.5 per cent (Table 1). The mean for number of female calves reaching milking herd per cow is 1.79 ± 1.20 C.V. being 66.9 per cent (Table 1). The least square mean for lifetime number of calf production per cow was 3.21 ± 0.25 . The least square mean for number of female calves born to a cow was 1.56 ± 0.17 . The least square mean for number of female calves reaching milking herd was 1.09 ± 0.14 (Table 1.1a).

(a) Period of first calving

The least square mean for P1, P2, P3, P4 and P5 periods were found 4.56 ± 0.37 , 3.60 ± 0.34 , 3.65 ± 0.37 , 2.29 ± 0.36 and 1.93 ± 0.44 calves respectively for number of calves born per cow, 2.11 ± 0.25 , 1.66 ± 0.22 , 1.73 ± 0.25 , 1.36 ± 0.24 and 0.95 ± 0.29 calves respectively for number of female calves born per cow and 1.60 ± 0.21 , 1.13 ± 0.19 , 1.01 ± 0.20 , 0.86 ± 0.20 and 0.85 ± 0.25 calves respectively for number of female calves reaching milking herd for each cow.

(b) Season of first calving

The least square mean for the S1 (March-June), S2 (July-October) and S3 (November-February) were found 3.15 ± 0.29 , 2.92 ± 0.38 and 3.54 ± 0.29 calves respectively for number of calves born per cow, 1.59 ± 0.19 , 1.26 ± 0.25 and 1.83 ± 0.20 calves respectively for number of female calves born per cow, 1.04 ± 0.16 , 0.98 ± 0.21 and 1.25 ± 0.16 calves respectively for number of female calves reaching milking herd per cow.

(c) Age at first calving

The least square mean for A1, A2, A3, A4 and A5 were found 4.23 ± 0.82 , 3.24 ± 0.36 , 3.27 ± 0.29 , 3.04 ± 0.31 and 2.24 ± 0.35 calves respectively for number of calves born per cow, 2.38 ± 0.54 , 1.54 ± 0.24 , 1.65 ± 0.19 , 1.35 ± 0.21 and 0.89 ± 0.23 calves respectively for number of female calves born per cow, 2.27 ± 0.45 , 0.90 ± 0.20 , 1.07 ± 0.16 , 0.78 ± 0.17 and 0.42 ± 0.19 calves respectively for number of female calves reaching milking herd per cow.

(d) First lactation milk yield

The least square mean for L1, L2, L3, L4, L5, L6 and L7 were found 1.39 ± 0.36 , 1.99 ± 0.39 , 3.17 ± 0.29 , 3.88 ± 0.30 , 4.52 ± 0.45 , 3.09 ± 0.80 and 4.40 ± 1.06 calves respectively for number of calves born per cow, 0.76 ± 0.24 , 1.06 ± 0.26 , 1.50 ± 0.19 , 1.97 ± 0.20 , 2.19 ± 0.53 , 1.25 ± 0.70 and 2.20 ± 1.06 calves respectively for number of female calves born per cow, 0.44 ± 0.20 , 0.65 ± 0.21 , 0.94 ± 0.16 , 1.53 ± 0.17 , 1.80 ± 0.25 , 1.15 ± 0.44 and 1.13 ± 0.59 calves respectively for number of female calves reaching milking herd per cow.

Discussion

1. Number of calves born per cow

The least square mean for number of calves produced by Kankrej cow during its lifetime in the herd was found 3.21 ± 0.25 . Higher estimates for number of calves born per cow than the present findings were reported by Kohli and Suri (1957) [12] in Haryana (4.67 calves), Singh and Sinha (1960) [33] in Tharparakar (4.86 calves), Gill (1981) [6] in Sahiwal (4.32 calves), Tomar and Basu (1981) [39] in Murrah buffaloes (4.37 calves), Schons *et al.* (1985) [29] in Angus beef cows (3.78 calves), Hegade and Bhatnagar (1985) [9] in Brown Swiss (4.06 calves) and cross bred (4.48 calves), Reddy and Basu (1985) [27] in Sahiwal cross bred (4.48 calves), Roy and Tripathi (1990) [28] in Holstein Friesian x Sahiwal / Tharparkar (4.48 calves), Tomar and Ram (1992) [40] in Murrah buffalo (3.59 calves), Rawal and Tomar (1994) [26] in Sahiwal cow (3.73 calves), Tomar *et al.* (1995) [45] in Red Sindhi (3.42 calves), Goshu (2005) [7] in Friesian Boran crossbred (3.58 calves), Ram and Goswami (2005) [24] in Tharparkar (4.37 calves), Shahi and Kumar (2006) [30] in Jersey x Sahiwal (3.93 calves), Abbas and Sachdeva (2008) [1] in Sahiwal (3.79 calves), Kumar *et al.* (2009) [16] in Haryana cow (4.9 calves), Jakhar *et al.* (2010) [10] in Haryana (3.7 calves), Singh *et al.* (2011) [35] in Sahiwal (4.19 calves), Goshu *et al.* (2014) [8] in Holstein Friesian (3.55 calves). Lower estimates for number of calves born per cow than the present findings were reported by Atrey *et al.* (2005) [2] in Frieswal (2.57 calves), Banik and Naskar (2006) [3] in Sahiwal (3.18), Kumar *et al.* (2014) [15] in Frieswal (2.71 calves).

Table 1: Mean, standard deviation and C.V. (%) of life time calf production traits

Sr. No.	Traits	No. of Observations	Mean	S.E.	S.D.	C.V. (%)
1	Number of calves born per cow	251	3.17	0.15	2.41	76.0
2	Number of female calves born per cow	251	2.01	0.99	1.37	68.5
3	Number of female calves reaching milking herd per cow	251	1.79	0.10	1.20	66.9

It was observed that less number of number of calves was produced by those cows which had usually longer age at first

calving and the cows which had comparatively shorter age at first calving produced more calves in the herd.

Table 1.1a: Least square mean and standard error life time calf production in Kankrej cattle across different non genetic factors

Sr. No.	Parameter	No. of Observations	NC	NFC	NFRMH
1	Total	251	3.21 ± 0.25	1.56 ± 0.17	1.09 ± 0.14
2	PFC		**	**	**
2.1	P1 (2001-2003)	59	$4.56^c \pm 0.37$	$2.11^a \pm 0.25$	$1.60^c \pm 0.21$
2.2	P2 (2004-2006)	67	$3.60^a \pm 0.34$	$1.66^{ab} \pm 0.22$	$1.13^b \pm 0.19$
2.3	P3 (2007-2009)	49	$3.65^a \pm 0.37$	$1.73^{abc} \pm 0.25$	$1.01^b \pm 0.20$
2.4	P4 (2010-2012)	48	$2.29^b \pm 0.36$	$1.36^c \pm 0.24$	$0.86^a \pm 0.20$
2.5	P5 (2013-2015)	28	$1.93^b \pm 0.44$	$0.95^{bc} \pm 0.29$	$0.85^a \pm 0.25$
3	SFC		Non Significant	**	**
3.1	S1 (Summer) March to June	109	3.15 ± 0.29	$1.59^{ab} \pm 0.19$	$1.04^{ab} \pm 0.16$
3.2	S2 (Rainy) July to October	47	2.92 ± 0.38	$1.26^b \pm 0.25$	$0.98^a \pm 0.21$

3.3	S3 (Winter) November to February	95	3.54 ± 0.29	1.83 ^a ± 0.20	1.25 ^b ± 0.16
4	AFC		Non Significant	Non Significant	Non significant
4.1	A1 (< 1001 days)	7	4.23 ^c ± 0.82	2.38 ± 0.54	2.27 ± 0.45
4.2	A2 (1001-1150 days)	43	3.24 ^{ab} ± 0.36	1.54 ± 0.24	0.90 ± 0.20
4.3	A3 (1151-1300 days)	79	3.27 ^b ± 0.29	1.65 ± 0.19	1.07 ± 0.16
4.4	A4 (1301-1450 days)	69	3.04 ^a ± 0.31	1.35 ± 0.21	0.78 ± 0.17
4.5	A5 (> 1450 days)	53	2.24 ^a ± 0.35	0.89 ± 0.23	0.42 ± 0.19
5	FLMY		**	**	**
5.1	L1 (< 1001 kg)	38	1.39 ^c ± 0.36	0.76 ^b ± 0.24	0.44 ^a ± 0.20
5.2	L2 (1001-1400 kg)	34	1.99 ^{bc} ± 0.39	1.06 ^b ± 0.26	0.65 ^a ± 0.21
5.3	L3 (1401-1800 kg)	66	3.17 ^b ± 0.29	1.50 ^{ab} ± 0.19	0.94 ^{ab} ± 0.16
5.4	L4 (1801-2200 kg)	75	3.88 ^{ab} ± 0.30	1.97 ^{ab} ± 0.20	1.53 ^c ± 0.17
5.5	L5 (2201-2600 kg)	27	4.52 ^a ± 0.45	2.19 ^a ± 0.53	1.80 ^c ± 0.25
5.6	L6 (2601-3000 kg)	7	3.09 ^{abc} ± 0.80	1.25 ^{ab} ± 0.70	1.15 ^b ± 0.44
5.7	L7 (> 3000 kg)	4	4.40 ^{ab} ± 1.06	2.20 ^{ab} ± 1.06	1.13 ^b ± 0.59

Table 1.1b: Least square analysis for life time calf production in Kankrej Cattle

Sr. No.	Source of Variation	d.f.	MS	R ²
1	Number of calves born per cow			
1.1	PFC	4	46.21**	13.25
1.2	SFC	2	6.40	0.97
1.3	AFC	4	10.33	3.33
1.4	FLMY	6	40.31**	17.99
2	Number of female calves born per cow			
2.1	PFC	4	6.81**	5.34
2.2	SFC	2	4.68**	1.97
2.3	AFC	4	5.62	3.99
2.4	FLMY	6	8.94**	10.11
3	Number of female calves reaching milking herd per cow			
3.1	PFC	4	4.30**	4.11
3.2	SFC	2	1.34**	1.01
3.3	AFC	4	6.06	6.19
3.4	FLMY	6	7.98**	12.31

**Significant at P < 0.01.

1.1 Effect of period of first calving on number of calves born per cow

In the present study, a significant effect of period of first calving on number of calves born per cow of Kankrej cow was observed. Similar results were reported by Hegade and Bhatnagar (1985) [9] in Brown Swiss and Brown Swiss x Zebu, Mukherjee and Tomar (1996) [21] in Brown Swiss cross, Atrey *et al.* (2005) [2] in Frieswal, Ram and Goswami (2005) [24] in Tharparkar, Goshu (2005) [7] in Friesian Boran crossbred, Banik and Naskar (2006) [3] in Sahiwal, Shahi and Kumar (2006) [30] in Jersey x Sahiwal, Abbas and Sachdeva (2008) [1] in Sahiwal, Kumar *et al.* (2009) [16] in Haryana, Jakhar *et al.* (2010) [10] in Haryana, Singh *et al.* (2011) [35] in Sahiwal, Kumar *et al.* (2014) [15] in Frieswal.

On the other hand, non significant effect of period of first calving on number of calves born per cow was reported by Kumar (1997) [14] in crossbred.

The numbers of calves born by each cow for the first period were more than those produced by cow in later periods and there was a declining trend in later periods due to successive culling. Decrease in number of calves born per cow from P1 to P5 may indirectly be related to decrease in productive herd life of cow in the herd.

1.2 Effect of season of first calving on number of calves born per cow

In the present study, a non significant effect of season of first calving on number of calves born per cow of Kankrej cow was observed. Similar results were reported by Goshu (2005) [7] in Friesian Boran crossbred, Ram and Goswami (2005) [24]

in Tharparkar, Shahi and Kumar (2006) [30] in Jersey x Sahiwal, Singh *et al.* (2011) [35] in Sahiwal, Goshu *et al.* (2014) [8] in Holstein Friesian.

On the other hand, significant effect of season of first calving on number of calves born per cow was reported by (23) in Red Sindhi, Mahdy (1994a) [20] in Egyptian buffaloes, Banik and Naskar (2006) [3] in Sahiwal.

1.3 Effect of age at first calving on number of calves born per cow

In the present study, a non significant effect of age at first calving on number of calves born per cow of Kankrej cow was observed. Similar results were reported by (4) in Cattle, Singh and Sinha (1960) [33] in Tharparkar, Atrey *et al.* (2005) [2] in Frieswal, Ram and Goswami (2005) [24] in Tharparkar, Abbas and Sachdeva (2008) [1] in Sahiwal.

On the other hand, significant effect of age at first calving on number of calves born per cow was reported by Mukherjee and Tomar (1996) [21] in Brown Swiss cross, Kumar *et al.* (2009) [16] in Haryana, Jakhar *et al.* (2010) [10] in Haryana, Goshu *et al.* (2014) [8] in Holstein Friesian.

1.4 Effect of first lactation milk yield on number of calves born per cow

In the present study, a significant effect of first lactation milk yield on number of calves born per cow of Kankrej cow was observed. Similar results were reported by Mukherjee and Tomar (1996) [21], Kumar (1997) [14] in crossbred, Atrey *et al.* (2005) [2] in Frieswal, Ram and Goswami (2005) [24] in Tharparkar, Abbas and Sachdeva (2008) [1] in Sahiwal, Kumar *et al.* (2009) [16] in Haryana, Goshu *et al.* (2014) [8] in Holstein Friesian, Kumar *et al.* (2014) [15] in Frieswal.

On the other hand, non significant effect of first lactation milk yield on number of calves born per cow was reported by Mahdy (1994a) [20] in Egyptian buffaloes.

An increasing trend was noticed for number of calves born with the increase in first lactation milk yield. It was found that higher milk producing cows had more number of number of calves as compared to low milk producers.

2. Number of female calves born per cow

The least square mean for number of female calves produced by Kankrej cow during its lifetime in the herd was found 1.56 ± 0.17. Higher estimates for number of female calves born per cow than the present finding were reported by Tomar and Basu (1981) [39] in Murrah buffalo (1.91 calves), (25) in Tharparkar (1.75 calves), (36) in Jersey x Red Sindhi (2.37 calves), Tomar and Ram (1992) [40] in Murrah buffalo (1.61 calves), Rawal and Tomar (1994) [26] in Sahiwal cow (1.8

calves), Tomar *et al.* (1995)^[45] in Red Sindhi cow (1.59 calves), Kumar (1997)^[14] in crossbred cattle (1.97 calves), Ram and Goswami (2005)^[24] in Tharparkar (1.8 calves), Shahi and Kumar (2006)^[30] in Jersey x Sahiwal (1.98 calves), Abbas and Sachdeva (2008)^[1] in Sahiwal (2.08 calves), Kumar *et al.* (2009)^[16] in Haryana (2.38 calves), Jakhar *et al.* (2010)^[10] in Haryana (1.88 calves), Goshu *et al.* (2014)^[8] in Holstein Friesian (1.68 calves).

Lower estimates for number of female calves born per cow than the present findings were reported by (17) in Red Sindhi cow (1.53 calves), Mukherjee and Tomar (1996)^[21] in Brown Swiss cross (1.47 calves), Banik and Naskar (2006)^[3] in Sahiwal (1.35 calves), Kumar *et al.* (2014)^[15] in Frieswal (1.32 calves).

Higher estimates for number of female calves born per cow than the present finding showed that the management of neonatal calf was better compared to present finding. It was observed that about 61 per cent of number of female calves born reached to milking herd and around 40 per cent of female calves were lost from the herd either due to death or culling.

2.1 Effect of period of first calving on number of female calves born per cow

In the present investigation, a significant effect of period of first calving on number of female calves born per cow of Kankrej cow was observed. Similar results were observed by (17) in Red Sindhi cow, Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, Atrey *et al.* (2005)^[2] in Frieswal, Ram and Goswami (2005)^[24] in Tharparkar, Banik and Naskar (2006)^[3] in Sahiwal, Shahi and Kumar (2006)^[30] in Jersey x Sahiwal, Kumar *et al.* (2009)^[16] in Haryana, Jakhar *et al.* (2010)^[10] in Haryana.

On the other hand, non significant effect of period of first calving on number of female calves born per cow was reported by Singh and Singh (1968) in Haryana cow^[38] in Haryana,^[31] in Gir crossbred,^[11] in Red Sindhi cow,^[34] in Gir cow,^[44] in crossbred,^[25] in Tharparkar,^[32] in crossbred,^[41] in Murrah buffalo, Kumar (1997)^[14] in crossbred cattle.

Decrease in mean of number of female calves born per cow from P1 to P5 showed that the improvement in herd due to selection/culling over the period.

2.2 Effect of season of first calving on number of female calves born per cow

In the present study, a significant effect of season of first calving on number of female calves born per cow of Kankrej cow was observed. Similar results were obtained by^[38] in Haryana,^[13] in Red Sindhi cow,^[5] in Egyptian buffalo,^[43] in Tharparkar,^[44] in Karan Fries, Tomar and Ram (1992)^[40] in Murrah buffalo, Banik and Naskar (2006)^[3] in Sahiwal.

On the other hand, significant effect of season of first calving on number of female calves born per cow was reported by^[37] in Haryana,^[46] in Sahiwal,^[31] in Gir cross bred,^[11] in Red Sindhi cows,^[34] in Gir cows,^[17] in Red Sindhi cow,^[25] in Tharparkar,^[41] in Murrah buffalo, Kumar (1997)^[14] in crossbred, Ram and Goswami (2005)^[24] in Tharparkar cow, Goshu *et al.* (2014)^[8] in Holstein Friesian.

Significantly number of female calves born per cow was highest in winter calvers. However, there was no significant difference in number of female calves born per cow between summer and rainy seasons. The significant effect of season of calving on number of female calves born per cow could be attributed to the changes in climatic conditions and feeding

regimes during different seasons.

2.3 Effect of age at first calving on number of female calves born per cow

In the present study, a non significant effect of age at first calving on number of female calves born per cow of Kankrej cow was observed. Similar results were observed by Kumar (1997)^[14] in crossbred, Atrey *et al.* (2005)^[2] in Frieswal, Abbas and Sachdeva (2008)^[1] in Sahiwal, Kumar *et al.* (2009)^[16] in Haryana, Goshu *et al.* (2014)^[8] in Holstein Friesian.

On the other hand, significant effect of age at first calving on number of female calves born per cow was reported by Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, Ram and Goswami (2005)^[24] in Tharparkar, Jakhar *et al.* (2010)^[10] in Haryana.

2.4 Effect of first lactation milk yield on number of female calves born per cow

In the present investigation, a significant effect of first lactation milk yield on number of female calves born per cow of Kankrej cow was observed. Similar results were observed by Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, Kumar (1997)^[14] in crossbred, Ram and Goswami (2005)^[24] in Tharparkar, Atrey *et al.* (2005)^[2] in Frieswal, Abbas and Sachdeva (2008)^[1] in Sahiwal, Kumar *et al.* (2009)^[16] in Haryana, Goshu *et al.* (2014)^[8] in Holstein Friesian.

An increasing trend was noticed for number of female calves born with the increase in first lactation milk yield. It was found that higher milk producing cows had more number of number of female calves as compared to low milk producers.

3. Number of female calves reaching milking herd per cow

The least square mean for number of female calves reaching milking herd per cow produced by Kankrej cow during its lifetime in the herd was found 1.09 ± 0.14 .

Higher estimates for number of female calves reaching milking herd per cow than the present findings were, however, reported by Schons *et al.* (1985)^[29] in Angus beef cows (1.1 calves), (25) in Tharparkar (1.16 calves) and Sahiwal (1.26), Rawal and Tomar (1994)^[26] in Sahiwal cow (1.26 calves), Shahi and Kumar (2006)^[30] in Jersey x Sahiwal (1.28), Abbas and Sachdeva (2008)^[1] in Sahiwal (1.61 calves), Kumar *et al.* (2009)^[16] in Haryana (1.2 calves), Goshu *et al.* (2014)^[8] in Holstein Friesian (1.12 calves).

Lower estimates for number of female calves reaching milking herd per cow than the present findings were reported by Tomar and Ram (1992)^[40] in Murrah buffalo (0.75 calves), (18) in Red Sindhi cows (0.77 calves), Tomar *et al.* (1995)^[45] in Red Sindhi Herd (0.94 calves), Kumar (1997)^[14] in crossbred cattle (1.01 calves), Atrey *et al.* (2005)^[2] in Frieswal (0.92 calves), Ram and Goswami (2005)^[24] in Tharparkar (0.65 calves), Banik and Naskar (2006)^[3] in Sahiwal (0.87 calves), Jakhar *et al.* (2010)^[10] in Haryana (0.74 calves).

The overall replacement rate on number of calf basis was observed to be 30 per cent and the remaining 70 per cent of calves born were lost from the herd as abnormal births, male births and the loss of female calves due to their death and culling before they attain the age at first calving. The present study has given a strong result regarding the replacement rate that about 3 to 4 pregnancies are required to produce one heifer replacement.

3.1 Effect of period of first calving on number of female calves reaching milking herd per cow

In the present investigation, a significant effect of period of first calving on number of female calves reaching milking herd per cow of Kankrej cow was observed. Similar results were reported by Tomar and Basu (1981)^[39] in Murrah buffaloes, (25) in Tharparkar and Sahiwal, (41) in Murrah buffalo, (18) in Red Sindhi, Rawal and Tomar (1994)^[26] in Sahiwal, (42) in Sahiwal, Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, (22) in crossbred, Atrey *et al.* (2005)^[2] in Frieswal, Ram and Goswami (2005)^[24] in Tharparkar, Banik and Naskar (2006)^[3] in Sahiwal, Jakhar *et al.* (2010)^[10] in Haryana.

On the other hand, non significant effect of period of first calving on number of female calves reaching milking herd per cow was reported by (43) in Tharparkar cow.

Significant effect of period of first calving was indicated for different management practices over the years due to implicit quality feed and fodder changes as well as the set of sires used and practice of different culling over the years.

3.2 Effect of season of first calving on number of female calves reaching milking herd per cow

In the present study, a significant effect of season of first calving on number of female calves reaching milking herd per cow of Kankrej cow was observed. Similar results were reported by Tomar and Basu (1981)^[39] in Murrah, (43) in Murrah, (19) in Red Sindhi cows, Banik and Naskar (2006)^[3] in Sahiwal.

On the other hand, non significant effect of season of first calving on number of female calves reaching milking herd per cow was reported by (44) in Tharparkar, (25) in Sahiwal, (41) in Murrah, Rawal and Tomar (1994)^[26] in Sahiwal, (22) in crossbred, Ram and Goswami (2005)^[24] in Tharparkar, Shahi and Kumar (2006)^[30] in Jersey x Sahiwal, Goshu *et al.* (2014)^[8] in Holstein Friesian.

Cows that calved during winter season (November-February) showed consistently higher replacement. The significantly lower replacement was observed in cows that calved during the monsoon (July-October) season. Cows that calved during the winter season were generally expected to be in their late pregnancy period in the preceding season (July-October) which bestowed ideal environmental conditions and abundant supply of green fodder. The favourable environment persisted in succeeding season (winter) when cows actually calved and milk production initiated. Such cows that freshened during winter season could have given high replacement rate.

3.3 Effect of age at first calving on number of female calves reaching milking herd per cow

In the present study a non significant effect of age at first calving on number of female calves reaching milking herd per cow of Kankrej cow was observed. Similar results were reported by Kumar (1997)^[14] in crossbred, Atrey *et al.* (2005)^[2] in Frieswal, Ram and Goswami (2005)^[24] in Tharparkar, Abbas and Sachdeva (2008)^[1] in Sahiwal, Kumar *et al.* (2009)^[16] in Haryana, Goshu *et al.* (2014)^[8] in Holstein Friesian.

On the other hand, significant effect of age at first calving on number of female calves reaching milking herd per cow was reported by Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, Jakhar *et al.* (2010)^[10] in Haryana.

3.4 Effect of first lactation milk yield on number of female calves reaching milking herd per cow

In the present study, a significant effect of first lactation milk yield on number of female calves reaching milking herd per cow of Kankrej cow was observed. Similar result was reported by Mukherjee and Tomar (1996)^[21] in Brown Swiss cross, Kumar (1997)^[14] in crossbred cattle, Atrey *et al.* (2005)^[2] in Frieswal, Ram and Goswami (2005)^[24] in Tharparkar, Abbas and Sachdeva (2008)^[1] in Sahiwal, Kumar *et al.* (2009)^[16] in Haryana.

On the other hand, non significant effect of first lactation milk yield on number of female calves reaching milking herd per cow was reported by Goshu *et al.* (2014)^[8] in Holstein Friesian.

The main reason for higher replacement with higher milk production in the first lactation that female calves of those cows with high milk production have been included in the herd as a selection.

Conclusion

In this study, it has been observed that around 61% of female calves born to the milking herd reached the milking herd while around 40% of female calves were lost from the herd either through death or culling.

The number of calves born per cow, number of female calves born per cow, number of female calves reaching milking herd per cow were significantly affected by period of first calving. Significant effect of first lactation milk yield was observed on number of calves born per cow, number of female calves born per cow and number of female calves reaching milking herd per cow.

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