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Subfertility in Males: An Important Cause of Bull Disposal in Bovines*

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ABSTRACT : The study had two objectives, namely, to estimate the andrological disorders leading to disposal of Karan Fries (KF), Sahiwal cattle and Murrah buffalo bulls and to study the effect of various factors (species/breeds, season of birth and period of birth) on male reproductive parameters. Records on occurrence of subfertility problems and disposal pattern of bulls maintained at the National Dairy Research Institute herd were collected for 15 years (1991 to 2005). Percentage of bulls producing freezable semen was less in the crossbred cattle (58.46%) as compared to Sahiwal (81.69%) and Murrah bulls (81.05%). Various subfertility traits like poor libido and unacceptable seminal profile were found to be the significant reasons ($p<0.01$) for culling of the breeding bulls. Inadequate sex drive was the main contributing factor for bull disposal in Sahiwal (22.55%) and Murrah bulls (15.12%) whereas poor semen quality and freezability were most frequently observed in KF bulls (24.29 and 7.29 percent, respectively). Least squares analyses of different male reproductive parameters showed that species/breeds had significant effect ($p<0.05$) on all traits except for frozen semen production periods (FSPP). Periods of birth were significantly different ($p<0.05$) for all traits except for semen volume. Age at first semen collection (AFSC), age at first semen freezing (AFSF) and age at disposal (AD) were highest in Murrah, while frozen semen production period (FSPP) and semen production period (SPP) were highest in KF and lowest in Sahiwal. The age at first semen donation and breeding period could be reduced by introducing the bulls to training at an early age. These results revealed a declining trend in AFSC, AFSF, FSPP, SPP and AD, thereby indicating an improvement in reproductive performance over the years. The age at first semen donation in bovines can be reduced by introducing the young male calves to training at an early age, which could increase the dosage of semen obtained from each male. (**Key Words :** Bull Disposal, Subfertility, Semen Quality, Libido, Semen Freezability)

INTRODUCTION

A systematic and intensive multistage selection of the male animals is practised in bull mother farms, commercial and institutional herds. Optimum serving capacity and seminal profile are indispensable parameters for evaluation of breeding soundness of dairy bulls. A wide variation in the male reproductive parameters is observed between the breeds of different species of dairy animals. Moreover, very few reports are available on the problems associated with sexual behavior and semen characteristics of exotic× indigenous crossbred bulls, under the tropical conditions. The production traits in animals are mainly genetic in nature; however, reproduction parameters are more influenced by environment. The present investigation was designed to investigate the occurrence of subfertility traits leading to wastage of dairy bulls and to study the factors like, species/breeds, season of birth and period of birth affecting the male reproductive parameters. Three species-breeds, namely, Karan Fries (KF), Sahiwal cattle and Murrah buffalo bulls were studied. The genetic and environmental back grounds of those three species-breeds under study were considered. The Karan Fries bulls were the crossbreds of Holstein Friesian with Tharparkar/ Sahiwal zebu cattle while the Sahiwal cattle and the Murrah bulls were purebred and produced through selective breeding. The animals were reared at the Artificial Breeding Complex (ABC), National Dairy Research Institute, Karnal, in loose housing system in individual bull pans, under stall-fed condition and uniform managemental practices.

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MATERIALS AND METHODS

Collection of data

Data on various causes of disposal and the reproduction parameters of Karan Fries cattle, Sahiwal cattle and Murrah buffalo bulls, during the period of 1991 to 2005, were compiled from the available calving records, auction lists and the performance record-registers. Data on male

Table 1. Detail of male calves born, reserved for freezable semen production in dairy bulls

Particulars	Karan Fries	Sahiwal	Murrah
Total born	1,744	606	994
Reserved	242	102	172
Died (among reserved)	12	5	8
Percentage of bulls reserved	13.88	16.83	17.30
Produced semen	195	71	95
Produced freezable semen	114	58	77
% bulls produced FS out of semen producing bulls	58.46	81.69	81.05

reproductive traits were available for a total of 202 bulls. Animals with incomplete records and under experimental trials were excluded from the study of the effect of different genetic and non-genetic factors on the fertility parameters. The subfertility traits leading to disposal of bulls included poor libido; poor semen quality (initial motility <40%) and poor semen freezability (post thaw motility<35%).

Statistical analysis

The generated data on male specific breeding soundness traits were subjected to least squares analysis to study the effect of species/breeds (Karan Fries crossbred, Sahiwal cattle and Murrah buffalo), season of birth and period of birth. Four seasons of birth were taken as summer (April to June); rainy (July to September); winter (October to January) and spring (February to March). The periods of birth were taken as four years interval according to the corresponding changes in the managemental practices, as, 1991 to 1994; 1995 to 1998; 1999 to 2002 and 2003 to 2005.

The least squares model (Harvey, 1975) used to study the effect of species-breeds, birth period and birth season on different reproductive parameters was.

$$Y_{ijkl} = \mu+B_i+S_j+P_k+I_{B.P}+e_{ijkl}$$

When, Y_{ijkl} = character variable of l^{th} bull under i^{th} breed, j^{th} season of birth and k^{th} period of birth; μ = population mean; B_i = fixed effect of i^{th} species/breed (i = 1, 2, 3); S_j = fixed effect of season of birth (j = 1, 2...4); P_k = fixed effect of k^{th} period of birth (k = 1, 2...4); $I_{B.P}$ = effect of interaction between species/breed and period; e_{ijkl} = random error for l^{th} observation under i^{th} breed, j^{th} season and k^{th} period of birth.

Chi-square test was done for the test of heterogeneity (Snedecor and Cochran, 1994) between the species/breeds group for different subfertility traits. The statistical software used for data analysis was Systat 11.

RESULTS

Production of freezable semen

The number of bulls, for individual species and breeds, reserved for breeding and those produced freezable semen during the period of 1991 to 2005 have been summarized in Table 1. Percent production of freezable semen out of the number of bulls that produced semen was highest in Sahiwal (81.69%) and lowest in Karan Fries (58.46%). Chi square test (Table 3) revealed significant difference among the three species/breeds for the number of bulls produced freezable ($p<0.10$) and non-freezable semen ($p<0.01$).

Incidence of subfertility

The occurrence of subfertility traits leading to disposal of dairy bulls maintained at the semen collection center has been tabulated in Table 2. Poor libido was the main cause of bull wastage in indigenous breeds of cattle (22.55%) and buffalo (15.12%), while poor seminal profile was highest in crossbred Karan Fries cattle (31.41%). Two cases of orchitis, one cryptorchidism and two bulls with penile deviation

Table 2. Incidence of subfertility and causes of disposal of bulls due to subfertility problems

Particulars	Karan Fries	Sahiwal	Murrah
Poor libido (PL)	28 (11.57)	23 (22.55)	26 (15.12)
Poor semen quality (PSQ)	58 (23.97)	4 (3.92)	6 (3.49)
Poor semen freezability (PSF)	18 (7. 44)	3 (2.94)	3 (1.74)
Total culled due to subfertility (i.e. PL, PSQ and PSF)	104 (42.98)	30 (29.41)	35 (20.35)
Orchitis	1	0	0
Cryptorchid	2	0	0
Penile Deviation	2	0	0
Bulls culled due to reasons other than subfertility problems	89	47	105
Bulls under semen donation trial or experiments	37	20	24

Data in parentheses denote percent values of poor libido, poor semen quality and freezability out of total bulls reserved.

Table 3. Test of heterogeneity (x^2 test) to study the effect of breed on semen freezability

	Karan Fries	Sahiwal	Murrah	x^2 value	p*
Freezable semen	114	58	77	0.961	0.078
Non- freezable semen	89	13	17	0.999	0.002
Total	195	71	95		

* p = Probability value at 2 degrees of freedom.

Table 4. x^2 test to study the effect of subfertility problems on disposal of bulls

	Subfertility problems	Other reasons	Total culled	x^2 value	p*
Karan Fries	104	89	193	0.999	0.0009
Sahiwal	30	47	77		
Murrah	35	105	140		
Total	169	241	410		

* p = Probability value at 2 degrees of freedom.

were encountered only in Karan Fries males during the tenure. Disposal pattern of the bulls showed that poor growth rate was specific to Karan Fries and Murrah but not for Sahiwal. Chi-square test revealed that the subfertility traits were significantly important reasons ($p<0.01$) leading to disposal of bulls (Table 4).

Effect of genetic and non-genetic factors on male reproductive parameters

Least squares analyses of the andrological parameters revealed that species-breeds (B) and periods of birth (P) had significant effect on most of the traits studied (Table 5). The least squares mean along with standard error of the species/breeds for different variables have been given in Table 6. Age at first semen collection (AFSC), age at first semen freezing (AFSF) and age at disposal (AD) were the

Table 5. Least squares analyses of variance for different reproductive traits of dairy bulls

SV	df	S. Vol.	MA	AD ($\times10^5$)	AFSC ($\times10^5$)	AFSF ($\times10^5$)	SPP ($\times10^5$)	FSPP ($\times10^5$)
B	2	30.22**	2.21**	9.32**	5.74**	2.72**	6.40*	0.39
P	3	4.5	1.11**	39.98**	6.80**	10.80**	14.9***	6.64*
S	3	1.7	0..30	3.05	0.46	0.25	4.26	4.12
B×P	6	2.38	0.44*	1.54	0.81**	0.99**	2.501	2.93
Residual	187	2.96	0.16	1.86	0.25	0.28	1.87	2.09

** $p<0.01$; * $p<0.05$.

SV = Sources of variation; B = Species/breeds; S = Seasons of birth; P = Periods of birth; df = Degrees of freedom; S. Vol. = Semen volume; MA = Mass activity; AD = Age at disposal; AFSC = Age at first semen collection; AFSF = Age at first semen freezing; FSPP = Frozen semen production period; SPP = Semen production period.

Table 6. Least squares mean±SE for semen volume, mass activity (MA), age at disposal (AD), age at first semen collection (AFSC), age at first semen freezing (AFSF), frozen semen production period (FSPP) and semen production period (SPP) for Karan Fries (KF), Sahiwal and Murrah Bulls

	Karan Fries (88)	Sahiwal (50)	Murrah (64)
S. vol.	4.73±0.21^a	4.60±0.27^a	3.109±0.31^b
MA	3.25±0.05^a	3.63±0.06^b	3.574±0.07^b
AFSC	872.06±19.12^a	973.04±24.65^b	1,105.553±28.68^c
AFSF	1,044.86±20.26^a	1,085.75±26.12^a	1,205.573±30.38^b
FSPP	577.38±55.35	522.29±71.35	559.032±83.00
SPP	884.24±52.37^a	669.95±67.51^b	725.153±78.53^{ab}
AD	1,768.94±54.55^a	1,649.79±65.05^a	1,918.36±61.03^b

Data in parentheses indicate number of observation

^{a,b} No common superscript between two levels of an effect indicates significant differences ($p<0.05$).

S. Vol. = Semen volume (ml); MA = Mass activity; AFSC = Age at first semen collection (days); AFSF = Age at first semen freezing (days); FSPP = Frozen semen production period (days); SPP = Semen production period (days); AD = Age at disposal (days).

highest in Murrah and the lowest in Karan Fries (for AFSF and AFSC) and Sahiwal (for AD), while frozen semen production period (FSPP) and semen production period (SPP) were the highest in KF and lowest in Sahiwal. The least squares means of the reproductive parameters show that AFSC, AFSF, FSPP, SPP and AD were showing a decreasing trend over the periods (Table 7). Semen volume and mass activity (M.A.) did not follow any definite trend over the periods.

DISCUSSION

Production of freezable semen

It was evident that culling rate of the male calves on the basis of expected predicted difference (EPD) was the highest in Karan Fries followed by Sahiwal and Murrah due to differences in respective herd-size at NDRI dairy farm. The initial selection of the male calves based on EPD has no impact on the reproductive potential of the future bulls. One of the notable observations in this regard is the maximum incidence of subfertility in the KF males among the dairy bulls; simultaneously the freezable semen production ability was also less in crossbred cattle. The seminal parameters of the crossbred bulls have been reported to be poor than the indigenous breeds in several reports (Sethi et al., 1989; Rao et al., 1995; Khate, 2005). In a study on 173 Frieswal bulls at PDC, Meerut, India, Tyagi et al. (2000) found that 54.91% and 45.09% of the bulls produced poor quality and freezable quality semen, respectively. This account was much higher than our observation at NDRI herd. Available reports show that about 50% of the crossbred bulls produce semen which is not cryopreservable (Sethi et al., 1989; Bhavsar, 1993; Sahni and Mohan, 1998). The possible reasons resulting in variability in cryopreservability of semen from different species-breeds has been addressed by researchers. Variations in spermatozoal resistance to hypertonic solutions may affect the differential cryopreservability of different bulls (Maule, 1962; Tyagi et al., 2000). Increase in exotic inheritance may improve the freezability of crossbred semen (Methew et al., 1982).

Incidence of subfertility

The present investigation shows that subfertility problems are one of the major causes of disposal of breeding bulls. Almost half to one-third of the reserved stock is disposed due to sub-optimal reproductive efficiency. A number of reports pertaining to the vital records on semen production parameters and bull wastage (Aehnelt et al., 1963; Walter and Weiser, 1966; Djimde and Weniger, 1984) indicate that infertility and subfertility are the major reasons for disposal of breeding bulls of dairy animals in the tropical and temperate countries. Available reports agree to our findings that poor seminal attributes and freezability is common among the crossbred males, while poor libido is an irrefutable cause of subfertility among the zebu breeds of cattle (Sethi et al., 1989; Rao et al., 1995; Mathur et al., 2002). Roman et al. (1968) indicated that reproductive inefficiency and inability to serve accounted for 47% and 16% respectively, of all reasons of disposal of beef sires in US and Canada during 1949 to 1964. The most common reasons given for culling of 469 bulls (at three AI centers in Kerala, India) were poor semen quality (45.42%), poor libido (36.46%), attainment of production targets (14.07%) and poor semen freezability (10.87%) (Sudheer and Xavier, 2000). Kodagali et al. (1980) found very high proportion (i.e. 23.81% and 38.09%) of Surti buffalo bulls (at Amul AI centers, India) were culled due to poor semen quality and overall sexual derangements, respectively, while the occurrence of poor libido was only 2.38%, during four years tenure at Anand, Gujarat, India.

A total of 3 cases of cryptorchidism and orchitis were recorded in Karan Fries bulls in the present study, whereas no such cases were found in Sahiwal and Murrah. The seminal profile of the cryptorchid and orchitic bulls was investigated. The orchitic bull (KF5340) and cryptorchid

Table 7. Least squares mean±SE for semen volume, mass activity, age at first semen collection (AFSC), age at first semen freezing (AFSF), frozen semen production period (FSPP), semen production period (SPP) and age at disposal (AD) (days) for different periods

	Period 1 (69)	Period 2 (49)	Period 3 (42)	Period 4 (42)
S. vol.	4.33±0.23	3.711±0.253	4.01±0.273	4.54±0.424
MA	3.60±0.05^{a}	3.671±0.059^{a}	3.34±0.064^{b}	3.33±0.099^{b}
AFSC	1,155.13±21.01^{a}	1,013.91±23.236^{b}	912.65±25.119^{c}	852.53±38.929^{c}
AFSF	1,301.85±22.26^{a}	1,203.99±24.617^{b}	984.94±26.612^{c}	957.48±41.241^{c}
FSPP	612.94±60.80^{ab}	724.38±67.251^{a}	521.28±72.701^{bc}	353.01±112.668^{c}
SPP	853.13±57.53^{a}	1,016.34±63.632^{a}	671.91±68.789^{b}	497.74±106.604^{b}
AD	2,033.18±58.87^{a}	2,058.01±64.92^{a}	1,605.60±73.62^{b}	1,419.32±74.84^{b}

Data in parentheses indicate number of observation

^{a,b} No common superscript between two levels of an effect indicates significant differences ($p<0.05$).

S. Vol. = Semen volume (ml); MA = Mass activity; AFSC = Age at first semen collection (days); AFSF = Age at first semen freezing (days); FSPP = Frozen semen production period (days); SPP = Semen production period (days); AD = Age at disposal (days).

bull (KF6575) donated freezable semen with considerably good mass activity (+3.5 to +4.0), while the other cryptorchid Karan Fries bull (KF 6826) did not donate any freezable semen and was auctioned due poor semen quality and freezability. Effect of uni-cryptorchidism has been demonstrated as to increase the dead sperm count (Daskin et al., 1998). Two Karan Fries bulls with penile deviation but acceptable seminal profile were culled, as this problem makes semen collection with artificial vagina challenging. Again, no culling was exercised due to incidence of infectious diseases. This can be attributed to regular vaccination and efficient health management practices at the institute farm. In our study, poor growth was one of the causes of disposal in Karan Fries (5) and Murrah calves (6). In an earlier study conducted by Sethi et al. (1989), it was documented that 12.2% of the selected Karan Fries male calves, at NDRI herd, were disposed due to poor growth rate and diseases.

Factors affecting the reproductive parameters of dairy bulls

Season of birth bears its effect up to few months of age of the animal and gradually fades away. In the present study, the seasons of birth didn't differ significantly for any of the seminal parameters, however, in a study on buffalo, the male calves born during spring season were found to have higher culling rate (Kodagali et al., 1980). Effect of period of birth and breed×period interaction are entirely herd specific. In the present context improvement over the period has been noted for almost all the parameters. Better managemental practices and regular monitoring of reproductive health have contributed to improvement of the reproductive parameters. Wilcox et al. (1966) found that the periods were affecting the semen production parameters significantly, while analyzing data on 3,774 males of US and Canada.

The seminal profile of crossbred bulls is comparatively poor than that of native breeds. Mass activity (MA) was less in KF and higher in Sahiwal and Murrah, which also conform to the major subfertility problem in crossbred bulls. Sethi et al. (1989) concluded that bulls donating larger volume of neat semen with higher mass activity are supposed to produce freezable semen.

The mean age of first semen collection (AFSC) and freezing (AFSF) were lowest in Karan Fries since it attains maturity at an early age than indigenous cattle and buffalo breed bulls. The maximum herd life of the Murrah bulls, as evident from the mean Age at disposal (AD), is explained by the delayed initiation of semen donation and freezable semen production. Our findings on the mean age at first semen collection are lesser than what was reported for Murrah bulls by Suryaprakasham and Rao (1993) but comparable for Sahiwal and crossbred bulls as reported by the above authors and Rao and Rao (1995) on Jersey× Ongole crossbred and Ongole bulls. Average age of first semen donation could be reduced by subjecting the bulls on training at an early age, without affecting the semen quality and freezability (Sethi et al., 1989). The age of starting semen donation is lower in crossbred than indigenous humped breed of cattle. The results in our study have revealed a lower breeding period of the Karan Fries bulls than the findings of Rao et al. (1995) and Sudheer and Xavier (2000) in various indigenous and crossbred bulls in other herds. Kodagali et al. (1980), while studying the culling percentage of Surti buffalo bulls, reported the mean age at disposal (AD) and breeding tenure as 2,330 and 480 days, respectively.

IMPLICATION

Subfertility problems like, poor libido, poor semen quality and freezability are significantly important reasons of dairy bull wastage. The occurrence of libido problem is predominant in the indigenous breeds of cattle and buffalo, whereas the poor seminal profile, especially poor semen cryopreservability are major constraints in crossbred cattle bulls. Semen donation parameters, like age at first semen collection, age at first semen freezing were significantly higher in Murrah buffalo and lower in Karan Fries bulls. The present study clearly demonstrates that there exists a variation in reproductive parameters in the bovine bulls, which could be studied at the molecular level to unveil any genomic markers associated with subfertility and/or infertility. The prized bulls may be extensively utilized to procure valuable semen from them by subjecting the young males to training at an early age, thereby, successfully curtailing the mean age of initiation of semen donation.

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