Lifetime semen production performance of cattle and buffalo bulls

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ABSTRACT

Semen production performance data of 88 buffalo and 179 cattle bulls of different breeds from 1975 to 2018, were collected from two frozen semen stations of BAIF Research Development Foundation. The objective of the present study was to document the lifetime semen producing performanceof cattle and buffalo bulls. Traits studied were lifetime frozen semen production doses (LFSP),lifetime production period (LPP),age at first semen production (AFSP) and age at last semen production (ALSP). The factors tested for influence on these traits were breed, period and season of birth.Overall means of AFSP, ALSP, LPP and LFSP were 1859.6, 4257.2, 2581.7 days and 183631.9 semen doses in buffalo bulls, while 1386.7, 4029.4, 2076.16 days and 264566.3 semen doses in cattle bulls.Production performance for results obtained for various breeds could be useful in devising important culling and disposal policies for AI centres in the country.

Key words: Semen Production, Lifetime Production, Breed

INTRODUCTION

Artificial insemination (AI), one of the widely used biotechnological tools is used to coverthe large population of cattle and buffalo in India. AI is not only used for the genetic improvement of livestock but also for the conservation purpose.With the consistent growing population of cattle and buffalo (PKR, 2019), mostly consisting of non-descript population, the demand for good quality semen is on rise to upgrade the non-descript population.

The information on semen production capacity of bulls of different breeds would prove useful inplanning to covermaximum breedable population. The requirement of semen doses of a

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particular breed over a period of time would help decide a minimumproduction target.A knowledge of the average first and last collection of freezable semen would help serve in the selection, culling and replacement decisions as the AI centersneed adult bulls and testing bulls to replace the adult stock. With this objective, the present study was designed to document the lifetime semen producing performance of cattle and buffalo bull breeds reared in the AI Stud Farm.

MATERIALS AND METHODS

Semen production performance data of 88 buffalo and 179 cattle bulls of different breeds were collected from two frozen semen stations of BAIF Research Development Foundation, viz. Uruli Kanchan, Pune, Maharashtra for the years between 1975-2018,and at Dharouli, Jind, Haryanafor the years between 2011-2018.The buffalo breeds included in the study were Banni (2), Bhadawari (4), Murrah (66), Jaffarabadi (5), and Surti(11) while the cattle breeds included in the study were Gir (16), Hallikar (4), Holstein Friesian (HF)100% (30), HF50% (31), HF62.5% (4), HF75% (27), Jersey 100% (25), Jersey 50% (12), Jersey 62.5% (7), Jersey 75% (9), Khillar, (2) and Sahiwal (12). The date of birth, first and last collection records and frozen semen doses produced per ejaculate were utilized for the analysis. The traits considered for the analysis were lifetime frozen semen production doses(LFSP),lifetime production period (LPP),age at first semen production (AFSP) and age at last semen production (ALSP). The period of birth was divided into five groups viz. <1980, 1981-1990, 1991-2000, 2001-2010 and 2011-2018. Season of birth were divided into three categories viz. summer (March to May), monsoon (June to October) and winter (November to February). Until 2004, the sperm concentration per frozen semen dose was 30 million. From 2005 onwards, the sperm concentration per semen dose was revised from 30 million to 20 million per dose. Considering this fact, the LFSP was studied only for the period after 2005. The records were subjected to statistical analysis using least square analysis using "*lm*" function in R statistical software (RCT, 2019 version 4.0.1.). Along with "*lm*" function, "*car*" and "*agricolae*" packages were used for computing ANOVA (Type III sum of square) and Duncan's multiple range test. The model for the analysis is given below:

$$Y_{ijkl} = \mu + B_i + S_j + A_k + e_{ijkl}$$

Where,

Y_{ijkl} = Lifetime semen production performance trait

μ = Overall mean

B_i = Effect of m^{th} breed (m = 1 to 5 or 12)

S_j = Effect of n^{th} season of birth (n = 1 to 3)

A_k = Effect of k^{th} period of birth (k = 1 to 5)

e_{ijkl} = Random error associated with Y^{ijkl} which is assumed to be normally and independently distributed with mean zero and constant variance

RESULTS AND DISCUSSION

Lifetime semen production performances of Buffalo and Cattle bulls

The least square means of lifetime frozen semen production traits like age at firstsemen production (AFSP) and last semen production (ALSP), lifetime frozen semen production doses (LFSP) and lifetime semen production period (LPP) of buffalo and cattle bulls are presented in Tables 1 and 2, respectively.

Breed had significant effect on AFSP. Banni and Bhadawari breeds had a higher AFSP in comparison with the other breeds while Murrah had the lowest AFSP. LFSP was highest in Murrah and lowest in Bhadawari buffalo breed. Banni and Jaffarabadi bulls did notdifferfrom each other in

these traits. Breed showed no significance for the ALSP, LFSP, and LPP traits.

The breed differences in the age at first collection of buffalo bull semen were due to difference in the age of the bulls purchased. Murrah bulls were purchased at a very young age of 18 to 24 months, while Banni and Bhadawari bulls were purchased at a comparatively older age of 3 years, subsequently thus delaying the collection of their first ejaculate. Mukhopadhyay *et al*. (2010), Khatun *et al*. (2013) and Ramajayan (2016) had reported a still lower age at first semen collection in Murrah buffaloes. Early sexual maturity leads to collection of semen at an early age resulting in an overall production of semen doses, reduction in generation intervaland subsequentlyresulting inincreased genetic gain.

Breed effect on lifetime production of semen doses was particularly due to preferential treatment at the semen station over the bulls. Murrah breeds are in huge demand in the field unlike the Banni and Bhadawari which have a very small breeding tract.They are also not been used for grading up purposes. Thus, the cattle breeds with less demand were subjected to fewer collections of semen and which resulted in the production of lesser number of doses.

From the averages presented for age at last semen collection and lifetime production period, it was also observed that on an average, the semen collection was carried out for approximately 8-9 years of productive life and which was found similar for all the breeds and may perhaps explain the reason for the non-significant effect due to breed.

All the lifetime production traits except LPP was found to be significantly affected by breed factor in cattle. AFSP was found to be the lowest in HF pure bulls. However, HF pure bulls did not differ significantly from other HF crossbreds and Jersey and their crossbred bulls except Jersey 62.5% bulls which had the highest AFSP. Indigenous bulls showed comparatively a higher AFSP and ALSP than the exotic and crossbred bulls. HF 100% bulls had the highest LFSP means in comparison to other breeds. Apart from Gir and Hallikar bulls, all the other breeds did not differ statistically from each other.

The different genotypic groups present, the number of bulls available in a particular genotype, the demand in field and the age of puberty was found to have a significant effect on all the lifetime semen production traits except lifetime production period in cattle.The exotic breeds HF and Jersey had a lower age of semen production and thus produced higher semen doses in comparison with the other breeds. This was followed by the crossbred bulls which had a lesser age at puberty in comparison with the indigenous breeds of cattleand which had a huge demand in the field for crossbreeding purposes.Thus the semen production from each pure and crossbred bull was observed to be higher than that produced by the indigenous bulls. The *Bos taurus* bulls attain sexual maturity at the age of 8 to 10 months of age while the *Bos indicus* bulls take a little longer to attain sexual maturity viz., 16-18 months (Wolf *et al.*, 1965; Almquist *et al.,* 1976; Lunstra *et al.*, 1978; Chenoweth *et al.,* 1996 and Vale Filho *et al.,* 1997). Brito *et al.* (2002) reported a slightly higher age at puberty in crossbred bulls (13.8 months; 421 days). Age at puberty depends on the early release of gonadotropin secretion and which usually increases between 2 to 5 months after birth. It had been observed that the pattern of secretion of gonadotropin differedbetween the early and late maturing bulls. A higher concentration of luteinizing hormone was found in early maturing bulls than in late maturing bulls(Evans *et al.,* 1995 and Aravindakshan *et al.,* 2000). Age at last semen production in cattle bulls showed little variation among the breeds (Table 2). It was also observed that the average lifetime production period among the cattle breedsin the present study was 6 to 7

years. This may perhaps explain the reason why there was no difference among the breeds for lifetime production period.

Age at first and last semen collection among the HF and Jersey crossbred and Sahiwal breed cited by different researchers (Rao, 1984; Suryaprakasam and Rao, 1993; Chauhan*et al.*, 2010; Mukhopadhyay *et al.,* 2010; Gopinathan, 2014; Khatun *et al.*, 2013 and Thippesamy *et al.,* 2014) reveal slightly lower means than the present study. Similarly, the lifetime production period and semen doses reported by Mukhopadhyay *et al.* (2010) and Gopinathan (2014) in Jersey and HF crossbred bulls were found to be lower than observed in the present study. The difference among the earlier reports and present study may perhaps be attributed to management measures practicedin the semen stations.

Period of birth had a significant effect on all the lifetime semen production traitsin cattle and buffalo bulls (except for lifetime frozen semen production in which the period of birth effect was not tested).The significant difference among the traits due to periodmay be due to the number of bulls studied and the increase in demand in the last two decades.Season of birth had no statistically significant effect on any lifetime production traits of both cattle and buffalo bulls.

SUMMARY

Production performance for results obtained for various breeds could prove useful in culling decisions and disposal policies for AI centres in the country.

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Table 1.

Least square mean of lifetime semen production traits in buffalo bulls

Levels	AFSP	ALSP	LFSP	LPP
Overall mean	1859.6±110.52	4257.2±229.8	183631.9±25077	2581.7±235.2
Breed	**	NS	NS	NS
Banni	2056±234.1[a]	5175±710	171812±65962	2765±736
Bhadawari	2270±188.4[a]	4548±524	100053±65300	1771±543
Jaffarabadi	1782±120.3[ab]	4538±480	209573±47807	2644±498
Murrah	1585±78.1[b]	4835±170	242330±21673	3166±176
Surti	1729±110.1[ab]	5039±301	-	2991±312
Period of birth	**	**	-	**
≤1980	1416±269[a]	6477±536[a]	-	2975±555[ab]
1981 to 1990	1315±137[c]	4916±291[b]	-	3441±301[a]
1991 to 2000	1712±129[b]	3850±320[c]	-	1725±332[b]
2001 to 2010	1288±109[c]	4065±208[c]	-	2528±216[b]
2011 to 2018	1567±226[bc]	-	-	-
Season of birth	NS	NS	NS	NS
Summer	1879±133	4781±296	175205±33227	2629±307
Monsoon	1849±117	5017±275	166817±44333	2816±286
Winter	1851±116	4684±284	200804±34978	2557±294

(**LFSP**: Lifetime frozen semen production doses; **LPP**: Lifetime production period; **AFSP**: Age at first semen production; **ALSP**: Age at last semen production)

Table 2.

Least square mean of lifetime semen production traits in cattle bulls

Levels	AFSP	ALSP	LFSP	LPP
Overall mean	1386.71±67.8	4029.4±109.08	264566.3±23939.1	2076.16±148.6
Breed	**	*	*	NS
Gir	1495±148.4[b]	4162±270[b]	151015±50337[b]	1844±291
Hallikar	1741±277.5[ab]	4263±504[b]	122239±87186 [b]	1502±543
HF100%	757±52.6[b]	3936±176[b]	391348±45254[a]	2295±189
HF50%	1259±99.5[b]	4247±197[ab]	298543±62184[ab]	2382±212
HF62.5%	1203±163.2[b]	5131±511[ab]	-	2293±551
HF75%	1135±74[b]	4395±209[ab]	347515±49024[ab]	2480±225
JR100%	941±59[b]	3910±178b [ab]	236561±53524[ab]	2176±192
JR50%	1211±134.3[b]	4731±297[ab]	354490±67826[ab]	2711±320
JR62.5%	2256±189.1[a]	5442±377[a]	-	1660±407
JR75%	1218±157.3[b]	4332±336[ab]	313282±107676 [ab]	2175±362
Khillar	1315±366[b]	3996±699[b]	187285±111309 [ab]	1742±754
Sahiwal	1663±150.8[ab]	4392±298[ab]	243387±89101 [ab]	1648±321
Period of birth	**	**	-	**
≤1980	1547±104.6[b]	5049±378[a]	-	1089±408[a]
1981 to 1990	1762±104.1[a]	4836±192[ab]	-	2154±207[b]
1991 to 2000	1290±86.2[b]	3952±147[b]	-	2530±159[b]
2001 to 2010	1193±69.9[b]	3809±133[b]	-	2530±143[b]
2011 to 2018	1268±93.6[b]	-	-	-
Season of birth	NS	NS	NS	NS
Summer	1463±82	4332±174	239561±41027	2047±187
Monsoon	1383±76.8	4536±184	241412±36884	2079±199
Winter	1390±77	4367±158	312726±36699	2100±170

(**LFSP**: Lifetime frozen semen production doses; **LPP**: Lifetime production period; **AFSP**: Age at first semen production; **ALSP**: Age at last semen production)