Pakistan Vet. J., 2007, 27(1): 20-24.

SEMEN PRODUCTION AND PRODUCTIVE LIFE OF SAHIWAL BULLS: RELATIONSHIP WITH GENETIC WORTH

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ABSTRACT

Objective of the present study was to document the semen producing ability, productive life and genetic ability for lactation milk yield of Sahiwal bulls used for artificial insemination (AI) in Punjab and to find the impact of AI bulls on the improvement of Sahiwal cattle. Data from Semen Production Unit (SPU), Qadirabad, Sahiwal, Pakistan were used for this purpose. A repeatability animal model was used for estimation of breeding values for lactation milk yield. Productive life of a bull was calculated as a difference between culling age and the age at first ejaculation. Number of bulls brought to SPU varied from 9 to 102 for any year. Average number of doses of semen produced by any bull for a year varied from 724 to 5745. On the average, 238 bulls produced 17143 ± 1164 semen doses during their average stay of 5.4 ± 0.2 years. About 50% of the bulls stayed for less than four years at the SPU; with a maximum range of 14 years. Progeny tested bulls (n=90) produced 5000 and 10000 semen doses (Y) in three and four years of stay (X), respectively ($Y = 24.8 + 2.3635 X - 0.0112 X^2$). To produce 20,000 doses, it is predicted that bulls need to stay for six and a half years at the SPU. There was no association between breeding values for lactation milk yield estimated under a repeatability animal model (EBVs) and number of semen doses produced (r = 0.17) and EBVs and number of daughters. Lack of genetic superiority of bulls used indicated that AI did not bring desired genetic improvement in Sahiwal cattle in the present situation. Modifications for judicious utilization of bulls are suggested along with improvements in data recording.

Key words: Artificial insemination, genetic improvement, Sahiwal cattle.

INTRODUCTION

Artificial Insemination (AI) is used as a tool for genetic improvement in farm animals. In this technique, semen from genetically superior males is collected, diluted and inseminated to a large number of female population that otherwise is impossible to cover through natural mating. For this purpose, semen of Sahiwal bulls is collected at Semen Production Unit (SPU), Qadirabad and disseminated throughout the Punjab province for use in AI.

In the absence of any breed improvement programme in the Sahiwal breed, the criteria of selection of Sahiwal bulls has been the dam's lactation milk yield. Cows at the livestock farms are grouped into different categories, depending upon their lactation milk yield. A cow is declared as having A, B, C or D category if she has produced lactation milk yield of ≥2700, 2250-2699, 1800-2249 or <1800 litres, respectively (Anonymous, 2000). Bulls fulfilling the breed's phenotypic characteristics are chosen from A-category dams and are brought to SPU Qadirabad. Sometimes, bulls from show ring winners of provincial or national competitions are also brought to SPU for using their semen in AI.

The efforts to compile the records of daughters of Sahiwal bulls for progeny testing at the government livestock farms started in the mid 80s (Chaudhry, 2006). The record keeping of Sahiwal cows at farmer level started with the inception of Research Centre for Conservation of Sahiwal Cattle at Jhang (Iqbal, 2005).

The age of the bull at semen collection not only affects the volume of the ejaculate, but also its quality. Mathevon *et al*. (1998) analyzed semen production data from 198 Holstein bulls, both young (up to 30 month old) and mature bulls (between 4 and 6 yr old), and reported that semen volume, sperm concentration, motility and total motile sperms generally improved significantly with age of young bulls ($P<0.001$). Season significantly affected all semen traits in young bulls but did not affect volume and sperm motility of mature bulls. This encourages keeping breeding bulls for longer duration. But if genetic ability of some bulls for milk yield is inferior to other bulls then there is no justification of using such bulls for AI. The objective of the present study was, thus, to document the semen producing ability, productive life and genetic ability for lactation milk yield of Sahiwal bulls used in AI at the SPU, Qadirabad and find if these bulls contributed to improvement in Sahiwal cattle.

MATERIALS AND METHODS

Multiple lactation records (n=23,761) of 5936 Sahiwal cows from five main Livestock Experiment Stations (LES) in Punjab province (Allahdad, Khanewal; Bahadurnagar, Okara; Fazalpur, Rajanpur; Jahangirabad, Khanewal; Khizerabad, Sargodha) from1964 to 2004 were used for the present study. A total of 396 Sahiwal bulls were brought to SPU, Qadirabad from 1972 to 2004. Available data from the SPU was matched with the pedigree and performance records of the five LESs mentioned above. Dams of 97 bulls could only be traced. In case of any doubt, history sheet information (individual cow record) available with LESs were assumed correct. Pedigree and performance (milk yield and lactation length) information on all the animals in the data set was used to estimate breeding values (EBVs) for bulls used for AI in the Punjab province.

The EBVs were estimated using an individual animal model, incorporating all known relationships and important environmental sources of variation. Bulls were ranked for lactation milk yield, using a repeatability animal model described by Khan (1998). The model included herd-year of calving (169), season of calving (4) and parity (10) as fixed effects. Random effects were individual animal and permanent environment. For ratio of error variance to additive genetic variance, heritability was estimated as described earlier (Rehman, 2006). Productive life of a bull was defined as the duration between the age at first ejaculate and its disposal from the SPU. Data on live bulls were not used for the present study because they did not have their disposal date as yet. The genetic and environmental variances were estimated by DFREML (Meyer, 1997). Coefficient of regression and correlation coefficients were estimated using Microsoft Excel (2000).

RESULTS AND DISCUSSION

Semen production from Sahiwal bulls at SPU Qadirabad was quite variable across years (Table 1). Number of bulls brought for semen production varied between 9 and 102 for one year. Average number of semen doses produced by bulls varied between 724 and 5745 with a maximum range of 2442-17801 doses for any year. Thus, there was improvement in the number of semen doses collected from a bull over the years.

The EBVs for lactation milk yield showed a wide variation among the bulls with authenticated pedigree information. Bulls supplied to SPU Qadirabad came from different sources and essential information about the bulls was missing. One of the major problems was identification numbers: which were multiple, prone to confusions and contradictions. As animal evaluation now-a-days depends heavily on pedigree and progeny relationships, pedigree information must be authentic and available at different places. The inflated records of dams to push Sahiwal bulls into A-category, especially for purchased dams, also dilute the authenticity of the data. In the absence of authentic data no model can reduce bias in evaluation procedure (Bhatti *et al*., 2007).

The relationship between EBVs for lactation milk yield and semen doses produced by a bull was not different from zero. The correlation coefficient between the two traits was 0.17 (Fig. 1). Relationship between number of semen doses produced by a bull and recorded daughters at the livestock experiment station was also close to zero (r=0.08) (Fig. 2). This indicates that genetically superior or inferior bulls had equal opportunity to be use for AI. Not only the selection of bull dams (on highest lactation yield) is unscientific (Bhatti *et al*., 2007) but also utilization of bulls, too. Many genetically superior bulls left few daughters and many inferior bulls left many daughters. This could have been avoided if there was a strong coordination between Directorate of Farms and Directorate of Breed Improvement. Absence of animal breeding experts in the directorates and lack of realization to select bulls on scientific lines are probably the major reasons for the indiscriminate use of bulls for AI.

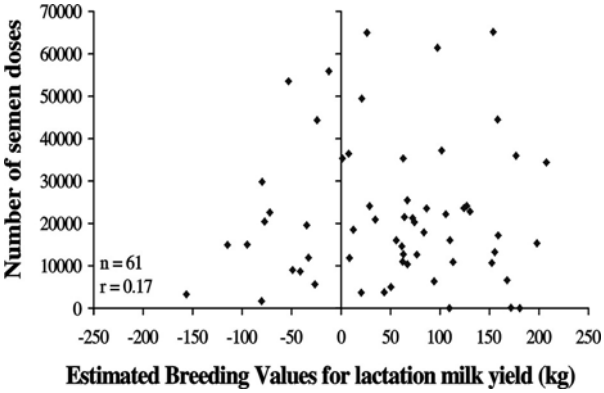

Fig. 1: Relationship between estimated breeding values for lactation milk yield and number of semen doses produced by a bull.

Data sheets being used for record keeping both at the livestock farms as well as at SPUs need to be modified. Traits such as scrotal circumstances (SC) may be measured for bulls but the trait should not be expected to bring revolution in the genetic ability of bulls for traits like milk yield or even age at first

Table 1: Semen doses produced by Sahiwal bulls at SPU Qadirabad during different years

Year	No. of bulls	Minimum	Maximum	Mean	S.D
1973-74	15	67	3882	1910	1214
1974-75	17	85	2442	724	794
1975-76	17	87	2875	1278	774
1976-77	15	129	6225	2056	1702
1977-78	16	150	3524	1338	975
1978-79	10	477	5315	3130	1626
1979-80	9	763	6403	3600	1920
1980-81	11	117	10807	4307	3701
1981-82	20	70	11101	2927	3629
1982-83	17	426	11304	4045	2816
1983-84	17	29	10066	5204	2741
1984-85	34	212	8273	4150	2510
1985-86	53	18	6971	2256	1948
1986-87	58	26	6369	2797	2166
1987-88	57	58	5407	2172	1378
1988-89	72	12	6444	28670	1785
1989-90	73	8	7504	3215	2256
1990-91	85	20	7748	2822	2121
1991-92	82	20	8042	2927	2167
1992-93	99	14	10096	3311	2587
1993-94	102	9	17801	3118	2923
1994-95	88	71	14297	4082	2372
1995-96	81	54	13778	4383	2575
1996-97	87	28	14448	3771	3314
1997-98	73	83	12623	5429	3085
1998-99	61	90	3477	1903	950
1999-00	74	117	13060	5162	3523
2000-01	83	26	14933	5568	4119
2001-02	76	66	14468	5745	3239
2002-03	84	30	13456	4789	3440
2003-04	77	239	14130	5522	2823

calving. It is generally implied that selection of better SC would help in the selection for early puberty in the daughters of such bulls (Anonymous, 1995). Selection for better SC in bulls to improve age at first calving of their daughters had some evidence (BIF, 1990) but recent studies have negated this concept (Martinez-Velazquez *et al*., 2003). The genetic response in female reproductive traits through sire selection for SC would not be effective. Therefore, measurement of SC may be important for more semen volume or better quality (Smith *et al*., 1989; Foote, 2002), but not for genetic improvement. Many of the male fertility parameters have good genetic control and can be improved adequately (Mathevon *et al*., 1998; Ducrocq and Humblot, 1998) but may not be useful indices for selection for higher milk yield.

The productive life of a bull is important for efficient utilization of resources. Semen volume and ejaculate characteristics improve with bull's age (Brito *et al*., 2002; Fuerst-Waltl *et al*., 2006). The productive life of Sahiwal bulls brought to SPU since 1972 ranged upto 14 years. Abut 50% of bulls produced semen for 3-4 years. On the average, 17143 ± 1164 semen doses were produced by an average bull (Table 2).

Out of 238, 10 bulls had productive life beyond 12 years (Fig. 3). Average number of semen doses produced by these bulls was 60070 ± 6524. The common duration of productive life was between 1 and

Table 2: Frequency of Sahiwal bulls for productive life and average semen doses produced

Productive life (years)	Number of bulls	Cumulative %age	Semen doses
<1	9	03. 8	586 ± 200
1-2	54	26.5	4102 ± 557
3-4	57	50.4	9908 ± 1015
5-6	48	70.6	13935 ± 1140
7-8	37	86.1	28154 ± 2190
9-10	12	91.2	33108 ± 4439
11-12	11	95.8	52708 ± 3630
>12	10	100.0	60070 ± 6524
Overall	238		17143 ± 1164

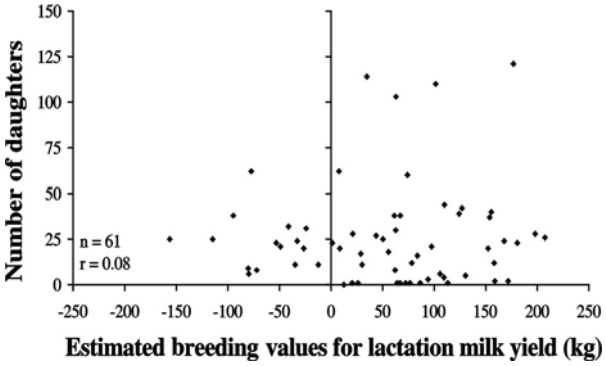

Fig. 2: Relationship between estimated breeding values for lactation milk yield and number of daughters produced by a bull.

6 years. There were many bulls that stayed on the SPU for many years but produced just few thousand semen doses, indicating lack of culling protocols for judicious use of space and resources at the SPU. These data were also used to predict productive life (Fig. 4). A quadratic fit was selected providing 74.2% coefficient of determination. Only bulls under progeny testing programme (n=90) were used because interpretations are intended to be used for allocation of resources for the purpose. Including all bulls would have yielded lesser accurate models because progeny testing bulls are more carefully utilized as compared to other bulls. The regression equation developed from the data was as under:

Productive life (months) = 24.8 +2.3635 (semen doses) – 0.0112 (semen doses)^2

Fig. 3: Distribution of Sahiwal bulls for productive life.

This meant that for allocation of resources, if 5000 semen doses were to be collected from a bull, on the average a bull needed to stay at the SPU for 36 months [= 24.8 +2.3635 (5000) – 0.0112 (5000)^2]. Similarly, for 10,000 semen doses, productive life would be 47 months and for 20,000 doses, it would be 68 months. The question that younger bulls should replace older bulls more frequently or older bulls be used as long as they produce good quality semen, has previously been addressed. Dahlin (1998) used various options to predict genetic gain in Sahiwal bulls. He recommended that young sire testing is more beneficial than older bulls. Therefore, under progeny testing programme, a bull should not stay at the SPU for more than 4 years to produce 10000 doses of semen. Under an efficient semen collection regime, this may be reduced to two years, as the present data indicated that many bulls produced more that 5000 doses per year. This could help reduce the generation interval and improve genetic gain. Bulls which had produced 10000 doses of semen may then be sent as community bulls for areas where there is no AI coverage as yet. This requires that data recording at SPU be modified to collect information for animal evaluation both from genetic improvement and reproductive efficiency.

Conclusions

The present data indicates that AI, an important tool for genetic improvement, did not bring desired genetic improvement in Sahiwal cattle due to indiscriminate use of bulls for AI in Punjab.

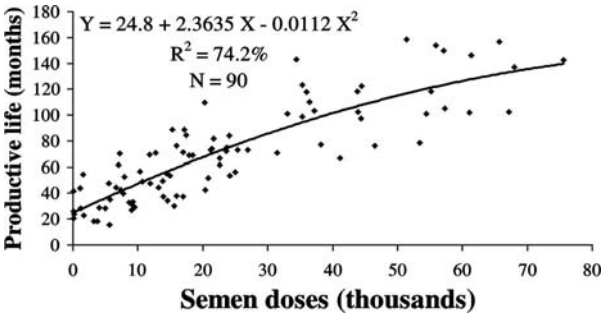

Fig. 4: Productive life vs semen doses produced by Sahiwal bulls under progeny testing programme.

Acknowledgements

This study was supported by Agriculture Linkage Program (ALP) of Pakistan Agriculture Research Council (PARC) through a project "Development of milk recording and genetic evaluation models in Sahiwal cattle" being executed at the Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad (Pakistan). Cooperation of Breed Improvement Directorate, Livestock and Dairy Development Department, Government of Punjab for providing data of semen production is gratefully acknowledged.

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