



Genetic improvement of Sahiwal cattle through associated herd progeny testing programme

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Received: 27 August 2020; Accepted: 7 December 2021

ABSTRACT

The breed improvement programme of Sahiwal cattle is implemented under AICRP on Cattle through associated herd progeny testing aiming for their conservation and propagation, and improvement in milk production. The production of frozen semen doses of genetically superior young bulls are being done at germplasm (GP) unit located at NDRI, Karnal and frozen semen doses of the bulls are supplied to all Sahiwal data recording (DR) units for test mating. During the last 11 years, 35 bulls in four sets have been inducted under the programme for test mating. First set of eight Sahiwal bulls were evaluated on the basis of 123 first lactation 305-days records of their daughters born during the period between 2011 and 2013 using Best Linear Unbiased Prediction (BLUP) method. The BLUP model included the Herd-year-season effect as fixed factor and sires as random factor. The overall average estimated breeding value (EBV) was 1957.76 kg and the values of bulls ranged between –16.84 (–0.86) to +31.98 (+1.63) kg. It was also recommended to use the frozen semen doses of two top ranked Sahiwal bulls for nominated mating for producing young male calves for increasing the milk production in subsequent generations. The results also revealed that the performance of Sahiwal cattle has improved over the years due to the implementation of the project, and continuous and sincere efforts are essential to propagate this valuable germplasm.

Keywords: Estimated breeding values, Genetic evaluation, Milk yield, Progeny testing, Sahiwal cattle

According to 20th Livestock Census, India has the largest cattle population of 192.49 million, which constitutes nearly 16% of the world's total cattle population. The indigenous/non-descript cattle constitutes 73.82% of the national cattle population while the rest 26.18% is constituted by the crossbreds of various breeds. Among the indigenous breeds of cattle, Sahiwal is one of the best dairy breeds known for its milk production, disease resistance, endurance to hot tropical climate, low maintenance cost and higher percentage of quality milk constituents in milk. Considering these inherent qualities, Sahiwal breed was utilized widely for crossing with European breeds to develop the crossbreds, viz. Australian milking zebu, Jamaica Hope, Australian Friesian Sahiwal, Mpwapwa and Pabna crosses.

Evaluation of breeding bulls is necessary for selection and dissemination of genetically superior germplasm for improving the milk production. The small herd size, lack of well-organized farms and proper recording system are the major constraints preventing the evaluation of breeding bulls extensively in our country. These difficulties are overcome by the concept of associated herd progeny testing

programme through which the bulls are evaluated utilizing large number of daughter records for testing.

ICAR-Central Institute for Research on Cattle, Meerut has taken up a genetic improvement program of important indigenous cattle breeds in collaboration with various agricultural/veterinary universities, State Government and NGOs. The objective of the project is to improve the overall performance of the important indigenous cattle breed through progeny testing and production of future young male calves using semen of proven bulls for elite mating. The objectives are to undertake testing and selection of bulls for bringing improvement in populations involved and to provide superior germplasm for utilization in developmental programmes for improving draft/draft and milk production.

The programme on genetic improvement of Sahiwal cattle is being implemented since 2010 under AICRP on Cattle for their conservation and propagation. ICAR-NDRI, Karnal was identified as the germplasm unit (GP unit) and semen doses of genetically superior young are being collected and frozen. A total of four associated herds were identified and included as data recording unit under existing program. Presently, these units are located at GADVASU, Ludhiana; GBPUA&T, Pantnagar; LUVAS, Hisar. Frozen semen doses are being supplied to the

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associated herds for AI and efforts are taken to increase the milk yield.

MATERIALS AND METHODS

Bull selection: Eight young bulls born through nominated mating at the Sahiwal herd of NDRI, Karnal were selected for the study based on their dam's milk yield. Frozen semen doses of these bulls were used in the associated herds. Total 123 daughters records of 8 bulls calved during 2011–13 and maintained under different data recording units of the project were utilized for evaluation of genetic worth of bulls. The basic information on pedigree of Sahiwal cattle were collected and the first lactation 305-days milk yield of daughter was predicted as the sum of each fortnightly daily milk record multiplied by 15. Abnormal records, viz. abortion, stillbirth, mastitis etc. were excluded from the study. Information on animals having incomplete lactation records due to early disposal was also excluded.

Based on agro-climatic conditions of the region, the whole year was divided into three seasons, viz. summer (March–June), monsoon (July–October) and winter (November–February). The information on centre, year and season of calving were utilized to generate the herd-year-season (HYS) effect which was considered as fixed effect while the effect of sire was considered as random. For sire evaluation, bulls having five and more daughters were only included. The estimated breeding values (EBV) of bulls were estimated by best linear unbiased prediction (BLUP) method as given by Henderson (1973, 1975) using the LSMLMW Model VIII (Harvey 1990). The numerator relationship matrix consisting of relationship between sires was considered for estimating the EBVs of the sires.

The general model of BLUP estimation was considered as follows:

$$Y_{ijk} = Xh_i + Zs_j + e_{ijk}$$

where Y_{ijk} , observation vector of trait with dimension $(n \times 1)$; X , design matrix or incidence matrix for fixed effects with dimension $(n \times p)$; h_i , vector for fixed effect of dimension $(p \times 1)$; Z , design matrix or incidence matrix for random effects with dimension $(n \times q)$; s_j , vector of random effect with mean zero and variance $G\sigma_s^2$ with dimension $(q \times 1)$; e_{ijk} , random error vector with dimension $(n \times 1)$ with mean zero and variance $I\sigma_e^2$.

RESULTS AND DISCUSSION

The productive and reproductive performance of the GP and DR units of Sahiwal cattle is presented in Table 1.

Germplasm unit (ICAR-NDRI Karnal): The average first lactation total milk yield, first lactation 305-days milk yield and first peak yield were 2210.34 ± 126.50 , 2148.63 ± 112.10 and 10.59 ± 0.54 respectively (Table 1). The first lactation 305-days milk yield obtained in this study was higher than the values reported by Ahmad *et al.* (2001), Monalisa (2010) and Dongre (2012). The average first lactation length was 288.0 ± 14.13 days. Overall average age at first calving, first service period, first dry period, first calving interval were 1176.55 ± 28.96 (39 months), 133.32 ± 14.95 , 140.18 ± 12.39 and 377.42 ± 14.92 days respectively. The wet and herd averages were 7.87 and 3.17 kg respectively.

Data recording units: The highest first lactation total milk yield and 305 days lactation milk yield of 2202.1 ± 84.4 and 2183.3 ± 81.9 kg was recorded in GADVASU, Ludhiana followed by 1949.71 ± 169.47 and 1900.41 ± 150.29 in GBPUAT, Pantnagar while the lowest yield of $1678.67 \pm$

Table 1. Productive and reproductive performance of Sahiwal cattle

Trait	NDRI, Karnal	GADVASU, Ludhiana	LUVAS, Hisar	GBPUA&T, Pantnagar
Age at first calving (days)	1176.55±28.96 (40)	1353.09±69.91 (11)	1310.36±73.32 (11)	1181.35±27.45 (31)
First lactation total milk yield (FLMY in kg)	2210.34±126.50 (29)	2202.1±84.4 (14)	1678.67±130.07 (17)	1949.71±169.47 (21)
First lactation 305-days or less milk yield (kg)	2148.63±112.10 (20)	2183.3±81.9 (14)	1636.39±117.03 (17)	1900.41±150.29 (21)
First lactation length (FLL in days)	288.0±14.13 (29)	272.5±14.15 (14)	265.94±14.45 (17)	267.85±16.30 (21)
First peak yield (FPY in kg)	10.59±0.54 (29)	12.84±0.5 (14)	9.31±0.35 (17)	12.78±0.53 (30)
First dry period (FDP in days)	140.18±12.39 (22)	163.4±15.7 (17)	173.12±16.51 (17)	159.25±19.69 (12)
First service period (FSP in days)	133.32±14.95 (22)	165.16±18.24 (17)	138.59±12.46 (17)	127.66±13.42 (21)
First calving interval (FCI in days)	377.42±14.92 (22)	450.0±17.97 (17)	427.47±12.26 (17)	431.16±28.30 (12)
All lactation total milk yield (kg)	2219.83±90.29 (109)	2227.5±87.6 (58)	1726.80±86.89 (54)	2078.62±98.00 (65)
All lactation 305-days or less milk yield (kg)	2128.42±77.45 (109)	2198.7±83.9 (58)	1707.88±84.34 (54)	1983.68±80.83 (65)
All lactation length (LL in days)	275.03±6.68 (109)	292.9±17.2 (58)	243.02±8.59 (55)	275.21±10.25 (65)
All lactation peak yield (PY in kg)	13.01±0.33 (109)	12.95±1.2 (58)	10.20±0.34 (62)	12.59±0.31 (65)
All lactation dry period (DP in days)	114.07±7.52 (41)	184.24±15.16 (43)	167.05±8.56 (43)	163.26±12.10 (38)
All lactation service period (SP in days)	128.17±7.62 (41)	159.05±7.44 (43)	123.61±8.38 (46)	143.27±8.22 (91)
All lactation calving Interval (CI in days)	374.31±3.45 (41)	446.22±11.4 (43)	412.70±8.45 (46)	445.07±16.33 (38)
Wet average (kg)	7.87	7.53	7.84	7.55
Dry average (kg)	3.17	5.42	4.13	4.50

Table 2. Set wise information of Sahiwal breed (since inception)

Particular	Set-1	Set-2	Set-3	Set-4	Total
Year of induction of set	2010	2013	2016	2019	–
No. of bulls inducted/used	8	7	10	10	35
No. of semen doses frozen	54754	64365	56869	53062	229050
No. of semen doses utilized	31959	30059	24050	20454	106522
Cows covered	840	784	614	306	2544
No. of female calves born	343	294	326	40	1003
No. of female reached AFC	225	147	6	0	378
No. of daughters completed 1 st lactation	221	105	5	0	331
Frozen semen doses available	22795	34306	32819	32608	122528

130.07 and 1636.39±117.03 kg was recorded in LUVAS, Hisar respectively. The average first lactation length of Sahiwal cows at Hisar, Ludhiana and Pantnagar were 265.94±14.45, 272.5±14.15 and 267.85±16.30 days respectively. The averages for first calving interval of Sahiwal in Hisar, Ludhiana and Pantnagar were 427.47±12.26, 450.0±17.97 and 431.16±28.30 days respectively. The lowest average age at first calving (AFC) of 1181.35±27.45 (39 months) was observed at Pantnagar unit while highest AFC of 1353.09±69.91 days (45 months) was noticed in GADVASU, Ludhiana. However, first service period was lowest (127.66±13.42 days) in GBPUAT, Pantnagar and highest (165.16±18.24 days) in GADVASU, Ludhiana. The average first dry period of Hisar, Ludhiana and Pantnagar was 173.12±16.51, 163.4±15.70 and 159.25±19.69 days respectively. The wet averages in Hisar, Ludhiana and Pantnagar were 7.84, 7.53 and 7.55 kg respectively while the herd averages were 4.13, 5.42 and 4.50 kg respectively.

Semen production: The details of first set of bulls on the number of bulls inducted, semen doses frozen, semen doses utilized, daughters born, daughters completed first lactation etc. are given in Table 2.

Genetic evaluation of first set of Sahiwal bulls: The descriptive statistics for first lactation 305-days milk yield of daughters of first set of Sahiwal bulls were calculated. The first lactation 305-days milk yield of Sahiwal cattle ranged between 633.2 to 3243.6 kg with an overall average of 2051.03 kg. The coefficient of variation was 27.86%.

The data on daughters' milk production were used for estimation of EBVs of Sahiwal bulls by BLUP method using the LSMLMW package of Harvey (Table 3). The average number of daughters per bull ranged between 10 for 1727

Table 3. Estimated Breeding values (EBVS) of first set of Sahiwal bulls

Sire No.	No. of daughters	Mean±SE (kg)	% of genetic superiority over population	Ranking
Overall	123	1957.76±59.13		
1681	14	1954.18±70.65	–3.582 (–0.18)	5
1727	10	1959.36±72.22	1.602 (+0.08)	2
1815	11	1955.86±71.23	–1.895 (–0.09)	4
1817	15	1951.78±71.00	–5.979 (–0.30)	7
1852	20	1989.75±69.09	31.989 (+1.63)	1
1854	22	1957.02±68.27	–0.738 (–0.03)	3
1909	15	1953.21±72.47	–4.555 (–0.23)	6
1958	16	1940.92±71.06	–16.841 (–0.86)	8

to 22 for 1854. Since the bulls were evaluated on the basis of daughters born in associated herds covering the farmer herds, the loss of data due to disposal of animals before completion of first lactation could not be avoided. The overall average breeding value of the Sahiwal bulls for first lactation 305-days milk yield was 1957.76 kg (Table 3).

The EBVs of Sahiwal bulls with the percent genetic superiority over population mean ranged between –16.84 (–0.86) to +31.98 (+1.63) kg. Among the eight bulls, two bulls (25%) had breeding values above the overall average while rest six bulls (75%) had breeding values lower than the overall average.

The breeding values of Sahiwal bulls was comparatively lower than the breeding values reported for Sahiwal cattle by Banik and Gandhi (2006), Raja (2010), Dongre and Gandhi (2014) and Gandhi and Raja (2018). However, the estimate was higher than the estimate of 1711.63 kg reported by Singh and Singh (2016) in Sahiwal cattle. The estimate was also lower than the EBV of 2137.17 kg reported by Pandey *et al.* (2013) in Vrindavani cattle and 2050.29 kg reported by Singh *et al.* (2020) in Kankrej cattle and 2563.79 kg by Singh *et al.* (2019) in Gir cattle. The estimated breeding values of Sahiwal bulls were comparatively higher as compared to the breeding values of Hariana and Ongole bulls reported by Singh *et al.* (2006, 2008 and 2012).

Pandey *et al.* (2013) observed and reported that 50% of sires evaluated had breeding values equal and above the overall average breeding value in Vrindavani cattle. Based on the estimated breeding values in this study and sire rankings, it was recommended to use the frozen semen doses of two Sahiwal bulls, viz. 1852 and 1727 to breed the elite cows for the production of young bull calves and increasing the milk production in subsequent generations.

ACKNOWLEDGEMENTS

Authors are thankful to the Directors (ICAR-CIRC, Meerut and ICAR-NDRI, Karnal) and Vice-Chancellors (GADVASU, Ludhiana; GBPUAT, Pantnagar and LUVAS, Hisar) for providing necessary facilities to execute the improvement programme in the home tract of breed. Authors also express their gratitude to the Deputy Director

General (Animal Sciences) and Assistant Director General (Animal Production and Breeding), ICAR, New Delhi.

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