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Assessment of expected genetic gain in average daily milk yield in different milk productivity groups on simulating selection intensity in Sahiwal cattle

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Sahiwal cattle, well-known for its higher milk production, significant power of endurance for hot climate of sub-tropics and low maintenance cost, is relatively resistant to diseases. The home tract of Sahiwal cattle is Montgomery district of erstwhile Punjab (presently part of Pakistan), India. Sahiwal cattle are found in Ferozpur and Amritsar districts of Punjab and Sri Ganganagar district of Rajasthan under field conditions. Furthermore, Sahiwal animals are also available at some organized farms in India. Milk productivity of Sahiwal cattle maintained at different herds is not up to the mark despite its high genetic worth. Therefore, it is of paramount importance to improve the production potential of our indigenous stock to cope up with the continuous increasing demand of milk and milk products.

The main aim of breeding programmes is to maximize genetic gain per unit of time for traits of economic importance in breed improvement programmes. Rendel and Robertson (1950) suggested that annual genetic gains up to 1% of the herd mean is possible; and to achieve it, intense selection of animals to be used as parents is needed along with minimizing the generation interval. Genetic gain per unit of time can be increased by selecting the superior sires or through increasing the intensity of female selection. There are methods that estimate expected genetic gain by utilizing the estimates of heritability, selection differential, intensity of selection and generation interval. The present study was conducted to estimate expected genetic gain (ΔG) in milk yield/day of 305 days or less lactation length (MY/LL) based on intensity of female selection, phenotypic standard deviation and heritability of the trait in Sahiwal cattle maintained at an organized herd of the institute.

Data on first lactation milk productivity (MY/LL) records of Sahiwal cattle maintained at an organized herd of the institute, spread over a period of 29 years (1988–2016) were utilized. The topographical location of ICAR-NDRI Livestock Farm is at an altitude of 250 m above the mean sea level in Indo-Gangetic alluvial plains on 29 42′ N latitude and 72 02′ E longitude. The genetic improvement programme in Sahiwal cattle followed at the farm is selective breeding under Progeny Testing Programme.

Data were first edited and abnormal records (dystocia, premature birth etc.) were excluded. Animals having less than 100 days lactation length and less than 3 kg daily milk yield were also not considered. Data were standardized using mean and standard deviation. First lactation milk productivity records (386) were finally utilized in this study.

Sahiwal animals were categorized into three different groups based on the productivity level, viz. low (3–5 kg), medium (>5–8 kg) and high (>8 kg) milk productivity groups. Expected genetic gain (ΔG) per generation in different productivity groups at various levels of intensity of selection was estimated by using intensity of selection (i), phenotypic standard deviation (σ_p) and heritability (h^2) of the trait as follows:

$$\Delta G = i\sigma_p h^2$$

Intensity of selection (i) was assumed as 60, 70, 80 and 90% for all the 3 groups and phenotypic standard deviation (σ_p) of daily milk yield was calculated for each group separately. Heritability for first lactation MY/LL was estimated by using mixed model least-squares analysis (Harvey 1990). Expected genetic gain per year was estimated by dividing the expected genetic gain per generation by generation interval, which was calculated by taking the average age of sire and dam when their first progeny was born in the herd.

The overall average first lactation milk yield/day of 305 days or less lactation length in Sahiwal cattle was 6.61 kg/day. The overall average daily milk yield/day of 305 days or less milk yield was comparable with the findings

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of Ratwan *et al.* (2017) who reported milk yield/day of 305 day or less milk yield as 6.97±0.21 kg/day in Jersey crossbred cattle maintained at an organized herd. However, Dhawan *et al.* (2015) and Kumar *et al.* (2017) reported daily milk yield as 5.34±0.08 and 5.49±0.47 kg/day in Sahiwal cattle. Heritability estimate of first lactation MY/LL was 0.36. The heritability estimate of daily milk yield/day of 305 days or less milk yield in the present study was similar to the findings of Saha *et al.* (2010) in Karan Fries cattle. On the contrary, Haile *et al*. (2009) in Ethiopian Boran cattle and Ratwan *et al.* (2017) in Jersey crossbred cattle reported comparatively lower and higher estimates of heritability, respectively.

In organized herds, Sahiwal animals of different productivity levels are maintained. Similarly, farmers rear animals of different productivity levels depending on the resources available. Sahiwal animals were categorized into 3 groups, viz. low, medium and high depending on the milk productivity of the animals. Average first lactation 305 days milk yield (305DMY) of low, medium and high milk productivity groups is presented in Table 1. The generation interval in Sahiwal cattle was estimated as 5.31 years. The expected genetic gain is assessed under different intensities (90, 80, 70 and 60%) of female selection. The expected genetic gain per generation at different milk productivity levels and selection intensities is presented in Table 2. Expected genetic gain per year in MY/LL at different productivity levels and selection intensities in Sahiwal cattle is shown in Fig. 1. At higher selection intensities, when the proportion of animals selected was less, a higher genetic gain was obtained. For example, when 90, 80, 70 and 60% of low productivity animals were selected, the expected genetic gain per generation in MY/LL increased from 43.92 g to 76.86 g to 109.80 g to 140.54 g, respectively. Hence, there was an increment of 42.85, 60 and 68.75% in genetic gain of daily milk yield across the generations when the proportion of animals selected was decreased from 90 to 80%, 90 to 70% and 90 to 60%, respectively.

In India, at organized herds, we can reduce the proportion of selected animals up to 70% maximally because generally a very few animals are disposed of voluntarily based on the expected producing ability (EPA). Major proportion of animals is disposed of due to involuntary reasons like reproductive problems, mastitis etc. In low milk productivity group, when proportion selected was reduced from 90 to 70% then the expected genetic gain per year in daily milk yield increased from 8.27 to 20.68 g/year (Fig. 1). Medium and high milk productivity groups revealed an increase from 11.93 to 29.83 g/year and 12.61 to 31.53 g/year on reducing the proportion of animals selected from 90 to 70%. The per cent increment in the expected genetic gain was 60% for low, medium and high milk productivity groups when proportion selected was reduced up to 70 from 90%. However, in commercial herds, proportion of animals selected can be reduced up to 60% for gaining more profit. On decreasing the proportion of animals selected from 90 to 60% in high milk productivity group, the expected genetic gain increased from 12.61 to 40.34 g/year with an increment of 68.74%.

Large change in the expected ΔG/year from low milk productivity group to medium productivity group was noticed but there was very less improvement in expected ΔG from medium to high productivity group at different levels of selection intensities. For example, the expected genetic gain in low, medium and high milk productivity

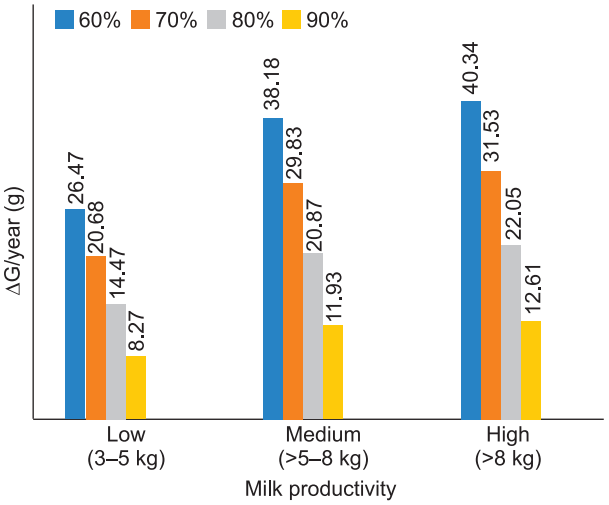

Fig. 1. Expected genetic gain per year in daily milk yield at different productivity and selection intensities in Sahiwal cattle

Table 1. Descriptive statistics of different milk productivity groups in Sahiwal cattle

	Productivity levels		
	Low (3–5 kg)	Medium (>5–8 kg)	High (>8 kg)
N	107	174	104
Mean productivity (kg)	4.04	6.59	9.26
Standard error	0.06	0.07	0.09
Standard deviation	0.61	0.88	0.93
Average 305DMY (kg)	941.21	1810.34	2734.14

Table 2. Expected genetic gain per generation at different productivity levels and selection intensities in Sahiwal cattle

Productivity	Proportion of animals selected	ΔG/generation (g)
Low (3–5 kg)	60%	140.54
Medium (>5–8 kg)	60%	202.75
High (>8 kg)	60%	214.20
Low (3–5 kg)	70%	109.80
Medium (>5–8 kg)	70%	158.40
High (>8 kg)	70%	167.40
Low (3–5 kg)	80%	76.86
Medium (>5-8 kg)	80%	110.80
High (>8 kg)	80%	117.10
Low (3–5 kg)	90%	43.92
Medium (>5–8 kg)	90%	63.36
High (>8 kg)	90%	66.96

groups was 26.47, 38.18 and 40.34 g/year, respectively, at 60% selection intensity. There was 11.71 g/year more expected genetic gain in medium productivity group as compared to low milk productivity group and 2.16 g/year more expected genetic gain in high milk productivity group as compared to medium milk productivity group.

There is no literature regarding expected genetic gain in daily milk yield in different productivity groups at different levels of selection intensity in Sahiwal cattle. However, Meera (2017) reported expected genetic gain in daily milk yield as 127.4, 145.4 and 343.3 g/generation in low, medium and high milk productivity groups at 70% selection intensity in HF crossbred cattle, and reported a more profound effect of selection intensity with high productivity animals unlike to the present findings.

In conclusion, at higher selection intensities, a higher genetic gain was obtained. A large change in expected ΔG/year was observed while shifting from low milk productivity group to medium productivity group. However, at different levels of selection intensities, there was very less improvement in the expected ΔG from medium to high productivity group.

SUMMARY

Data on first lactation milk productivity (milk yield per day of 305 days or less lactation length) records of Sahiwal cattle maintained at an organized herd of ICAR-National Dairy Research Institute, Karnal, Haryana, India were utilized. Records (386) of Sahiwal animals spread over a period of 29 years (1988–2016) were categorized into groups, viz. low (3–5 kg), medium (>5–8 kg) and high (>8 kg) based on the milk productivity level. Expected genetic gain (ΔG)/generation in different productivity groups at different levels of intensity of selection was estimated using intensity of selection (i), phenotypic standard deviation (s_p) and heritability (h^2) of the trait. The expected genetic gain/generation obtained was divided by generation interval to get genetic gain/year. The overall average first lactation milk yield/day of 305 days or less lactation length (MY/LL) in Sahiwal cattle was observed as 6.61 kg/day. Heritability estimate of first lactation MY/LL was 0.36. Average first lactation 305 days milk yield (305 DMY) of low, medium and high milk productivity groups was 941.21, 1810.34 and 2734.14 kg, respectively. The generation interval in Sahiwal cattle was estimated as 5.31 years. Results showed that when the proportion of animals selected was less, i.e. at higher selection intensities, a higher genetic gain was obtained. There was more change in expected ΔG/year while shifting from low milk productivity group to medium productivity group but there was very less improvement in the expected ΔG from medium to high productivity group at different levels of selection intensities.

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