

Evaluation of relative economic value of performance traits in Sahiwal cattle

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ABSTRACT

Estimation of economic values is essential to decide the monetary importance of traits to be incorporated in breeding programs. The present study was conducted to estimate the relative economic value of first lactation traits, viz. 305-day milk yield (305DMY), average daily milk yield (ADMY), calving to first insemination interval (CFI), days open (DO), pregnancy rate (PR) and longevity (LNG) in Sahiwal cattle. Data spanning over duration of 29 years pertaining to production, reproduction and longevity of Sahiwal cattle kept at ICAR-NDRI herd were utilized. Averages of first lactation traits, viz. 305DMY, ADMY, CFI, DO, PR and LNG were obtained as 1822.59 kg, 6.62 kg/day, 85.56 days, 150.48 days, 38.00% and 2711.95 days, respectively with lactation length of 303.02 days in Sahiwal cattle. Expenses involved for different groups of animals for five years (2012-2016) were considered for appraising relative economic values of above-mentioned performance traits. Major expenses considered were per day cost of feeding, treatment, labour and artificial insemination for each animal. Cost of production of one kg milk was calculated as ₹ 23.68 which was the economic value of 305DMY and ADMY. The per unit expenses for traits CFI, DO, PR and LNG were ₹ 156.79, 156.79, 86.65, and 141.21, respectively in Sahiwal cattle. Relative economic values were estimated as 1, 1, -6.62, -6.62, 3.66 and 5.96 for 305DMY, ADMY, CFI, DO, PR and LNG, respectively. Relative economic values estimated in the present study will be helpful for constructing selection indices for genetic progress of Sahiwal cattle.

Keywords: Longevity, Production, Relative economic value, Reproduction, Sahiwal cattle

Animal improvement through selection is the main aim of animal breeder. According to Smith (1983), animal improvement aims to increase the profit by increasing the frequency of favourable genes for economically important traits. Wolf *et al.* (2011) reported that formulation of profit function from which economic values are derived depends on the traits considered in breeding objective. Economic values are important for judging the economic significance of traits to be incorporated in a breeding objective and economic value refers to the probable increase in herd annual profit due to a unit increase in the trait as a result of selection (Jorge-Junior *et al.* 2007, Ratwan *et al.* 2021a). Selection index generally refers to a linear combination of various traits which are used to calculate total score for each individual and is used as a selection criterion in animal breeding. Selection index is a function of economics of farm and prevalent genetic status of pertinent traits (Mrode 1995). Therefore, the selection index recognizes the economic merit of an individual animal as a function of various traits in the breeding objective, weighted by their respective relative economic values (Leitch 1994). VanRaden (2002) defined relative emphasis for a trait as

the economic value times standard deviation divided by the sum of absolute values of these products, then multiplied by 100. Miglior *et al.* (2005) used similar definition, but dividing instead of multiplying economic values by standard deviations. An economic value is the profit change when a given trait varies by one unit, keeping all other traits in the index same. Two approaches can be used for the estimation of economic values i.e. normative approach or expenditure-income method and positive approach, based on future prices (Gibson 1989, Groen 1989, Newman *et al.* 1992). Mulder and Jansen (2001) reported that normative approach or expenditure-income method is mainly used for the construction of selection indices in animal breeding.

There are a number of production and reproduction traits like 305-day milk yield, average daily milk yield (ADMY), calving to first insemination interval (CFI), days open (DO), pregnancy rate (PR) which are of economic importance in dairy cattle (Ratwan *et al.* 2016, 2018, 2019a, 2019b, 2020a, 2020b and 2021b). Longevity or length of productive life has major economic significance in dairy cattle due to its large impact on herd profitability (Essl 1998, Sewalam *et al.* 2005, Ratwan *et al.* 2020a). Various nations have incorporated longevity in their dairy cattle breeding objectives due to high economic importance of the trait (Wesseldijk 2004, Miglior *et al.* 2005). In Sahiwal cattle, knowledge regarding estimation of economic and relative economic values of different traits is scanty.

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Therefore, current study was undertaken for calculating the economic and relative economic values of different production, reproduction and longevity traits in Sahiwal cattle.

MATERIALS AND METHODS

Data: The present study was conducted on the Sahiwal cattle kept at an organized herd of ICAR-National Dairy Research Institute (NDRI), Karnal, Haryana, India. Data spanning over a period of twenty-nine years (1988-2016) regarding production, reproduction and longevity traits of Sahiwal cattle were utilized. Data were edited firstly and unusual data were excluded. Animals having less than 100 days of lactation length were also not considered in the study. Mean and standard deviation of each trait was used for standardizing data. Significance of non-genetic factors like season of calving, period of calving and age group at calving was assessed by using least-squares analysis (Harvey 1990) and then adjustment of data was done for significant effects. Initially, records of 703 first lactation Sahiwal animals were recorded but finally, 386 first lactation animals were considered after editing and standardization of records.

Traits: Six first lactation traits, viz. 305-day milk yield (305DMY), average daily milk yield (ADMY), calving to first insemination interval (CFI), days open (DO), pregnancy rate (PR) and longevity (LNG) were considered for estimation of relative economic values. First lactation 305-day milk production is the most basic performance record in the herd and is important in selection of animals to be kept at the farm. In Indian conditions, average daily milk production is the most conversant trait for livestock owners and may assist in selecting superior germplasm. Calving to first insemination interval assesses the ability of cow to resume estrus cycle after calving and is an economically significant trait (Ismael *et al.* 2016). Days open is the interval between calving to successful insemination and is essential in defining the reproductive proficiency of cows. Pregnancy rate may be defined as the percentage of non-pregnant cows that become expectant during each 21-day period and is a direct measure that how quickly the cows again become pregnant post calving. Pregnancy rate was calculated as: $PR = 21 / (\text{Days open} - \text{Voluntary Waiting Period} + 11)$. Longevity of animal was considered as the duration from date of birth to date of disposal or death.

Statistical analysis: In this study, relative economic

values of various traits were calculated based on the expenses involved for the different groups of animals during past five years (2012-2016) as suggested by Chakravarty *et al.* (1991). To estimate relative economic values for different traits, main expenses considered were feeding cost, treatment, labour and artificial insemination cost per day per animal. The average expenditure involved in different seasons was considered for the calculation of economic values due to variations in the cost as well as feeds in different seasons. Earnings from calf sale, dung, urine, devaluation of fixed expenses etc., were not taken into account for calculating the relative economic values.

To estimate the cost of rearing of one animal per day, animals were grouped into different categories (0-3 months, >3-6 months, >6-12 months, >12 months, dry stock and lactating animals). These categories were considered based on the feeding schedule followed at the herd. Average cost of feed/day for each category was calculated. Average cost of treatment/day/animal was calculated separately for 0-6 month group and adult animals. Similarly, labour charges were calculated for 0-1 year and >1 year categories based on norms of one labour/25 animals (0-1 year) and one labour/10 adult animals. Economic value of milk yield was the selling price of milk during different months of the year. The average cost of production of one kg milk was estimated and relative economic values of other traits were appraised by keeping economic value of milk as unity and appropriate sign was assigned to the relative economic values.

RESULTS AND DISCUSSION

For calculation of relative economic value of different traits, animals were categorized into various groups, viz. 0-3 month, >3-6 months, >6-12 months and >1 year as per the feeding schedule and price of feed/day/animal was calculated for each group based on average of five years (2012-2016). During 0-36 days of age, Sahiwal calves were fed on milk as per body weight. Afterwards, calves were shifted to calf starter along with milk feeding up to 3 months. Calves >3 months were provided green fodder and concentrate in the diet. Major fodder crops fed were maize (*Zea mays*), jowar (*Sorghum bicolor*), cowpea (*Vigna unguiculata*), bajra (*Pennisetum glaucum*), lucerne (*Medicago sativa*) and barseem (*Trifolium alexandrinum*) depending on the season and availability. Wheat straw and silage were also fed to the adult animals. Total expenditure

Table 1. Total feed and fodder expenditure per day for Sahiwal calf during 0-3 months

Age of calf	Feed components	Requirement (kg/day)	Expenditure/animal/day (₹)	Total expenditure /animal/ day (₹)
0-5 days	Milk	2	47.36	47.36
6-36 days	Milk	3	71.04	71.04
>36-60 days	Milk	4	94.72	99.22
	Calf Starter	250 g	4.50	
61-90 days	Milk	2.5	59.20	68.20
	Calf Starter	500 g	9.00	
Average cost/day (₹)			71.55	

Table 2. Total feed and fodder expenditure per day for Sahiwal calf during 3-6 months in different seasons of different years

Cost in Year/Season	Summer	Rainy	Autumn	Winter
2012	19.99	16.71	17.53	21.60
2013	30.57	29.55	29.44	22.46
2014	30.09	33.28	33.64	35.02
2015	31.95	36.17	31.34	39.42
2016	30.39	32.90	28.16	30.67
Season wise average cost (₹)	28.60	29.44	28.02	29.83
Overall average cost/day(₹)	28.97			

Table 3. Total feed and fodder expenditure per day for Sahiwal calf during 6-12 months in different seasons of different years

Year/Season	Summer	Rainy	Autumn	Winter
2012	40.77	40.46	41.86	45.90
2013	50.47	41.54	46.24	51.78
2014	38.68	50.41	48.33	47.84
2015	51.05	45.75	47.12	57.02
2016	53.01	50.86	46.07	48.59
Season wise average cost (₹)	46.80	45.80	45.92	49.03
Overall average cost/day (₹)	46.89			

Table 4. Total feed and fodder expenditure per day for adult Sahiwal cattle in different seasons of different years

Year/Season	Winter	Summer	Rainy	Autumn
2012	118.827	152.204	77.864	82.995
2013	86.631	160.468	116.829	92.738
2014	127.984	171.851	101.574	88.270
2015	116.442	103.738	99.772	96.693
2016	180.281	176.299	91.977	89.215
Season wise average cost (₹)	126.033	152.912	97.603	89.982
Overall average cost/day (₹)	116.633			

involved for feed and fodder for 0-3 month, >3-6 months, >6-12 months and >1 year Sahiwal animal/day is presented in the Tables 1, 2, 3 and 4, respectively.

Diseases like coccidiosis, enteritis, pneumonia, lameness, theileriosis, naval ill and joint ill occurred frequently in calves of 0-6 months, thus, average cost per day per animal was calculated in view of above mentioned diseases. Average treatment cost for enteritis/coccidiosis, pneumonia and other diseases (lameness, theileriosis, naval ill and joint ill) was ₹ 14.481, 1.325 and 0.767, respectively in 0-6 months' calves. Average treatment cost/day/calf was found to be ₹ 16.566 at National Dairy Research Institute farm. Reproductive disorders (viz. retention of placenta, prolapse, metritis, pyometra, anestrus, cystic ovary and repeat breeding) and mastitis occurred predominantly in adult Sahiwal cattle. The expenditure on treatment of

these diseases along with lameness and general cases was considered for estimation of average cost/day/adult Sahiwal animal. The average cost of treatment for reproductive disorders, mastitis and general cases including lameness was found to be ₹ 8.41, 4.10 and 4.31, respectively in adult Sahiwal cattle.

Further, one labor was assigned to take care of 25 calves while in adult animals, one labour per 10 adult animals was allotted as per standards at NDRI herd. There was variation in the labour charges for last five years. Thus, average labor cost/day/animal was also taken into account for calculating the economic values of considered traits. Labour charges per day per small and adult animal were calculated as ₹ 9.28 and ₹ 23.21 (Table 5). Expenses incurred on semen straw for artificial insemination (AI) were also summed up for

Table 5. Total labor expenditure per day for Sahiwal cattle up to one year in different years

Year	Per day labor cost	Per day/animal cost	
		Up to 1 year	Adult
2012	200.00	8.00	20.00
2013	200.00	8.00	20.00
2014	223.33	8.93	22.33
2015	223.33	8.93	22.33
2016	314.00	12.56	31.40
Average cost (₹)	232.13	9.28	23.21

calculating the economic values in this study. However, the charges of AI technician were not considered. The average number of services per conception was observed as 1.86 for first parity. Thus, about two inseminations per animal were needed for successful pregnancy. The cost of Sahiwal semen straw available at Animal Breeding Research Centre, NDRI is ₹ 20 per straw. Hence, AI expenditure of ₹ 40 per animal was considered for estimating the economic values in this study. Average expenses per day per animal occurred on feed and fodder, treatment, labour and artificial insemination were calculated as ₹ 116.63, 16.82, 23.21 and 0.13, respectively. Consequently, total expense/day/adult Sahiwal cattle for different input constituents was estimated as ₹ 156.79.

Averages of first lactation traits viz., 305DMY, ADMY, CFI, DO, PR and LNG in Sahiwal cattle were obtained as 1822.59 kg, 6.62 kg/day, 85.56 days, 150.48 days, 38.00% and 2711.95 days, respectively with lactation length of 303.02 days by Ratwan *et al.* (2020a) using the same data set. In the present study, total expenditure per animal per lactation was estimated as ₹ 47510.51 and average per day per animal expense in course of this duration was ₹ 156.79. The cost of production of one kg milk was ₹ 23.68 which was the economic value of 305DMY and ADMY. The economic value of pregnancy rate was determined by the cost of producing 1% PR in Sahiwal cattle. Average first lactation pregnancy rate of Sahiwal cattle was 38%. Total expenditure per cycle (21 days) per animal was estimated as ₹ 3292.59. So, the cost of 1% PR was estimated as ₹ 86.65. Likewise, cost of production of one day of CFI

was economic value of CFI. Average CFI after first calving in Sahiwal cattle was 85.56 days, thus, total cost per animal for the CFI was ₹ 13414.95 and cost of one day of CFI was ₹ 156.79. Likewise, average first DO in Sahiwal cattle was 150.48 days and therefore, total expenditure per animal for the trait was obtained as ₹ 23593.76 resulting in cost per unit as ₹ 156.79. Further, the cost of raising Sahiwal animals till age at first calving was assessed at the outset to obtain the economic value for longevity. This is due to the reason that expenses per animal per day varied up to one year of age and for adult animals due to distinct feeding plan for each group of animals. In Sahiwal cattle, average longevity after completion of first lactation was observed as 2711.95 days and the total expenses for longevity were estimated as ₹ 382946.14. Consequently, the total cost of longevity trait per animal per day was calculated as ₹ 141.21. Relative economic values of different traits in Sahiwal cattle (Table 6) were estimated by considering the relative economic value of milk as one and appropriate sign was assigned to the relative economic values. Valsalan *et al.* (2014) estimated the economic values of production and fertility in Murrah buffaloes using the expenditure and income method based on one-year data. Like present study, they also considered feed and fodder, labour, treatment and artificial insemination as major sources of expenditure and reported average expenditure/day/buffalo on these items as ₹ 126.12, ₹ 20, ₹ 10 and ₹ 0.22, respectively. The expenditure of feed and fodder and AI was comparatively less in this study as compared to Valsalan *et al.* (2014). The cost of production of one kg milk yield was obtained as ₹ 23.68 in Sahiwal cattle in this study, however, Valsalan *et al.* (2014) reported cost of production of one kg milk containing 6.5% and 4% fat as ₹ 29.35 and ₹ 22, respectively in Murrah buffaloes. Likewise, Gonge (2018) estimated economic values of 305-day milk yield, wet average, calving to first insemination interval, pregnancy rate and longevity in Karan Fries (Holstein cross) cattle and it was reported that average expenditure/day/animal on feed and fodder, labour, treatment and artificial insemination was ₹ 116.63, ₹ 23.20, ₹ 69.44 and ₹ 0.14, respectively. The cost of one kg milk was ₹ 17.5 for Karan Fries cattle which was comparatively less than the cost per kg milk yield for Sahiwal cattle. Relative economic values were calculated as -6.62, -6.62, 3.66, and 5.96 for CFI, DO, PR and LNG, correspondingly in present study, while Gonge (2018) reported relative economic values for CFI, PR and LNG as -11.9, 8.31 and 10.65, respectively in Karan Fries cattle.

In conclusion, present study revealed that maximum expenditure occurred for the feed and fodder of the Sahiwal animals. Total expenses per day per Sahiwal cattle were obtained as ₹ 156.79 and per kg cost of milk production was ₹ 23.68 in current study which was the cost of production of one unit of 305DMY and ADMY. Costs of production of one unit of other traits viz. CFI, DO, PR and LNG were (in ₹) 156.79, 156.79, 86.65 and 141.21, respectively. Relative economic values for 305DMY, WA, CFI, DO, PR and LNG were calculated as 1, 1, -6.62, -6.62, 3.66 and

5.96, respectively in Sahiwal cattle. The findings of present study will be helpful for constructing selection indices to genetically improve Sahiwal cattle.

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