



Optimization of Economic Traits of Sahiwal Cattle

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ABSTRACT

A study was conducted for estimation of optimum range of age at first calving (AFC), service period (SP) and preceding dry period (DP) on Sahiwal cattle (n=462) data, spread over a period of 15 years (1997-2011), maintained at Livestock Research Center, National Dairy Research Institute, Karnal. In order to determine the optimum range of these economic traits class interval method was used. A class was considered as optimum, if it accommodated maximum number of observations along with better productive performance on the basis of four production parameters i.e., 305 days or less days milk yield (305DMY), total milk yield (TMY), milk yield per day of lactation length (MY/LL) and milk yield per day of calving interval (MY/CI). In this study, optimum level of AFC, SP and preceding DP were found to be 32-37 months, 55-88 days and 49-88 days, respectively. Because of high rearing costs of heifers, managing heifers to first calving at 32 to 37 months of age could be very advantageous. The present obtained ranges of optimum SP and preceding DP can help in obtaining one calf per year in indigenous cattle that, in turn, will help in improving overall productivity of indigenous cattle.

Keywords: optimization, age at first calving, service period, preceding dry period

Livestock is an integral part of agriculture in India (Patil *et al.* 2014). Livestock sector not only provides nutrients to human diet through milk, eggs, meat and various by products but also plays an important role in utilization of non-edible agricultural by-products (Chauhan and Ghosh 2014). Sahiwal, in its native tract, is considered as the best cattle breed for milk production in tropical conditions (Maule, 1990). Well known for its remarkable characteristics to produce and reproduce adequately under tropical conditions that have attracted various countries to produce crossbreds and upgrading their local breeds (Ilatsia *et al.* 2012).

Despite of so many remarkable characteristics, there has been a wide variability in the range of economic traits values of Sahiwal cattle: the mean age at first calving (AFC) ranging between 879.00 ± 9.00 days (Bhatnagar and Sharma, 1976) to 1446.09 ± 16.85 days (Singh, 1992); the average values of service period (SP) ranging

from 68.07 ± 2.3 days (Basu *et al.* 1979) to 271 ± 8.7 days (Pundir and Raheja, 1995); the mean values of dry period (DP) ranging between 117.28 ± 8.68 days (Banik 2004) and 244 ± 3 days (Rehman *et al.* 2008).

The AFC changes the heifer from a non-productive animal to an income generating cow. AFC is an important factor in reducing cost of rearing replacement stock in dairy herds (Ettema and Santos 2004). Delayed AFC reduces the economic value of the animals due to production of less offspring in their lifetime (Grajales *et al.* 2006). So, it is essential to get an optimum balance between expected increase in production and expected increase in additional rearing and other costs to maximize net returns in the first lactation.

An optimum SP is necessary for providing the required rest to the animal after calving so that proper involution of uterus and energy regain take place for subsequent lactation. However, both shorter and longer service period

causes loss of production. DP is important for regeneration of the mammary gland and its preparation for ensuing lactation (Annen *et al.* 2004). Too short (<1 month) and too long (>3 months) dry periods adversely affect the milk yield in the next lactation (Weglarzy *et al.* 2007).

In Sahiwal's home tract, there is not just population decline (Ilatsia *et al.* 2007), but performance also has been reported to deteriorate (Rehman *et al.* 2008). These wide ranges in values of economic traits might be a reason, among others, behind the deterioration of overall performance of Sahiwal cattle

Having considered all these intricacies, the objective of the present study was to estimate the effect of AFC, length of SP and duration of preceding DP on milk production parameters and to limit these economic traits values into a narrower range which could be considered as 'optimum' in relation to productive performance of Sahiwal cattle.

MATERIALS AND METHODS

The present investigation was conducted on Sahiwal cattle (n= 462) maintained at Livestock Research Centre, National Dairy Research Institute (NDRI), Karnal, Haryana. Study area is located at 29°42'N latitude and 72°02'E longitude with an altitude of 250 m above the mean sea level in the bed of Indo-Gangetic alluvial plain. A subtropical climate with maximum air temperature during summer about 45-48°C and minimum temperature during winter near to 1-4°C prevail in the area. In the study area relative humidity ranges between 41-85% and annual rainfall between 760-960 mm.

Source of Data

The data for present study were collected from history sheets of Sahiwal cattle maintained at DCB division of NDRI, Karnal. The data comprising of production and reproduction records of Sahiwal cattle spread over a period of 15 years (1997-2011) were utilized for this study.

Different economic traits taken for consideration were AFC, SP and preceding DP; and optimum ranges of these trait values were estimated on the basis of four milk production parameters i.e. 305 days or less days milk yield (305DMY), total milk yield (TMY), milk yield per day of lactation length (MY/LL) and milk yield per day of calving interval (MY/CI). Incomplete lactations for

any recorded reasons and lactation records of less than 100 days were considered as abnormal and such records were not included in this analysis. To ensure the normal distribution of mean values for different economic traits i.e. AFC, SP and preceding DP, outliers were removed and data within the range of mean \pm 2SD was taken under study. A range (class) of economic trait values was considered as optimum, if it had maximum number of observations along with better productive performance based on the above milk production parameters.

Class interval method

This method was used for optimization of various economic traits, and the class intervals for traits under this study were calculated with the help of Sturges formula (1926).

$$CI = \frac{R}{1 + 3.322 \log_{10} N}$$

where,

CI = Width of each class / class interval

N = Number of observations

R = Range (maximum observation – minimum observation)

$1 + 3.322 \log_{10} N$ = Number of classes

The following classes of AFC, SP and preceding DP were made according to the above formula: AFC was divided into six classes i.e. less than 976 days, 976-1043 days, 1044-1111 days, 1112-1179 days, 1180-1247 days and more than 1247 days; SP was divided into eight classes i.e. less than 54 days, 55-88 days, 89-122 days, 123-156 days, 157-190 days, 191-224 days, 225-258 days and more than 258 days; preceding DP was divided into nine classes i.e. less than 48 days, 49-88 days, 89-128 days, 129-168 days, 169-208 days, 209-248 days, 249-288 days, 289-328 days and more than 328 days. Statistical analysis was performed using SAS version 9.2.

RESULTS AND DISCUSSION

Optimization of age at first calving

The average values of milk production parameters i.e. 305DMY, TMY, MY/LL and MY/CI for each class of

Table 1: Average milk production parameters for different classes of AFC in Sahiwal cattle

Class No.	AFC (days)	% of observations	305DMY (kg)	TMY (kg)	MY/LL (kg)	MY/CI (kg)
1	< 976	12.28	1239 ± 122	1335 ± 138	4.76 ± 0.28	3.08 ± 0.35
2	976-1043	16.38	1475 ± 121	1574 ± 141	5.38 ± 0.29	3.36 ± 0.35
3	1044-1111	27.99	1394 ± 93	1547 ± 119	5.14 ± 0.23	3.09 ± 0.27
4	1112-1179	18.09	1281 ± 106	1381 ± 129	4.98 ± 0.28	2.71 ± 0.32
5	1180-1247	7.51	1522 ± 181	1733 ± 257	5.56 ± 0.48	3.37 ± 0.53
6	> 1247	17.74	1650 ± 153	1749 ± 208	5.75 ± 0.42	3.75 ± 0.46

Table 2: Effect of different classes of economic traits on milk production parameters of Sahiwal cattle

Sources of variation	305 DMY		TMY		MY/LL		MY/CI	
	df	F-value	df	F-value	df	F-value	df	F-value
AFC classes	5	1.2	5	0.97	5	1.22	5	0.95
SP Classes	7	1.18	7	2.39*	7	0.93	7	2.91*
Preceding DP classes	8	13.02*	8	11.96*	8	12.60*	8	9.30*

*significant at 5% level (p< 0.05)

AFC were estimated and presented in Table 1. The results showed that maximum average values of these parameters were observed for the animals having AFC more than 1247 days (6th class) and minimum for the cows which had AFC below 976 days (1st class). Maximum percentage of animals fell in the 3rd class of AFC, whereas first class of AFC had minimum percentage of animals. The rate of change in milk production parameters with respect to change in AFC showed that the milk production was lowest for 1st class, then there was a sharp rise in 2nd class, and later milk production decreased gradually up to 4th class, after that it increased in the last two classes. Increase in milk yield with increased AFC can be attributed to proper physiological maturity and ductal growth of the mammary gland. Decreased milk production in 3rd and 4th classes might be because of some reproductive disorders and poor management of the cows, which caused delayed maturity and lower production. In case of last two classes, both AFC and milk production was highest that can be correlated with attaining full maturity.

The least squares analysis showed that the effect of AFC class on milk production parameters was non-significant (Table 2). However, only 12% of total animals fell in first

class and their average milk production was considerably lower than later classes. Maximum percent of animals fell in 3rd class of AFC. If 2nd and 3rd classes were merged together then a relatively wider range of AFC class (976-1111 days) can be observed which not only accommodated maximum observations (about 45%) but also had better productive performances in comparison to just earlier and later classes.

From the above discussion of four milk yield parameters (305DMY, TMY, MY/LL, and MY/CI), it was observed that the age of 976-1111 days or 32 to 37 months for AFC can be considered as ‘optimum age at first calving’ for Sahiwal cattle, as about half (45%) of total observations were found in this range of AFC with comparatively better production averages. The present findings are in close agreement with the work done by Madani *et al.* (2008) who reported 30 to 36 months as optimum AFC for dairy cows reared in semi arid region of Algeria. Batra and Desai (1964) reported that 31-32 months of AFC was appropriate for high milk production in Sahiwal cattle, whereas Singh (1986) observed 41 to 45 months age as optimum AFC for Sahiwal cattle.

Table 3: Average milk production parameters for different classes of SP in Sahiwal cattle

Class No.	SP (days)	% of observations	305 DMY (Kg)	TMY (Kg)*	MY/LL (Kg)	MY/CI (Kg)*
1	< 55	13.06	1496 ± 72	1496 ± 72 ^b	6.20 ± 0.23	4.47 ± 0.21 ^a
2	55-88	27.45	1644 ± 52	1646 ± 52 ^{ab}	6.50 ± 0.15	4.61 ± 0.15 ^a
3	89-122	18.16	1683 ± 67	1724 ± 71 ^{ab}	6.26 ± 0.18	4.41 ± 0.18 ^a
4	123-156	12.24	1793 ± 86	1881 ± 96 ^{ab}	6.39 ± 0.23	4.47 ± 0.22 ^a
5	157-190	8.27	1691 ± 94	1810 ± 109 ^{ab}	6.01 ± 0.23	3.94 ± 0.24 ^{ab}
6	191-224	6.94	1719 ± 113	1870 ± 135 ^{ab}	5.92 ± 0.30	3.84 ± 0.28 ^{ab}
7	225-258	5.41	1724 ± 126	1920 ± 159 ^{ab}	5.94 ± 0.32	3.71 ± 0.30 ^{ab}
8	>258	8.47	1788 ± 163	1998 ± 201 ^{ab}	6.28 ± 0.40	3.41 ± 0.37 ^b

*significant at 5% level ($p < 0.05$); Means bearing same superscript did not differ significantly

Table 4: Average milk production parameters for different classes of preceding Dry Period in Sahiwal cattle

Class No.	Preceding DP days)	% of observations	305 DMY (Kg)*	TMY (Kg)*	MY/LL (Kg)*	MY/CI (Kg)*
1	< 49	2.49	1503 ± 177 ^{bc}	1533 ± 185 ^{bcd}	5.97 ± 0.46 ^{bcd}	3.77 ± 0.53 ^{bc}
2	49-88	32.47	2068 ± 46 ^a	2154 ± 51 ^a	7.42 ± 0.12 ^a	5.38 ± 0.16 ^a
3	89-128	12.88	1826 ± 73 ^{ab}	1907 ± 90 ^{ab}	6.92 ± 0.19 ^{ab}	4.98 ± 0.26 ^{ab}
4	129-168	10.93	1787 ± 69 ^{ab}	1834 ± 78 ^{abc}	6.97 ± 0.20 ^{ab}	4.53 ± 0.24 ^{ab}
5	169-208	9.63	1608 ± 100 ^{bc}	1650 ± 110 ^{bcd}	6.40 ± 0.26 ^{abc}	4.02 ± 0.29 ^{bc}
6	209-248	8.98	1350 ± 97 ^c	1391 ± 107 ^{cd}	5.68 ± 0.27 ^{cd}	3.59 ± 0.27 ^{bc}
7	249-288	9.20	1263 ± 97 ^c	1288 ± 102 ^d	5.37 ± 0.26 ^{cd}	3.45 ± 0.29 ^{bc}
8	289-328	5.41	1281 ± 118 ^c	1310 ± 125 ^d	5.11 ± 0.31 ^d	3.19 ± 0.33 ^{bc}
9	>328	8.01	1357 ± 169 ^{bc}	1407 ± 206 ^{cd}	5.69 ± 0.44 ^{cd}	3.86 ± 0.52 ^{bc}

*significant at 5% level ($p < 0.05$); Means bearing same superscript did not differ significantly

Optimization of service period

The average values of production parameters i.e. 305DMY, TMY, MY/LL and MY/CI, for each class of SP was estimated and presented in Table 3. The present results showed that maximum average 305DMY/TMY was observed for SP more than 258 days (8th class), while

minimum 305DMY/TMY was observed for 20-54 days (1st class) SP. The least squares analysis revealed that the effect of the SP class on average TMY and MY/CI was significant ($p < 0.05$) (Table 2). The maximum and minimum average MY/LL were obtained for 2nd class and 6th class of SP, respectively. The maximum average

MY/CI was observed for SP ranging from 55-88 days (2nd class), while minimum MY/CI was obtained for 8th class of SP. Maximum percentage of animals fell in 2nd class, whereas the 7th class of SP had minimum percentage of animals (Table 3).

From the discussion of above four milk yield parameters, it was observed that 2nd class of SP i.e. 55-88 days (around 2-3 months) showed maximum number of observations (about 28%) with better production performance; therefore, it can be considered as 'optimum service period' for Sahiwal cattle. Estimates similar to the present findings have also been reported by Jadhav (1990), who found 61-80 days as optimum SP in cross-bred animals.

Optimization of preceding dry period

The averages of production parameters i.e. 305DMY, TMY, MY/LL and MY/CI, for each class of preceding dry period were estimated and presented in Table 4. Maximum average values of 305DMY/TMY, MY/LL and MY/CI were observed for preceding DP ranged from 49-88 days (2nd class), while minimum averages of 305DMY/TMY, MY/LL and MY/CI were obtained for 7th class, 8th class and 8th class of preceding DP, respectively. Maximum percentage of animals fell in 2nd class (49-88 days) and 1st class of preceding DP had minimum percentage of animals (Table 4).

The least squares analysis had shown that the effect of preceding DP class on all four milk production parameters was significant ($p < 0.05$) (Table 2). Results of present study indicated that too short (<49 days) and too long (>88 days) dry periods adversely affected the milk yield, which has been supported by the findings of Weglarzy *et al.* (2007). Higher production performance of the animals for 49-88 days of preceding DP may be correlated with the fact that within this time period the animals could regain their energy, which have been depleted in previous lactation, and revitalize their mammary tissues for ensuing lactation.

From the above discussion, it was observed that all the production parameter were maximum for the animals which had preceding DP of 49-88 days. Having accommodated maximum numbers of animals (about 33%) together with higher production performance, 49-88 days (around 1.5-3 months) of preceding DP may be considered as 'optimum preceding DP' for Sahiwal cattle. The present results are in

close agreement with the work done by Ahmad and Ahmed (1981) who reported highest milk yield for preceding dry period of 61 to 91 days in Sahiwal cattle. However, Karol Weglarzy (2009) concluded that the most favourable DP for production in the coming lactation should last 2-3 months; while Pytlewski *et al.* (2009) reported 64-70 days DP as the most beneficial in terms of milk yield per 305-day lactation in Polish Black-and-White Holstein-Friesian cows.

CONCLUSION

The present results strengthen the importance of an optimum range of economic traits values which not only consolidates the whole production cycle of dairy animals but also exhibits the hidden potential of zebu germplasm that needs to be tapped in near future. Because of high rearing costs of heifers, managing heifers to first calving at 32 to 37 months of age could be very advantageous. The present obtained range of optimum SP and preceding DP can help in obtaining one calf per year in indigenous cattle that, in turn, helps in improving overall productivity of indigenous cattle. However, the problem in optimization of various economic traits is debatable; and large data size can help in obtaining more valuable results. Further, to determine the optimum range of economic traits more emphasis should be given for maximizing profit rather than maximizing milk production.

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