

Role of additive and multiplicative age correction factors in sire evaluation of Haryana cattle

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ABSTRACT

Data on 491 first lactation records of Haryana cows sired by 41 sires maintained from 1995–2006 at 5 farms, viz. Germ Plasm Unit, CCSHAU, Hisar; Government Livestock Farm, Hisar; Kurukshetra Gaushala, Hisar; Gaushala Bhiwani and Gaushala Jind under ICAR project entitled, “Genetic Improvement of Indigenous Breeds of Cattle (Haryana Unit)” were analyzed for developing and evaluating the efficiency of additive and multiplicative age correction factors. Age at first calving was classified into 11 classes with an interval of 120 days between classes. The model used for least squares analysis and for deriving the age correction factors included herd, period of calving, season of calving and age groups as fixed effects and lactation length as a covariate. Both the age correction factors were equally effective on the basis of mean, F-ratio and R^2 value, while multiplicative age correction factors were more effective in retaining similar coefficient of variation (CV) for all subclasses of age groups as that of uncorrected data and reducing the residual variance as compared to uncorrected and additively corrected data. Out of 41 sires; 19 sires were having positive estimated breeding value (EBV's) from uncorrected, additively (ACD), and multiplicatively corrected data (MCD) with percent range of superiority over herd average as 0.96–37.30, 1.49–38.77 and 0.99–38.53, respectively. These findings indicated that ACD and MCD discriminated among the sires to the maximum extent as compared to uncorrected data. The rank correlations among EBV's of sires estimated from uncorrected, ACD and MCD were very high (0.98) revealing that both additive and multiplicative correction factors were equally effective in evaluating the sires. As far as comparison among both the age correction factors is concerned, multiplicative age correction factors were more effective in cow evaluation, whereas additive age correction factors seemed to be more effective for sire evaluation.

Key words: Additive correction factors, Cattle, Multiplicative correction factors

The age at first calving varies from cow to cow as this trait is considered to be governed more by environmental factors i.e. feeding and managerial practices. Apart from genetic influence, cow's milk yield is affected by age at calving. Therefore, the milk production record of a dairy animal has to be pre-corrected for age at calving to make a more reliable and less biased comparison among cows. Mostly, sires are evaluated on the basis of first lactation milk yield of their daughters; so, there is a need to correct the first lactation milk yield of cows for age at first calving to have more accurate estimate of breeding values of sires (Gandhi 2000, Kumar and Singh 2003, Dawande *et al.* 2007). Influence of age at first calving on milk yield is more pronounced even that of sires (Miller 1973, Kumar and Gandhi 1995). Hence, this becomes more pertinent to correct the first lactation milk yield of daughters of different sires

for age at first calving. Therefore, this investigation was undertaken to develop additive and multiplicative age correction factors for cow and sire evaluation in Haryana cattle.

MATERIALS AND METHODS

Data on 491 first lactation milk yield of Haryana cattle, progeny of 41 sires; maintained at 5 farms, viz. Germplasm Centre, CCSHAU, Hisar; Government Livestock Farm, Hisar; Gaushalas, Hisar; Bhiwani and Jind from 1995–2006 were analysed. Only those cows completing a lactation length of atleast 100 days were included in the study. The whole duration of 12 years was divided into 3 periods of 4 year each. The year was divided into 4 seasons namely April to June (summer); July to September (rainy); October to November (autumn) and December to March (winter). Age at first calving was classified into 11 classes with an interval of 120 days between classes, starting from ≤ 1200 days to ≥ 2281 days.

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The least squares analysis of variance technique (Harvey 1987) was used to study the effect of age at first calving and other factors on milk yield. A model incorporating herd, period of calving, season of calving and age groups as fixed effects and lactation length as covariate was used. Least squares constants and least squares means obtained from the above model were used to derive the additive and multiplicative age correction factors for milk yield as follows:

Additive correction factors (ACF): Additive correction factors were obtained by subtracting least squares constant of the base class from the least squares constant of the respective class. The class with largest number of observations (1561–1680 days) was considered as the base class.

Multiplicative correction factors (MCF): Multiplicative correction factors were derived from the least squares means using the following expression as used by Miller *et al.* (1966) and Gacula *et al.* (1968).

$$MCF = LSM_b / LSM_i$$

LSM_b is the least squares means for the base class.

LSM_i is the least squares means for the i th age class.

The first lactation milk records were corrected by using age correction factors derived above. Additive correction factors were subtracted from the observed milk yield whereas, multiplicative correction factors were multiplied with the observed milk yield to obtain age corrected milk yield.

To compare the effectiveness of ACF and MCF the same model incorporating the same effects was fitted again on additively (ACD) and multiplicatively corrected data (MCD) and these correction factors were compared using criterion of mean, coefficient of variation (CV), F-ratio of age groups, residual variance, and R^2 value.

The best linear unbiased prediction (BLUP) procedure described by Henderson (1973) was used to estimate the breeding value of sires from uncorrected, ACD and MCD. The mixed model used for estimation of EBV's of sires comprising set of sires, herd, period of calving and season

of calving as fixed effects and sire within set as random effect. The estimated breeding value of sires was obtained by multiplying the BLUP values by 2.

The spearman's rank correlations (Steel and Torrie 1980) were calculated among the ranking of sires by different methods.

RESULTS AND DISCUSSION

The least squares analysis of variance revealed that age groups had significant ($P < 0.05$) effect on first lactation milk yield. The coefficient of determination (R^2) value for age group was 3.79%, hence there is need to correct the milk yield for age. The least squares constants and means along with additive and multiplicative age correction factor for various age classes are given in Table 1. The highest least squares constants (60.11±29.37 kg) and means (962.16±30.76 kg) were observed for 1921–2040 days age class. The least squares constants and mean for the base class (1561–1680 days) was –31.35±23.75 kg and 870.70±23.47 kg, respectively. The least squares constants and means did not show regular trend for the different age groups. Similar trends were also observed by Gandhi and Gurnani (1997) and Kumar and Singh (2003) in Karan Fries cattle and Dawande *et al.* (2007) in Holstein Friesian halfbreds. On the other hand, Gandhi and Singh (1999) and Gandhi (2000) observed an increasing trend in least squares constants and means with increase in age in Karan Fries cattle.

The additive correction factors ranged between –18.93 kg for 1321–1440 days age class and 91.45 kg for 1921–2040 days age class. Multiplicative factors ranged between 0.90 for 1921–2040 days age class to 1.02 for 1321–1440 days age class. Age correction factors also did not show any regular trend.

Effectiveness of correction factors

The overall population means for uncorrected, additively corrected data (ACD) and multiplicatively corrected data

Table 1. Least squares constants (LSC), means (LSM) and additive and multiplicative age correction factors for first lactation milk yield in Haryana cattle

AFC (days)	No of observatoins	LSC±SE	LSM±SE	ACF	MCF
up to 1200 (1)	30	0.20±38.82	902.25±40.83	31.55	0.9650
1201–1320 (2)	27	2.59±38.29	904.64±40.80	33.94	0.9625
1321–1440 (3)	52	–50.28±29.56	851.77±29.91	–18.93	1.0222
1441–1560 (4)	77	–25.49±24.13	873.56±24.67	2.86	0.9967
1561–1680 (5)	87	–31.35±23.75	870.70±23.47	0.00	1.0000
1681–1800 (6)	63	1.55±26.14	903.59±27.15	32.90	0.9636
1801–1920 (7)	55	18.53±27.33	920.58±28.54	49.88	0.9458
1921–2040 (8)	46	60.11±29.37	962.16±30.76	91.46	0.9049
2041–2160 (9)	21	37.98±43.29	940.03±46.88	69.33	0.9262
2161–2280 (10)	11	–24.83±58.02	877.22±64.26	6.52	0.9926
>2280 (11)	22	13.99±42.29	916.04±45.10	45.34	0.9505

Figures in parentheses are age groups.

Table 2. Mean (kg) and coefficient of variation (%) of first lactation milk yield for uncorrected, additively (ACD) and multiplicatively corrected data (MCD) in different age groups

Age groups	No of observations	Uncorrected		ACD		MCD	
		Mean	CV	Mean	CV	Mean	CV
1	30	902.25	24.79	870.25	25.69	876.44	25.03
2	27	904.64	23.44	870.64	24.35	869.89	23.91
3	52	851.77	25.32	869.77	24.80	869.02	24.35
4	77	873.56	24.78	870.56	24.86	874.39	24.29
-5	87	870.70	25.14	870.70	25.14	872.52	24.61
6	63	903.59	23.84	870.60	24.75	866.43	24.40
7	55	920.58	22.99	870.58	24.31	872.65	23.79
8	46	962.16	21.68	870.16	23.98	857.88	23.86
9	21	940.03	22.85	870.03	24.69	871.75	24.18
10	11	877.21	24.30	870.21	24.49	868.70	24.07
11	22	916.04	23.09	870.03	24.31	867.99	23.91
Overall	491	902.05	32.53	870.32	33.70	869.78	33.09

(MCD) were 902.05, 870.32 and 869.78 kg, respectively, with 21.83, 22.47 and 22.07% CV for each set of data (Table 2). The overall mean for ACD was slightly higher than the mean from MCD. The milk yield corrected for age at first calving by ACF were similar in age classes, similarly, milk yield corrected by MCF was more or less compatible to each other with the difference of 18.56 kg between the maximum (≤ 1200 days) and minimum (1921–2040 days) age class. Since ACF retained constant least squares means, it could be regarded as the most efficient method. Similar results were also reported by Chauhan (1988) and Saxena *et al.* (1991) and Malik (1995). The CV of ACD and MCD were similar to that of uncorrected milk yield for all age groups as well as for overall age groups. As both the correction factors were effective in retaining overall mean and CV of population near to the mean and CV of uncorrected data, it revealed that both the age correction factors were almost equally appropriate. These finding were in agreement with the findings of Chauhan (1988), Saxena *et al.* (1991), Kumar and Gandhi (1995), Gandhi and Gurnani (1997) and Gandhi (2000).

The F-value for the effect of age groups on first lactation milk yield was almost zero for both the corrected data as compared to significant F-value ($P < 0.05$) for uncorrected data (Table 3). It indicated that both the correction factors were appropriate ones and equally effective in removing the effect of age from first lactation milk yield. These findings

Table 3. F-value, residual variance and R^2 value of first lactation milk yield for uncorrected, additively (ACD) and multiplicatively corrected data (MCD) in different age groups

	Uncorrected	ACD	MCD
F-value	1.89	0.00	0.02
Residual variance	40379.06	40379.06	38865.77
R^2 value (%)	64.5	64.0	63.7

were in consonance to the findings of Kumar and Gandhi (1995), Gandhi and Gurnani (1997), Gandhi (2000) and Kumar and Singh (2003). Dawande *et al.* (2007) also reported around zero F-value for effect of age groups on milk yield. The residual variance of MCD was lesser than the residual variance from uncorrected and additively corrected data. It revealed that MCFs were more efficient as compared to ACFs. These results were in agreement with the findings of Chauhan (1988), Saxena *et al.* (1991), Gandhi and Gurnami (1997) and Gandhi (2000). However, Kumar and Gandhi (1995) found that ACFs were more effective as compared to MCFs in terms of reducing residual variance in Murrah buffaloes. The coefficient of determination (R^2 value) of fitting the model from ACFs and MCFs factors were 0.5 and 0.8% less than that from uncorrected data (64.5%). As both the correction factors were having almost similar coefficient of variation, both seem to be equally effective for correcting the first lactation milk yield. Kumar and Gandhi (1995) and Gandhi (2000) also reported similar findings. The herd average and range of estimated breeding values (EBVs) for different sires for all the 3 data sets revealed that about 46.34% (19 out of 41) of sires were having positive EBVs over herd average (Table 4). The per cent range of EBVs of sires having positive deviation from herd averages from uncorrected, ACD and MCD were 0.96–37.31, 1.49–38.78 and 0.99–38.53, respectively. The high range of superiority in ACD and MCD indicated that both the corrected data sets discriminated among the bulls to the maximum extent as compared to uncorrected data.

A simulation study was done to find out the superiority of bulls over the herd average when 5, 10, 15, 20 and 25% of sires were selected (Table 5). When 5% (2 out of 41) of sires were selected the percent ranges of superiority of sires over herd average was more from additively and multiplicatively corrected data. Gandhi (2000) also reported higher range of superiority of ACD and MCD over uncorrected data. On the

Table 4. Range of breeding values (EBVs) of sires estimated from uncorrected, additively corrected (ACD) and multiplicatively corrected data (MCD)

Data	Herd average (kg)	Range of EBVs (kg)	No of sires having '+' EBVs	Range of EBVs of sires having positive deviation (kg)	Range of percent superiority
Uncorrected	915.48	655.87 (12)–1257.91 (11)	19	924.29 (27)–1257.91 (11)	0.962–37.305
ACD	894.14	637.86 (12)–1240.84 (11)	19	907.44 (17)–1240.84 (11)	1.487–38.775
MCD	894.32	6944.14 (12)–1235.86 (11)	19	903.14 (17)–1235.86 (11)	0.986–38.525

Figures in parentheses indicate number of sires.

Table 5. Range of superiority of sires over herd average for different proportions of sires selected

Data	Proportion of sires selected				
	25%	20%	15%	10%	5%
Uncorrected	976.07–1257.91 (6.62–37.31)	1010.59–1257.91 (10.39–37.31)	1052.34–1257.91 (14.95–37.31)	1103.05–1257.91 (20.49–37.31)	1207.23–1257.91 (31.87–37.31)
ACD	968.82–1240.84 (8.35–38.78)	987.20–1240.84 (10.41–38.78)	1036.06–1240.84 (15.87–38.78)	1084.18–1240.84 (21.25–38.78)	1156.40–1240.84 (29.33–38.78)
MCD	970.64–1238.86 (8.53–38.53)	979.96–1238.86 (9.58–38.53)	1034.52–1238.86 (15.68–38.53)	1082.78–1238.86 (21.07–38.53)	1149.14–1238.86 (28.49–38.53)

Figures in parentheses indicate superiority over herd average in per cent.

other hand, Kumar and Gandhi (1994) reported lower range of superiority over herd averages from ACD than that from uncorrected data in Murrah buffaloes. Higher per cent ranges of superiority from ACD and MCD as compared to uncorrected data for different proportions selected (10, 15, 20 and 25%) were also observed, indicating that both the correction factors seem to have an edge over uncorrected data.

The rank correlations between the EBVs of sires estimated on different data sets were high (0.980). The rank correlation of EBV's of uncorrected data with ACD and MCD were 0.980 and 0.982, respectively. The rank correlation of EBVs of ACD and MCD was 0.998. These results revealed that ranking of sires from uncorrected and both the corrected data sets were almost similar. Kumar and Gandhi (1994) also reported near to unity rank correlations among uncorrected, additively corrected and multiplicatively corrected data sets in Murrah buffaloes.

Combining the results from different criteria, it may be concluded that both additive and multiplicative age correction factors were comparatively more effective in sire evaluation than from uncorrected data in Haryana cattle. As far as comparison among both the age correction factors is concerned, multiplicative age correction factors seem to be more effective in cow evaluation, whereas additive age correction factors were more effective for sire evaluation.

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