Genetic Gain in Productive Traits and Nonproductive Traits through Selection Indices in HF×Gir Halfbreds

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ABSTRACT
The present investigation entitled, “Genetic gain in productive and non productive traits through selection indices in HF xGir halfbreds” undertaken to assess the magnitude of different factors along with generations affecting the reproductive and productive traits. The data pertaining to HF x Gir halfbreds maintained from year 1972 to 2016 at RCDP on cattle, M.P.K.V., Rahuri were used for present investigation.
In HF x Gir halfbred cows the heritability of AFC, SP, PMY, LMY, LL, DP< CI, MY/CI, MY/LL was 0.521 ± 0.517, 0.132 ± 0.104, 0.432 ± 0.433, 0.259 ± 0.227, 0.330 ± 0.031, 0.430 ± 0.430, 0.087 ± 0.066, 0.077 ± 0.060 and 0.056 ± 0.061, respectively.
Out of 28 selection indices constructed for HF x Gir halfbreds, index I²₄ to I²₈ from four traits combination were found to be relatively efficient indices and rated as the most useful indices for their high reliability and expected genetic gain.
Keywords: Economics, Animals, Genetic, Halfbreds

INTRODUCTION
The economics of dairy industry is based on productivity of animals which is governed by several productive traits. The dairy animals are kept for milk production and their selection is done for their breeding value (genetic worth). The aim of the present day livestock breeder is to raise the animals on commercial line based on the principle of maximum gain from minimum input. It means that the animals which will bring maximum economic returns are kept while the rest unwanted low profitable stock culled at an earliest to reduce pressure on space and resources and also to increase efficiency of management. For proper selection and culling, a kind of yard stick is needed to discriminate the animals likely to bring maximum economic returns from those less profitable. To develop this kind of discriminating yard stick, all economically important traits are taken into account and combined according to their relative economic weights into a net economic score for each animal.

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The relative weight of a trait depends upon its heritability, relative economic value and association with other traits. The animals which rank best on this scale are retained and other culled for maximum returns from a livestock enterprises.

**MATERIALS AND METHODS**

The data of HF x Gir halfbreds maintained at Research Cum Development Project on Cattle, M.P.K.V., Rahuri for a period of 44 years (1972 to 2016). The data were classified according to genetic groups, period of birth/calving and season of birth/calving. The data collected according to period of birth classified into 6 groups as \(P_1 (1972-1978), P_2 (1979-1985), P_3 (1986-1992), P_4 (1993-1999), P_5 (2000-2006), P_6 (2006 and above)\). Period of calving \(P_1 (1974-1980), P_2 (1981-1987), P_3 (1988-1994), P_4 (1995-2001), P_5 (2002-2008), P_6 (2008 and above)\) Viz., 5 order of lactation viz. L1 lactation order 1, L2 lactation order 2, L3 lactation order 3, L4 lactation order 4, lactation order 5; Season of birth coded as Rainy (June – September) coded \(S_1\), Winter (October – January) \(S_2\), Summer (February – May) \(S_3\), Peak milk yield group (kg) as \(Y_1 <12.00kg, Y_2 12-14kg, Y_3 >14kg\).

**Model – I**

The least squares means of age at first calving estimated by considering period of birth and season of birth effects. The following model used for estimation,

\[
Y_{ijk} = \mu + P_i + S_j + e_{ijk}
\]

**Model – II**

The least squares means of service period, calving interval, lactation milk yield, lactation length, dry period, milk yield per day of calving interval and milk yield per day of lactation length were estimated by considering period of calving, season of calving, lactation order and peak milk yield effects. The following model used for estimation,

\[
Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + e_{ijklm}
\]

**Model – III**

Least squares analysis of some reproduction and production traits as affected by generation carried out by using following statistical model.

\[
Y_{ij} = \mu + G_i + e_{ij}
\]

Duncan’s Multiple Range Test

\[
(Y_i - Y_j) \times \sqrt{2/C_{ii} + (C_{jj} - C_{ij})} \geq \sigma^2 Z (P, n_e)
\]

Construction of selection indices

Selection indices constructed by using different traits in different combinations according to Cunningham (1969).

**Model for estimation of relative efficiency of index**

The relative efficiency of the index \(I_i\) was computed as per Hogsett and Nordskog (1958).

\[
\Delta H (I_i) = \cdots \cdots \\
\text{Relative efficiency} = \cdots \cdots \\
\Delta H (Is)
\]

Where,

\(I_i\) = \(i^{th}\) index whose relative efficiency was estimated

\(Is\) = Standard index with maximum aggregate genetic gain

**RESULT AND DISCUSSION**

An index method is more efficient for selection of an animal than tandem method or independent culling method, because it results in more genetic improvement for the time and efforts put in it’s use. The rate of genetic gain
Selection indices were constructed by incorporating age at first calving (AFC), service period (SP), calving interval (CI), lactation length (LL), dry period (DP), lactation milk yield (LMY) and milk yield per day of calving interval (MY/CI) and milk yield per day of lactation length (MY/LL). Total 150 selection indices were constructed in all possible combinations of four traits. However, out of them only 28 have given precise estimates and are presented in Table 1.

Partial regression coefficient of different traits (b values) and measure of the accuracy (rIH value) of different indices have been presented in Table 1 The partial regression coefficients of different traits (b values) and measure of the relative economic values, heritability and correlations with other traits.

**Efficiency of selection indices**
The chief measure of utility of an index is its correlation with aggregate breeding value, rIH. The genetic response to selection is proportional to this correlation. Out of 28 selection indices constructed for HF x Gir halfbreds, index I_{24} with four traits combination [(-9.907) (CI) + (-0.5409) (LL) + (-15.287) (DP) + (89.66) (PMY)] was found to be the most useful index. Using this index the response in each trait per generation was expected to be -1.76 days in calving interval (CI), 70.29 days in lactation length (LL), -84.4 days in dry period and 0.049 kg in peak milk yield (PMY).

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Out of 28 selection indices constructed for HF x Gir halfbreds, index I_{24} to I_{28} from four traits combination were found to be relatively efficient indices and rated as the most useful indices for their high reliability and expected genetic gain.

### Table 1: Selection indices for HF x Gir halfbreds (four traits combination)

| Index | Particulars | Traits | AFC | CI | SP | LMY | rIH | ΔH |
|-------|-------------|--------|-----|----|----|-----|-----|----|
| I_1   | B Value     | -0.422 | 0.0314 | 0.1959 | 1.071 | rIH=0.6892 | ΔH=193.59 |
|       | R.E.V.      | -10.88 | -15.52 | -12.35 | 1     |       |     |    |
|       | Δ gi        | -168.63 | -19.27 | 55.018 | -7.2938 |       |     |    |
| I_2   | B Value     | -3.034 | -8.9966 | 5.6954 | -0.9930 | rIH=0.5284 | ΔH=539.63 |
|       | R.E.V.      | -10.88 | 1 | -12.35 | -15.52 |       |     |    |
|       | Δ gi        | -296.8 | -0.445 | -0.375 | -0.013 |       |     |    |
| I_3   | B Value     | -3.5998 | 1.200 | 0.0135 | -1.543 | rIH=0.5808 | ΔH=664.96 |
|       | R.E.V.      | -10.88 | -15.52 | -12.35 | -12.02 |       |     |    |
|       | Δ gi        | -294.99 | -1.921 | -3.326 | -0.436 |       |     |    |
| I_4   | B Value     | -3.4088 | 0.410 | -0.2465 | -2.034 | rIH=0.5778 | ΔH=609.68 |
|       | R.E.V.      | -10.88 | -15.52 | -12.35 | -11.05 |       |     |    |
|       | Δ gi        | -294.99 | -1.921 | -3.326 | -0.436 |       |     |    |
| I_5   | B Value     | -3.1609 | -0.6345 | 0.08289 | -22.014 | rIH=0.5229 | ΔH=569.77 |
|       | R.E.V.      | -10.88 | -12.35 | -12.00 | 10.38 |       |     |    |
|       | Δ gi        | -295.21 | -3.3135 | -9.5747 | -0.0354 |       |     |    |
| I_6   | B Value     | -3.1825 | -0.6086 | 0.59789 | 3.4986 | rIH=0.5172 | ΔH=572.48 |
|       | R.E.V.      | -10.88 | -12.35 | -14.49 | 10.99 |       |     |    |
|       | Δ gi        | -295.61 | -3.1993 | -0.329 | -0.0342 |       |     |    |
| I_7   | B Value     | -3.2549 | -0.2445 | -8.9768 | 6.24738 | rIH=0.5365 | ΔH=580.48 |
|       | R.E.V.      | -10.88 | -12.35 | -41.05 | 10.99 |       |     |    |
|       | Δ gi        | -298.4 | -3.1644 | 0.438 | 0.0369 |       |     |    |
| Index | Particulars | AFC | CI | PMY | MY/CI |
|-------|-------------|-----|-----|-----|-------|
| Ia    | B Value     | -3.1337 | -0.231 | -0.2911 | 1.4512 | rIH = 0.5369 | ΔH = 580.48 |
|       | R.E.V.      | -10.88 | -12.36 | -11.05 | 10.96  |               |               |
|       | Δ gi        | -0.2981 | -0.2013 | -0.0654 | 0.0602 |               |               |
| Ib    | B Value     | -3.0448 | -0.2825 | 0.0128 | 0.4052 | rIH = 0.50738 | ΔH = 544.62 |
|       | R.E.V.      | -10.88 | -15.52 | 12.00  | 14.49  |               |               |
|       | Δ gi        | -0.2938 | -1.7598 | -121.96 | -0.512 |               |               |
| Ic    | B Value     | -3.1081 | -0.0444 | 0.0166 | 0.0815 | rIH = 0.53492 | ΔH = 553.303 |
|       | R.E.V.      | -10.88 | -15.52 | 12.00  | -11.05 |               |               |
|       | Δ gi        | -0.2939 | -1.8284 | -105.96 | -0.0999 |               |               |
| Id    | B Value     | -3.0822 | -0.0465 | 0.0703 | 0.5248 | rIH = 0.53521 | ΔH = 553.36 |
|       | R.E.V.      | -10.88 | -15.52 | 12.00  | 10.98  |               |               |
|       | Δ gi        | -0.2939 | -1.8272 | -114.91 | 0.0044 |               |               |
| Ie    | B Value     | -3.1144 | -0.0729 | 0.1637 | 0.8275 | rIH = 0.54924 | ΔH = 556.178 |
|       | R.E.V.      | -10.88 | -15.52 | 14.49  | 12.00  |               |               |
|       | Δ gi        | -0.2902 | -1.7588 | -123.01 | 0.0048 |               |               |
| If    | B Value     | -3.1244 | -0.0795 | -0.3374 | 1.4853 | rIH = 0.56508 | ΔH = 555.19 |
|       | R.E.V.      | -10.88 | -15.52 | 14.49  | 12.00  |               |               |
|       | Δ gi        | -0.2960 | -1.8762 | -106.83 | -0.485 |               |               |
| Ig    | B Value     | -3.0923 | 0.0474 | 0.0373 | 1.5068 | rIH = 0.4761 | ΔH = 514.27 |
|       | R.E.V.      | -10.88 | 12.00  | 14.49  | -12.02 |               |               |
|       | Δ gi        | -0.2778 | 324.45 | 0.0096 | -5.285 |               |               |
| Ih    | B Value     | -2.8769 | -0.0416 | 0.3945 | 24.714 | rIH = 0.5041 | ΔH = 530.71 |
|       | R.E.V.      | -10.88 | 12.00  | 14.49  | -12.02 |               |               |
|       | Δ gi        | -0.2544 | -320.36 | -5.5605 | -0.057 |               |               |
| Ii    | B Value     | -3.1192 | 0.11971 | 1.8111 | -46.234 | rIH = 0.5024 | ΔH = 593.90 |
|       | R.E.V.      | -10.88 | 12.00  | 14.49  | -12.02 |               |               |
|       | Δ gi        | -0.2819 | 312.22 | 5.5636 | 0.03913 |               |               |
| Ij    | B Value     | -2.9408 | -0.0145 | 0.4477 | 18.946 | rIH = 0.53245 | ΔH = 553.81 |
|       | R.E.V.      | -10.88 | 12.00  | 14.49  | -12.02 |               |               |
|       | Δ gi        | -0.279378 | 451.81 | 0.035 | -0.035 |               |               |

| Index | Particulars | AFC | CI | PMY | MY/CI |
|-------|-------------|-----|-----|-----|-------|
| Ia    | B Value     | -2.9699 | -0.1614 | -15.702 | 10.7566 | rIH = 0.5155 | ΔH = 530.89 |
|       | R.E.V.      | -10.88 | 14.49  | -11.05 | 10.96  |               |               |
|       | Δ gi        | -0.2339 | -0.6305 | -0.0648 | 0.0064 |               |               |
| Ib    | B Value     | 3.1504 | -8.9086 | 56.594 | -0.9931 | rIH = 0.5264 | ΔH = 539.63 |
|       | R.E.V.      | 10.88 | -11.05 | 10.98  | 10.98  |               |               |
|       | Δ gi        | 2.2318 | -0.0445 | 0.0775 | 0.0013 |               |               |
| Ic    | B Value     | 3.2598 | -0.8399 | -2.8814 | 1.0691 | rIH = 0.5393 | ΔH = 530.59 |
|       | R.E.V.      | -10.88 | -12.02 | -11.05 | 10.98  |               |               |
|       | Δ gi        | 2.4455 | -3.9225 | 0.0935 | 0.00049 |               |               |
| Id    | B Value     | 9.0784 | -0.5409 | -15.287 | 89.667 | rIH = 0.8901 | ΔH = 1149.46 |
|       | R.E.V.      | -15.52 | 14.49  | -12.02 | -11.05 |               |               |
|       | Δ gi        | 1.7814 | 30.2952 | 44.481 | 0.1402 |               |               |
| Ie    | B Value     | 0.05306 | 0.2786 | 1.1793 | 0.2477 | rIH = 0.82678 | ΔH = 44.179 |
|       | R.E.V.      | -15.52 | 14.49  | -11.05 | 10.98  |               |               |
|       | Δ gi        | 1.4011 | 1.5688 | 0.0269 | 0.0051 |               |               |
| If    | B Value     | -0.0862 | 0.67155 | 1.98383 | 8.3132 | rIH = 0.88063 | ΔH = 51.216 |
|       | R.E.V.      | -15.52 | 14.49  | -11.05 | 10.96  |               |               |
|       | Δ gi        | -0.3986 | 1.5892 | -0.0335 | 0.035372 |               |               |

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| Index | Particulars | Traits |
|-------|-------------|--------|
| I_{17} | B Value | -1.3031 | 2.1377 | 72.6337 | -94.184 |
|       | R.E.V. | -15.52 | 14.49 | 10.98 | 10.96 |
|       | Δ gi | -60.729 | -37.94 | -0.0086 | 0.05544 |
| I_{18} | B Value | 0.82212 | -1.9008 | 72.3355 | -80.755 |
|       | R.E.V. | -15.52 | -12.02 | 10.98 | 10.96 |
|       | Δ gi | -4.7436 | -119.55 | 0.1139 | 0.1693 |

Abbreviations:
- AFC = Age at first calving.
- SP = service period.
- LL = lactation length.
- DP = dry period.
- CI = calving interval.
- LMY = lactation milk yield.
- MY/CI = Milk yield per day of calving interval.
- R.E.V. = Relative economic weights.
- Δ gi = Gain in each trait.
- ΔH = Overall genetic gain.
- rIH = Correlation between genetic worth and index.

REFERENCES

Banerjee, Sandip & Banerjee, S. (2002). Correlation between some reproduction and production traits in Holstein Friesian x Sahiwal crossbred cows. *Indian Vet. J.* 79(2), 927-930.

Cunningham, E. P. (1969). Animal Breeding Theory. Landbruck Sokobhandelen Universities, Forlaget Yollabekk, 0510.

Deokar, D. K., & Ulmek, B. R. (2001). Studies on lactation length in Jersey cattle. *J. Maharashtre Agric. Univ.* 26(1), 104-106.

Hazel, L. N., & Lush, J. L. (1942). The efficiency of three methods of selection. *J. Heridity. 33*, 393-399.

Hogsett, M. L., & Nordskog, A. W. (1958). *Poult. Sci.* , 37, 1404-1419.

Krammer, C. Y. (1957). Extension of multiple range test to group related adjusted mean-Biometrics 13, 20.

Smith, C. (1983). Effect of changes in economic weights on the efficiency of index selection. *J. Anim. Sci.*, 56, 1057-1064.

Swiger, L. A., Harvey, W. R., Everson, D. O., & Gregory, K. E. (1964). The variance of interclass correlation involving groups with one observation. *Biometrics.* 20, 818-826.