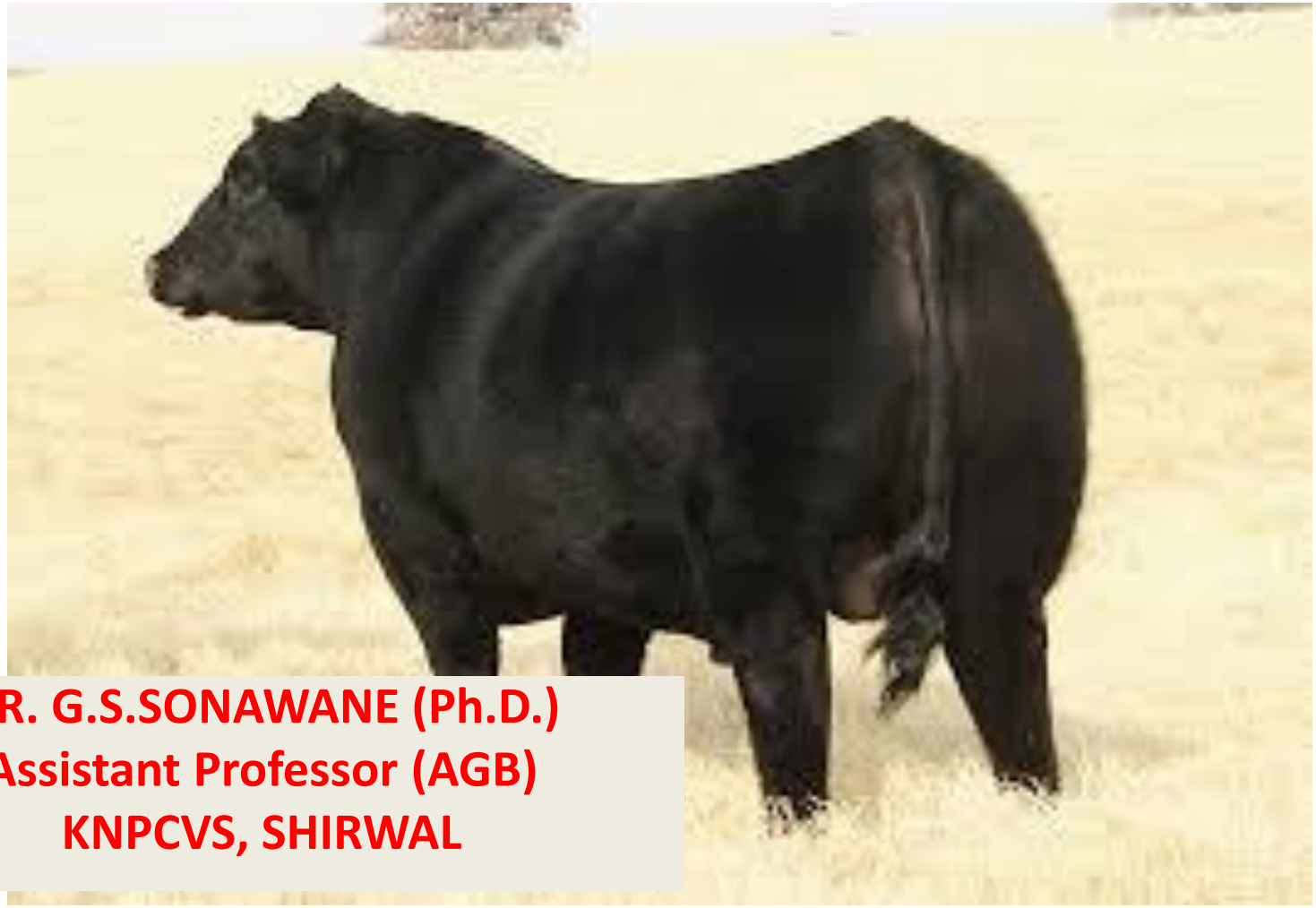
SIRE EVALUATION



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Sire Evaluation

- Increasing the productivity through genetic improvement requires adequate identification and intensive selection of genetically superior sires.
- About 93 per cent of the total herd improvement comes from breeding of young bulls from tested sires and only six per cent from selection of dams.
- Thus, selection of bulls is of great importance in dairy herd improvement.

Contn..

- The breeding value refers to the average genetic effect of the genes passed on by the individual to its offspring and is estimated to know whether the individual is genetically superior to other individuals or not for the trait concerned.
- For maximizing the genetic gain by sire selection, it is essential that the method of estimating breeding values of sires should be unbiased and efficient.

Contn..

- sire's production transmitting ability can be estimated by mathematical means and expressed as a single figure known as sire index.
- Selection indexes can simplify the process of choosing service sires for dairy herds.
- **A selection index incorporates several traits into a single genetic value.**
- Traits are combined into the index based on **relative economic weights** of the traits.

Sire Indices

- Simple daughter average index,
- Equiparent / Intermediate / Dairy bull index / Yapp’s Index,
- Mount hope index,
- Heizer’s index,
- Gifford’s index,
- Regression index or rice index,
- Tomar index,
- Corrected daughter average index / Krishnan’s index,
- Dairy search index / Sundaresan index,
- Contemporary and herd-mate comparison,
- Best linear unbiased prediction (BLUP).

Simple Daughter Average Index

- The simplest way to evaluate a bull is by his daughter's production alone (**Edward, 1932).**
- The fault with this method is that it does not consider the probable contributions of the dam.
- It would be all right if all the bulls were bred to average group of cows.

$SI = Di = (1 / mi)\Sigma Dij$

where,

- Dij = yield of jth daughter of the ith sire
- mi = number of dams mated to ith sire

- This index when used for ranking sires would be subject to bias if the levels of production of dams allotted to different sires were unequal.

Equiparent / Intermediate / Dairy Bull Index / Yapp's Index

- This index **(Yapp, 1925)** is based on the principle that the two parents contribute equally to the genetic make up of the progeny.
- This index overestimates the breeding value of a sire mated to set of dams inferior on the average and underestimates if dams happen to be superior on the average to the general level of herd.

SI = 2D – M

Where,

- D = average yield of daughters of the sire;
- M = average yield of dams mated to the sire

- In Yapp's formula, the potential transmitting ability can be expressed in terms of 4% fat corrected milk.

Mount Hope Index

Goodale (1927)

- He suggested that in mating between animals of unequal levels of milk production is on the average about 7 / 10 of the distance above the level of the lower parent.
- While butter fat production is about 4 / 10 of the distance above the lower level.
- To get this index, compute the average mature equivalent of milk production of the dams of these daughters and take the difference between these averages.

Adjustment in Index

- If the daughter's average exceeds the dam's average, add **3 /7 (0.4286)** of the difference to the daughter's average to get the bull's milk index figure.
- If the daughter's average is less than the dam's average, subtract **7 / 3 (2.333**) of the difference to the daughter's average to get the bull's milk index figure.
- If the daughter's **butter fat average** exceeds the dam's average, add three halves or 1.5 of the difference to the daughter's average to get the bull's butter fat index figure.
- If the daughter's butter fat average is less than the dam's average, subtract 2 / 3 or 0.6667 of the difference to the daughter's average to get the bull's butter fat index figure.

Formula

- **For milk yield**

  $S = D + (D - M) \times 3/7$ if $D>M$

  $S = D - (M - D) \times 7/3$ if $M>D$

- **For Butter fat %**

  $S = D + (D - M) \times 3/2$ if $D>M$

  $S = D + (M - D) \times 2/3$ if $M>D$

HEIZER'S INDEX

- This index is used to determine the transmitting ability of individual bulls with regard to **milk production**.
- This method is based on **progeny selection**.

Formula

$$Y = 3 / 8 X + 3 / 4 I + 1 / 4 B$$

Where,

Y - daughter’s average production

X - dam’s average production

I - sire’s index

B - Breed or Herd average

GIFFORD'S INDEX

- Gifford (1930) suggested that the bull index can be estimated from the daughters' records ignoring the dams, provided the dams are not a selected group.

$$\boxed{SI = 2P - H}$$

where,

- H = herd average;
- P = daughters average

Regression Index or Rice Index

- Rice has proposed this index based on the fact that the overall regression of the daughter's records on those of their dams was approximately 0.5.
- This index simply regresses the equal parent index half way.

Regression Index = 0.5 (Equal Parent index) + 0.5 (Breed Average)

Tomar Index

- This index depends on dam-daughter comparison and on simultaneous use of the merits of the dams and the daughters over their contemporary herd averages.

$$I = D + (De - Me)$$

Where,

- De - daughter's expected average = D x daughter's contemporary herd average
- Me - dam's expected average = M x dam's contemporary herd average

Corrected Daughter Average Index / Krishna's Index

- This index (Krishnan, 1956) corrects the daughters' average for the influence of different production levels of dams sired by different bulls on the basis of regression of daughters' records on dams.
- The term "b(M - A)" appearing in the index is correction for the genetic superiority or inferiority of a set of dams allotted to the sire over the herd average.

Formula

$$SI = D - b\,(M - A)$$

Where,

D = daughter's average;

M = dam's average;

A = herd average

b = regression coefficient of daughters' yield on dam's yield

Dairy Search Index / Sundaresan Index

- Under Indian conditions, evaluation of bulls is made with information from a very few daughters and from records subjected to serious environmental differences.
- **Sundaresan (1965)** gave two methods one for sire evaluation at farm level and another for key-village.

The farm method takes dam-daughter records in to consideration.

$$\mathbf{SI = \mu + n / (n + 12) (D - CD) - b (M - CM)}$$

- **For key-village level the dam's record is not available so, he modified the formula as**

$$\boxed{SI = \mu + n / (n + 12)\ (D - CD)}$$

Where,

- μ = herd average;
- n = number of daughters per sire;
- D = average of daughters;
- CD = average of contemporaries of daughters;
- b = intra-sire regression of daughters on dam;
- M = average of dams;
- CM = average of contemporaries of dams

Contemporary Comparison

- If changes in the environment conditions from time to time were of significance, then the relevant records made at different times needed adjustments.
- The value was based on the comparison of average of the daughters of the bull with average of the contemporary daughters of the same group but sired by different bulls.
- The difference between the two averages was weighted for the number of heifers in each sire group.
- **The contemporary group will allow effective adjustment of major environment effects.**

Formula

$$SI = \mu + \{n / n + k\} (D - C)$$

Where,

- n = number of daughters;
- C = average of daughters' contemporaries;
- k = ratio of error variance to sire variance

Herd-mate Comparison

- This method **(Henderson and Carter, 1957)** compares each cow's record with the records of other cows milking in the same herd at the same time.
- The herd, year and season variations account for about 50% of the total variation in milk production.
- This method eliminates the herd-year-season variation from the estimate of the sire index.

Formula

$$PD = [(ni / (ni + 20)] \{Di - 0.9 (HMi – A) – A\}$$

Where,

- PD = predicted difference;
- ni = number of daughters at the ith herd-mate level
- Di = average of the daughters at the ith herd-mate level
- HMi = average of the herd-mates at ith herd-mate level

Modified Contemporary Comparison

- Since only contemporaries of **first calvers** are considered, the herds less than 20 to 30 cows might not have any contemporary for comparison.
- However, the comparison of progeny with contemporaries of all ages might improve the accuracy of sire evaluation.
- But comparing cows in first lactation with older cows that are survivors of culling for yield could be important sources of biases in dairy sire evaluation.

Formula

$$MCA = [n1\ X1 + W\ (Xi - Bias)] / (n1 + W)$$

where,

- n1 = number of contemporaries of first lactation
- X1 = average of the contemporaries of first lactation
- Xi = average of the contemporaries of later lactation
- W = weight given to later lactation herd-mates

- Bias = adjustment for later lactation cows, being the survivors of culling
- The bias is calculated as average within herd-year-season difference between first and later lactation cows, adjusted for genetic trend.

$$\mathbf{SI = A + \{n / (n + k)\} (D - MCA)}$$

BEST LINEAR UNBIASED PREDICTION (BLUP)

- When the performance records are used as clues in selection index, it is automatically assumed that the records have been adjusted previously for all known sources of environmental bias using adjustment factors.

- This method (**Henderson *et al.*, 1975)** is mainly based on **least-squares method.**

- The basic steps involved in BLUP estimates are as an expression (model) that describes an individual's performances in terms of all factors, that need to be taken into account *i.e.,* **herd-year-season model will be**

Formula

$$Y_{ijk} = \mu + f_i + s_j + e_{ijk}$$

where,

- Y_{ijk} = measurement on the kth progeny of the jth sire born in the ith herd- year- season
- μ = over all mean
- f_i = effect of the ith herd- year- season
- s_j = effect on the jth sire born
- e_{ijk} = residual error

BLUP is the best method for evaluating the breeding value of bulls and rank the sires according to their genetic merit because of the following reasons

- Corrects the data automatically for all known **non genetic sources**
- Estimates simultaneously all the factors concerned
- Uses available a priori information **more efficiently and more flexibly**
- **Maximizes the correlation between predictor and predict**
- Provides an estimate of response to selection for groups of animals born in different years
- Accounts for complications such as non-random mating, genetic and environmental trends over time, herd differences in the average breeding value of dams and bias due to selection and culling
- **Estimates also the breeding value of individual having no records.**