SOME PRINCIPLES FOR DAIRY SIRE EVALUATION

Principles for dairy sire evaluation have been put forward for millenia. At the start of planned improvement in the last century, the belonging to a herd-book or some coat patterns were assumed to constitute evidence of quality. The body conformation and pedigree information were used for sire evaluation, followed by the various systems of progeny testing: first dam-daughter comparisons, next contemporary comparisons and now comparisons to a genetic base level. Each selection criterion apparently was effective for some time increasing uniformity and making it necessary to refine the methods and to define new principles. In the following, some principles for evaluating dairy sires will be discussed, which at present warrant attention.

1. THE STANDARD ERROR OF THE EXPECTED DIFFERENCE

Sires are evaluated on basis of the performance of the first crop of daughters by estimating the expected difference from future daughters.

\[ ED = R \cdot P \quad (10), \]

where,

\[ ED \] = the expected performance (difference) from future daughters.

\[ P \] = the mean past performance (difference) of daughters.

\[ R \] = the repeatability = \( n/(n + k) \), where.

\[ n \] = the number of daughters, and.

\[ k \] = \( V_s/V_r \), where.

\[ V_s \] = the sire variance.

\[ V_r \] = the residual variance.

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Including the standard error of $ED$ for sire evaluation seems to be an important principle considering the vast use by A.I. of semen from a few progeny tested sires. Breeders using progeny tested sires wonder how much worse the second crop of daughters might be.

Following Suller (15):

$$V_{ED} = V_e (1 - R) = V_e / (n + k),$$

where,

$$SE_{ED} = (V_{ED})^{1/2} = \text{the standard error of } ED.$$

Table 1 portrays the effects of varying $n$ on $ED$ and on $SE_{ED}$.

**TABLE 1**

<table>
<thead>
<tr>
<th>Daughters</th>
<th>Repeatability</th>
<th>Past daughter difference: +300 Kg milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0.61</td>
<td>$+183$</td>
</tr>
<tr>
<td>50</td>
<td>0.76</td>
<td>$+228$</td>
</tr>
<tr>
<td>75</td>
<td>0.82</td>
<td>$+246$</td>
</tr>
<tr>
<td>100</td>
<td>0.86</td>
<td>$+258$</td>
</tr>
<tr>
<td>150</td>
<td>0.90</td>
<td>$+270$</td>
</tr>
</tbody>
</table>

* The lower 0.05 confidence limit of $ED$.

For a daughter performance of +300 Kg milk, tested by 25 and 100 daughters, the difference in $ED$ (expected daughter performance) is 75 Kg, but the difference in the lower 0.05 confidence limit of the estimate ($ED - 2 SE_{ED}$) is 193 Kg.

The error variance of the expected inheritance of an individual son from its sire is $V_s (4-R)$. When the repeatability of a sire's progeny test was 0.8, then the error variance of the expected inheritance of a son from his sire will be 0.8 of the additive variance in the population ($3.2 V_s$), which means a standard error of about 400 Kg milk. Large $ED$ variations amongst sons of one sire have therefore to be expected. Considering $SE_{ED}$ may induce breeders to save a lot of money paid now for semen or for sons of fancy bulls.

2. **Considering the genetic level of the contemporaries**

The Contemporary Comparison ($CC$) has been in use for two decades (12) for estimating $ED$. $CC$ assumes randomness of contemporaries for each sire. Using proven sires invalidates this assumption. The genetic level of herdmates changes from year to year and for A.I. centres. Methods have recently been developed to account for these differences. Cornell workers (8) devised a least-squares analysis for contemporary sires within age groups and testing regions and by using sires with overlapping progeny groups as connecting links.

In the Israeli progeny testing system half the genetic value of each sire is expressed as a cumulative difference ($CD$) from a base population. The usual
contemporary comparison is calculated and the genetic value of each contemporary is estimated by the \( CD \) of her sire. The \( CD \) of a sire is his \( CC \) plus the weighted mean \( CD \) of the sires of his daughters contemporaries. In the first cycle of calculations all \( CD \) values of contemporaries were considered zero.

\[
CD_i = CC_i + \frac{1}{N} CDCn, \text{ where.}
\]

\( CD_i \) = the cumulative difference of daughters of sire \( i \) (\( \frac{1}{2} \) EBV).
\( CC_i \) = the contemporary comparison for sire \( i \).
\( CDCn \) = the mean cumulative difference of the sires of the contemporaries to daughters \( i \).

\( CD \) makes it also possible to compare bull-dams from different herds and years.

\[
CD_j = h^2(Y_j - C_j) + CDCn_j, \text{ where.}
\]

\( CD_j \) = the cumulative difference of cow \( j \).
\( Y_j \) & \( C_j \) = are the yield of cow \( j \) and the mean yields of her contemporaries, and.
\( CDCn_j \) = the mean \( CD \) of the sires of the contemporaries.

Summing up \( CD \) over herds, A.I. centres, years and breeds makes it possible to estimate the respective genetic gains.

3. PART-TIME AND 2ND LACTATION TESTS

Preliminary part-lactation tests (PL) have become ubiquitous and selection on PL could steepen the lactation decline and reduce improvement in total lactations (6). Table 2 presents correlations (\( r \)) and regressions (\( b \)) between PL and 305 day 1st and 2nd lactation progeny tests (\( CD \)) in Israeli dairy herds. For sires differing by 100 Kg in 122 days, 183 Kg difference in 305 days may be expected with a standard error of 97 Kg for the individual sire. The ranking among bulls differing above 100 Kg in 122 days may therefore hardly change in 305 days.

\( r \) between 1st and 2nd lactations was 0.75, exactly as found for the British-Friesians (3). For 100 Kg \( CD \) in 1st lactation, there were 91 Kg in 2nd lactation, but the residual error was 151 Kg, indicating that the ranking of sires selected on 1st lactations could easily change at 2nd lactations. A tandem sire selection is therefore suggested in which culling and using sires are started following the 122 day test, but the decisions for long-term use and for breeding sons could take account of both lactations.

<table>
<thead>
<tr>
<th>Kg FCM</th>
<th>Cumulative Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>122 day 1st</td>
<td>305 day 1st</td>
</tr>
<tr>
<td>122 day 1st</td>
<td>305 day 2nd</td>
</tr>
<tr>
<td>305 day 1st</td>
<td>305 day 2nd</td>
</tr>
</tbody>
</table>

* For each sire more than 50 daughters in each lactation.
4. ADJUSTMENT FOR DAYS OPEN

Another important aspect for sire evaluation is adjustment for days open. Schaefer et al. (13) have shown that random variation in days open could change the ranking of sires even when the number of heifer daughters per sire was above 2000. Israeli data indicate that the effects of days open on yields of multiparae were still more pronounced than on yields of primiparae (Table 3). A month delay in conception biased 305 days yields against actual annual yields of heifers and cows by 207 Kg and 357 Kg milk, respectively.

TABLE 3
REGRESSION ON 30 DAYS OPEN IN ISRAELI DAIRY HERDS

<table>
<thead>
<tr>
<th>Character</th>
<th>Heifers</th>
<th>Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>305 day Kg milk</td>
<td>4536</td>
<td>+ 267 Kg</td>
</tr>
<tr>
<td>Annual * Kg milk</td>
<td>5389</td>
<td>+ 60 Kg</td>
</tr>
</tbody>
</table>

*a = intercept.

*b = regression on 30 days.

Annual Kg milk = \[\frac{365 \times \text{lactation Kg milk}}{\text{days between calvings}}\]

In Israel yield estimates for progeny testing are adjusted to a standard length of 91 days open (5). Since the first daughters of a sire to finish lactations for progeny tests are those with short calving intervals, such an adjustment seems necessary for preventing bias of the ED estimates for young sires.

5. PERFORMANCE TESTS AND PROGENY TESTS FOR GROWTH RATE

The conformation of the bull has for many years constituted a criterion for his evaluation. It seems plausible, that relative length and looks, defined as Dairy Characters, may reflect high levels of some endocrine and metabolic activities associated with milk production. Correlations of about 0.3 were reported for some length measurements, such as tail length, and milk yields (14), but very little evidence seems to exist for associations within breeds between conformation ratings of bulls and milk yields of daughters.

New aspects of performance may in future become valuable for estimating ED. Some associations have been reported between milk yields of daughters with both blood group constituents (9) and thyroid activity (7) of the sires.

Growth rate is for the time being probably the only economic trait measurable on the sire. In Israel the regression of ED for growth by sons in commercial herds on growth performance of sires has been 0.2. Culling young bulls on growth performance could eliminate potential sire lines and reduce the selection intensity.
for bull-dams. It seems advisable to select performance tested bulls within sires and to take into account the yield differences between the bull-dams by forming an index of expected yield and growth. When 6-7% of the mean yield deviation of a bull-dam can reasonably be expected in her granddaughters (17), 20% of a bull's growth deviation in his sons' ED, and the relative value for ED of Kg liveweight of sons at 14 months to Kg milk = 1 : 7.8 (16), then the economic expectancy from one Kg liveweight of the bull equals 20-25 Kg milk of a bull-dam.

As offspring data become available, index selection based on progeny tests for both growth of bull calves and yields of daughters could increase income and protein production (16).

6. Survival of calves from primiparae

Calf mortality from heifer calvings exceeds twice to three times the incidence of cow calvings (2). Considerable differences between progeny groups have been reported (4). Incorporating the sire effect for stillbirth, postnatal death and difficult delivery in an index will give relatively highest repeatability values (2). In Israeli dairy herds, \( \sqrt{V_r/V_s} \), for such a calving index was 63, thus, 250 heifer mate calvings would give 0.8 repeatability.

It is suggested to test yield proven sires for heifer breeding adaptation. Since heifers constitute only about one fourth of the females for breeding, sires for heifers could be selected among the proven sires and in this way calf mortality could be reduced without affecting selection intensity for milk yields. The additive standard deviation for calf mortality from heifers was found to be similar to the mean incidence, so that large initial response to selection can be expected.

7. Improvement paths

Sire evaluation and selection constitute the major part of breed improvement, although in recent years the selection path dam-son has gained importance following computer preselection of bull-dams (1). The selection path sire-son was previously the principle improvement factor (11), but severe selection among sires for this path has reduced both the variation among them and the correlation between ED of sires and sons (17). The contribution of this path could again be increased by considering second lactation tests, for which the genetic variation among selected sires is still large.

The improvement path sire-to-cow was found to be economically most important (1), since the income from selecting sires for producing cows precedes the income derived from breeding future sires.

Concludingly it may be stated that selecting appropriate sire evaluation principles can for little costs contribute greatly to genetic and economic improvement.

ZUSAMMENFASSUNG

Es wurde vorgeschlagen die folgenden Masstäbe und Prinzipien bei der Stierprüfung und Auslese zu berücksichtigen:
1. Den Standardfehler des geschätzten Zuchtwerters (ZW).
2. Den ZW der Vergleichstiere.
3. Den ZW für die Einsatzleistungen, Färsenleistungen und zweite Laktationen mit Tandemselektion.
4. Die Tage Abkalben-Wiederaufnahme der Töchter.
6. Ermittlung der Eignung milchgeprüfter Stiere (MS) für Färsenbesamung und selektierte Anpaarung der MS mit Färsen ohne diesbezüglichen Stierausmerzung.

RESUMEN

Los siguientes puntos resumen la estimación del valor de los toros:
1. Obtención del error standard del valor de evaluación estimado (VE).
2. VE de las vacas contemporáneas.
3. VE de las lactaciones iniciales, primera y segunda, en selección en serie (tandem).
4. Número de días desde el parto hasta la nueva concepción.
5. Examen del rendimiento con respecto al aumento del peso (AP). Selección de los toros jóvenes dentro de los padres, considerando el índice AP y la producción de la madre.
6. Consideración de los toros probados para la producción lechera con respecto a su adaptación para la inseminación de vacas.

REFERENCES