ESTIMATION OF GENETIC GAIN IN CZECH RED PIED CATTLE

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L. SEREDA **

In 1944 Dickerson and Hazel published an important paper on the effectiveness of selection based on progeny testing results as a supplement to earlier culling in livestock. They also gave the quantitative expression of the worth of this method from the point of view of genetic gain. Rendel and Robertson (1950) adapted these principles for the study of the effectiveness of selection in dairy cattle in the case of closed population without progeny testing. At the same time Robertson and Rendel (1950) elaborated this system using progeny testing in dairy cattle. Mahadevan (1950, 1951) applied then this method for the estimation of genetic gain in commercial and leading dairy herds of Ayrshire cattle. The same was done by Rendel, Robertson and Alim (1951) in 22 herds of seven various breeds of dairy cattle.


In Czechoslovakia the method of evaluating breeding bulls by contemporary comparison was widely used since 1960. Large scale units and nearly 100% A.I. enabled to introduce this method of progeny testing in the whole State (Váchal and Siler, 1960; Siler, 1963, 1968). A lot of data from milk recording and progeny testing were accumulated making possible the estimation of genetic gain in milk production and the solution of many others related questions.

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MATERIAL AND METHODS

For the estimation of genetic gain in milk production of Czech Red Pied cattle which is the main breed in Czech Republic the basic data from milk recording and progeny testing collected in the State Breeding Organization were used.

The estimation of genetic gain is based on the principles of directional selection in population genetics (Lush, 1948; Lerner, 1950, 1958; Falconer, 1960 and others). The measure of the effectiveness of selection is then the genetic gain per unit of time. The amount of genetic gain in this case is then

\[ R = \frac{\Delta_c}{I} \]

where \( R \) is the amount of genetic gain per unit of time, \( \Delta_c \) is the genetic gain per one generation and \( I \) is the generation interval in years.

**TABLE 1**

*The transfer of genes from generation to generation through four paths (adapted according to Rendel and Robertson, 1950)*

RENDEL and ROBERTSON (1950) and ROBERTSON and RENDEL (1950) developed the basic idea on the transfer of genes from one generation to the next generation.
by four paths as shown on Table 1. The initial parental population is thus divided
in four groups building the next generation of males and females. It is then
necessary to estimate the partial selection effects and generation intervals for
each of these four groups. On the basis of this knowledge it is then possible
to calculate the total amount of genetic gain per one year as given on Table 2.

**TABLE 2**

**ESTIMATION OF GENETIC GAIN**

<table>
<thead>
<tr>
<th>Parental group</th>
<th>Selection effect</th>
<th>Generation interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_S</td>
<td>Δ G_s</td>
<td>Δ I_s</td>
</tr>
<tr>
<td>S_D</td>
<td>Δ G_d</td>
<td>Δ I_d</td>
</tr>
<tr>
<td>D_S</td>
<td>Δ G_d</td>
<td>Δ I_d</td>
</tr>
<tr>
<td>S_D</td>
<td>Δ G_d</td>
<td>Δ I_d</td>
</tr>
</tbody>
</table>

\[
R = \frac{\Delta G_s + \Delta G_d + \Delta G_d + \Delta G_d}{\Delta I_s + \Delta I_d + \Delta I_d + \Delta I_d}
\]

**RESULTS AND DISCUSSION**

For four parental groups mentioned above we found values of selection effects
and generation intervals summarised on Table 3. On the basis of these figures
we estimated genetic gain for milk production per one year as

\[
R = \frac{215 + 112 + 240 + 33}{8 + 7.3 + 7.5 + 4.5} = \frac{600}{27.3} = 21.98 \text{ Kg}
\]

This value is not so far from an earlier estimation of 25.80 Kg found by Siler
and Nedelova (1968).

The value of genetic gain is expressed not only in absolute figures but also
as a percentage of the average milk production. For comparison of the value
of our estimation a brief summary of findings of some other authors is also
given (Table 4). The figures in this table indicate it is possible to calculate with
the net genetic improvement of 1.2% of the average milk production per one year.

A very interesting problem is the participation of four parental groups in the final amount of genetic gain. For comparison again we give Table 5 summarising the relative portions of individual parental groups on the total genetic gain. On

<table>
<thead>
<tr>
<th>Parental group</th>
<th>$\triangle G$ (kgs)</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_S$</td>
<td>215</td>
<td>8.0</td>
</tr>
<tr>
<td>$S_D$</td>
<td>112</td>
<td>7.3</td>
</tr>
<tr>
<td>$D_S$</td>
<td>240</td>
<td>7.5</td>
</tr>
<tr>
<td>$D_D$</td>
<td>33</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>27.3</td>
</tr>
</tbody>
</table>

**TABLE 4**

**Comparison of the values of the genetic gain per one year in % of the average milk production by various authors**

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robertson and Rendel</td>
<td>1950</td>
<td>1.5</td>
</tr>
<tr>
<td>Specht and Mc Gilliard</td>
<td>1960</td>
<td>2.0</td>
</tr>
<tr>
<td>Skjervold</td>
<td>1963</td>
<td>2.0</td>
</tr>
<tr>
<td>Syrstad</td>
<td>1966</td>
<td>0.7</td>
</tr>
<tr>
<td>Siler and Nedelová</td>
<td>1968</td>
<td>1.2</td>
</tr>
<tr>
<td>Siler and Sereda</td>
<td>1971</td>
<td>0.9</td>
</tr>
</tbody>
</table>

the basis of these figures it is possible to say that the predominant part of genetic improvement is given by parents of next sons which is fully in harmony with the main principle of selection programme in cattle breeding, i.e. with getting sons sired by the best bulls and with a strong selection among them.

These relative values also indicate the next possibilities for further increasing of the genetic gain. This problem is at this time very actual. As regards our conditions we emphasize in contrast with other schemes the selection of cows
on the first lactation. This selection could increase the total genetic gain per one year about 7-15% depending on the intensity of selection within cows on the first lactation as shown by Váchal, Sereda and Poděbradský (1972).

TABLE 5
COMPARISON OF THE PERCENTUAL VALUES OF INDIVIDUAL PARENTAL GROUPS ON THE TOTAL GENETIC GAIN

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>$S_1$</th>
<th>$S_2$</th>
<th>$D_1$</th>
<th>$D_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robertson and Rendel</td>
<td>1950</td>
<td>43</td>
<td>18</td>
<td>33</td>
<td>16</td>
</tr>
<tr>
<td>Skjervold</td>
<td>1963</td>
<td>46</td>
<td>24</td>
<td>24</td>
<td>6</td>
</tr>
<tr>
<td>Syrstad</td>
<td>1966+</td>
<td>35</td>
<td>11</td>
<td>49</td>
<td>5</td>
</tr>
<tr>
<td>Syrstad</td>
<td>1966++</td>
<td>41</td>
<td>10</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>Siler and Sereda</td>
<td>1971</td>
<td>33</td>
<td>19</td>
<td>39</td>
<td>9</td>
</tr>
</tbody>
</table>

+ 1957-1961
++ 1962-1964

SUMMARY

In the population of Czech Red Pied cattle where the CC method for the evaluation of breeding bulls is widely used the genetic gain in milk production was estimated. On the basis of the estimation of selection effects and generation intervals for four possible paths realising the transfer of genes from generation to generation the genetic gain per one year of 22 Kg milk was found. This figure represents an increase of 0.92% per year in milk production. As regards the composition of this genetic gain it is mostly done by parents of next sons (72%). For further increasing of the genetic gain selection within cows on the first lactation based on their own performance is emphasized.

RESUMEN

En la población de ganado vacuno checo berrendo en colorado, en el que el método CC para la valoración de los toros reproductores se emplea amplia-mente, se ha calculado la ganancia genética en producción lechera. Sobre la base de la estimación de los efectos de selección y de los intervalos de generación para cuatro posibles medios de actuación, realizando la transferencia de genes de generación en generación, se encontró una ganancia genética anual de 22 Kg de leche. Esta cifra representa un aumento de 0.92% por año en la producción lechera. Con referencia a la composición de esta ganancia genética, es lograda con mayor intensidad por los padres de los hijos más cercanos (72%). Para posteriores aumentos de la ganancia genética se recomienda la selección entre vacas en primera lactación, basándose en sus propios rendimientos.
RESUME

On a calculé le gain génétique de la production laitière dans la population de bétail bovin Tchéque tacheté rouge, dans laquelle la méthode CC pour la valoration de taureaux reproducteurs est largement employée. Sur la base de la estimation des effets de sélection et des intervalles de génération pour quatre possibles moyens d’activité, en réalisant la transference de gènes de génération en génération, on trouva un gain génétique annuel de 22 Kg de lait. Cette chiffre représente une augmentation de 0,92 % par an dans la production laitière. Quant à la composition de ce gain génétique, on y est arrivé plus intensement par les progéniteurs des fils les plus proches (72 %). Pour augmentations postérieures du gain génétique, on recommande la sélection entre vaches en première lactation, tout en se basant sur leurs propres rendements.

REFERENCES


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