A problem of great significance in an up-to-date breeding of the dual-purpose cattle is an estimation of a possible genetic gain and the factors influencing the expected progress as well as the extent of their action. Numerous studies devoted to this problem indicate that a wide use of artificial insemination together with a well-designed breeding program are expected to bring an annual genetic gain in milk recording reaching 2% of an average performance in a population under Improvement Program (Robertson and Rendel, 1950; Skjervold, 1963; Skjervold and Langholz, 1964). It should be noted that a contribution of different paths (from sire to son, from sire to daughter, from dam to son, from dam to daughter) in the transmitting of the genetic progress is clearly different (Robertson and Rendel, 1950; Skjervold, 1963; Skjervold and Langholz, 1964; Lindhé, 1969; Stalinski et al., 1971). As it can be seen from the afore-mentioned studies, the most considerable contribution to the genetic gain comes from the selection along the path: sire-son, but mention should be made here of the importance of the path: dam-son, which according to theoretical calculations has been estimated at 25 to 34%. According to Syrstad (1966) it can reach 49% for an observed genetic progress constituting the highest percentage to be obtained in the breeding progress of the Norwegian cattle population under study (for the paths dam-son and dam-daughter jointly he acquired 49 to 54%).

These results clearly demonstrate the importance of a correct estimation and cow selection, in particular, for potential bull dams in A.I. stations.

In the evaluation of the breeding value of the cows three stages can be distinguished:

— milk sampling and recording,
— elimination of the environmental effects,
— breeding value-seLECTION INDEX.
The first problem (milk sampling and recording) has been given much attention in literature and will not be presented here. Mention must be made only of different approaches given to it in many countries, depending upon a trend in cattle productivity or variations in milk recording systems, size of a population under control, number of traits under evaluation, etc.

Elimination of environmental effects can be considered in estimating the breeding value of cows in two ways: through corrections or estimates within animal groups for which the effect of environmental conditions is about the same. In estimating the breeding value of cows the latter procedure is used and estimates are made within herd, year and calving season. Attempts are made of introducing standardization of environmental conditions through the estimating of the potential bull dams in special stations (modelled after the stations for bulls testing).

The question of estimating the breeding value in cows as comparatively new problem, has been given little attention in literature and only few countries have been involved into the relevant studies: U.S.A., Canada, New Zealand, Norway, Sweden, Finland, West Germany. Theoretically there do not seem to exist considerable differences in the assumptions concerning the estimation of the breeding value of cows and bulls. They are based on the selection index worked out by Hazel in 1943. The most simple solutions have been given by Lush (1947) and Johansson (1961), and they have been used up to the present day with some modifications. When estimating the breeding value of the cows the main emphasis is on the own performance or own performance and half sibs performance (sire index) rather than on dam performance, maternal half sibs and progeny. It should be noted that in the case of own performance and dam performance, estimate is based on the first to fourth (fifth) lactations, while for the rest of information sources mostly the first lactation is considered. Theoretical considerations connected with this problem which refer to the weights given to different information sources and a correlation between the observed breeding value and the index were given by Le Roy (1958), Robertson (1959), Skjervold and Odegard (1959), Young (1961), Searl (1963), Zuk (1971), Skjervold (1973).

You will find below a few formulae used by various authors in estimating cows breeding value.

Johansson (1961) has given two indices, one of them being based on own performance, estimated within herd:

\[ I = h^2 (P_x - A) + A \]  

where:  
- \( h^2 \) is the heritability within herd,  
- \( P_x \) is the cow's performance within herd, year and calving season,  
- \( A \) is the mean average performance of herd-mates within year and calving season.

In the case of considering the breed average Johansson (1961) has given the following formula:

\[ I = h^2 (P_z - A) + h^2_A (A - P) + P \]  

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where: $h^2_A$ is the heritability of the differences between herds, which is generally taken at the level $h^2_A = 0.1$.

$P$ is the breed average.

Both the indices cited here have been used by Lindström (1969) in his extensive investigations on the Finish cattle.

Skjervold (1962, 1965), when discussing the selection methods applied in Norway, has given a slightly modified form of the above index:

$$I = \frac{[h^2 (P_s - A) + h^2_A (A - P) + P] \times 100}{P}$$  \[3\]

Here a modification consists in expressing the index as a relative breeding value (RBV).

Syrstad (1971) has extended the problem under discussion into Norwegian conditions presenting four different indices based on own performance, dam performance and paternal half sibs performance in various combinations. The indices are as follows:

In the case of own performance the index is identical to index given by Skjervold (1962, 1965).

For own performance and dam performance:

$$I = [0.94 h^2 (P_s - A) + 0.1 (A - P)] 100/P + (0.5 - 0.4 h^2) (D - 100) + 100$$  \[4\]

For own performance and sire performance:

$$I = [0.84 h^2 (P_s - A) + 0.1 (A - P)] 100/P + (0.5 - 0.4 h^2) (S - 100) + 100$$  \[5\]

For own performance, dam and sire performance:

$$I = [0.80 h^2 (P_s - A) + 0.1 (A - P)] 100/P + (0.5 - 0.4 h^2) (S + D - 200) + 100$$  \[6\]

where: $S$ and $D$ denote deviations in the dam or half sibs performances from the average for herd-mates.

In Canada (Burnside, 1969) and in the USA (USDA-DHIA, 1972) the indexes are based on own performance and paternal half-sibs. In the case of the USA index the breeding value of the cow is expressed as «transmitting ability». Colleau and Pouitou (1973) have described cow index currently used in France. The information include performance of ancestors, own performance or progeny performance. In Austria (Essl and Haiger, 1973) and in West Germany (Förster, 1971; Förster et al., 1972), (Schwarz, 1970, 1972) estimation of cows breeding value is based on own performance.

Whatever a method of computing weights given to different information sources and irrespective of some different assumptions taken by some countries one thing should be stressed here, that with a greater number of lactations used, an assumption is made of the same heritability for the successive lactations. If,
what agrees with the results of many authors, the heritability of successive lactations decreases, an error may be involved. It would seem more advisable to treat every lactation as a "separate trait," if the advantages of such an approach compensated for the degree of complicating the way of comparing the index.

The afore-mentioned indices refer to one trait only, milk recording or milk fat yield. In most European countries attention is given to the dual-purpose cattle, what resulted in a necessity of estimating many other traits, such as: protein content, milking ability, health, fertility, body conformation.

Two approaches can be distinguished in the Improvement Program of traits: through the selection of independent culling levels or through the construction of selection indices including more traits.

As an example for a selection of the culling levels can be cited a procedure connected with the selection of potential bull dams used in Bavaria (Schwarz, 1970, 1972), or in Poland. It may be defined as a multistage system, the criteria being here: records in herd-books, absolute milk production, butter fat percentage, superiority over herd-mates in milk yield or butter fat yield, and body conformation.

In the case of constructing selection indexes for more traits most often are included here: milk yield, fat yield, milk fat percentage and type (Harvey and Lush, 1952; Tabler and Touchberry, 1955, 1959; Wilton and VanVleck, 1968). It should be noted here that in selection milk production and growth rate are often given jointly (Soller et al., 1966).

The problem of accuracy in evaluating the animal's breeding value has been the subject of the investigations by Lush (1947), Le Roy (1958), Skjervold and Odegard (1959), Robertson (1959), Zuk (1971), Young (1961) and others.

To present the magnitude of a correlation between the observed breeding value and animal index let us consider an example taken from the studies of Zarnecki (1973). The author working out the assumptions for estimating the breeding value of the cows for Scottish MMB defined a correlation \( r_{G} \) for different sources of information beginning with one own performance one to several (four) own performances and dam performance, paternal half sibs, maternal half sibs as well as progeny. The obtained results indicate that \( r_{G} \) may range from 0.5 to 0.78 for the heritability — \( h^2 = 0.25 \) beginning with one own performance to maximum number of information utilised in the index.

The U.S.A. has been using a slightly different approach giving in the results of estimating the breeding value, the reliability of cow's index is given which is the function of weights given to own cow's performance and its paternal half sibs estimated from the formula:

\[
\begin{align*}
    w_I + R \frac{w_2}{4} \quad [7]
\end{align*}
\]

where: \( R \) is the repeatability of bull's index — cow's sire, the index being within the range 22 to 44%.

The estimation of the breeding value of cows can be made in a so called active population of cows (a part of population under milk recording). If this evaluation is made in terms of selecting best animals for planned matings there can be two alternative solutions. The first one is based on the evaluation and
selection of the registered cows (in West Germany or in Poland). The second approach consists in performing selection in the whole active population excluding a part used for sampling young bulls. This kind of solution is under way in Norway. A disadvantage of the first concept is to provide a rather reduced selection basis in the case of considerable differences between the number of cows under milk recording and that of the registered cows. On the other hand, it should be born in mind that herd-books records are a reliable source of background information about the animals. Whereas, a cow selection for planned matings within the whole of an active population, sometimes results in a considerable extension of the selection basis what should be taken as an advantageous approach to the breeding program.

As it has been mentioned, the size of cow populations to be estimated, is found to depend, among others, on a number of registered cows or on the size of an active population, the numbers of animals being obviously very high.

Everything seems to indicate a necessity of introducing a special system of evaluation pertaining to the breeding program which could provide in a short time data for breeders management and for the breeders themselves. While much attention is being given now to the estimation of the breeding values in bulls in many countries (comparative studies are under way), the systems of estimating the breeding value of cows, according to available sources, are under elaboration only in some countries. It is hoped that more consideration will be given to this problem in the nearest future.

RESUME

Dans les programmes d'élevage, le calcul de la valeur de production des femelles reproductrices et leur sélection possède une grande importance, particulièrement dans le choix des mères destinées aux futurs reproducteurs mâles.

Dans des autres pays le calcul est différent. En petit nombre des cas pourtant sont appliqués des systèmes contenant ce problème en manière collective, c'est-à-dire, contenant des problèmes totales génétiques, d'élevage, économiques et d'organisation.

Dans ce rapport sont discutés les index des femelles réproductrices appliqués dans quelques pays, les problèmes d'exactitude de calcul de la valeur d'élevage et quelques uns moments concernants d'organisation de cet calcul.

ZUSAMMENFASSUNG


Im vorliegendem Referat sind die Indices der Kühe besprochen die in manchen Ländern benutzt werden. Spricht man auch über die Genauigkeit der Zuchtwertschätzung und dieser Momenten, welche sich mit Organization der Prüfung verbinden.
REFERENCES