ESTIMATION OF GENETIC GAIN IN CZECH RED PIED CATTLE

Estimación de la ganancia genética en el ganado vacuno checo berrendo en colorado

Estimation du gain génétique dans le bétail Tchèque tacheté rouge

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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.

Many years later FEWSON (1963) discussed this method in his theoretical paper on selection and SKJERVOLD (1965, 1967) in his papers on selection programmes in cattle. Also SYRSTAD (1966) evaluated in the same way genetic change in Norwegian 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.

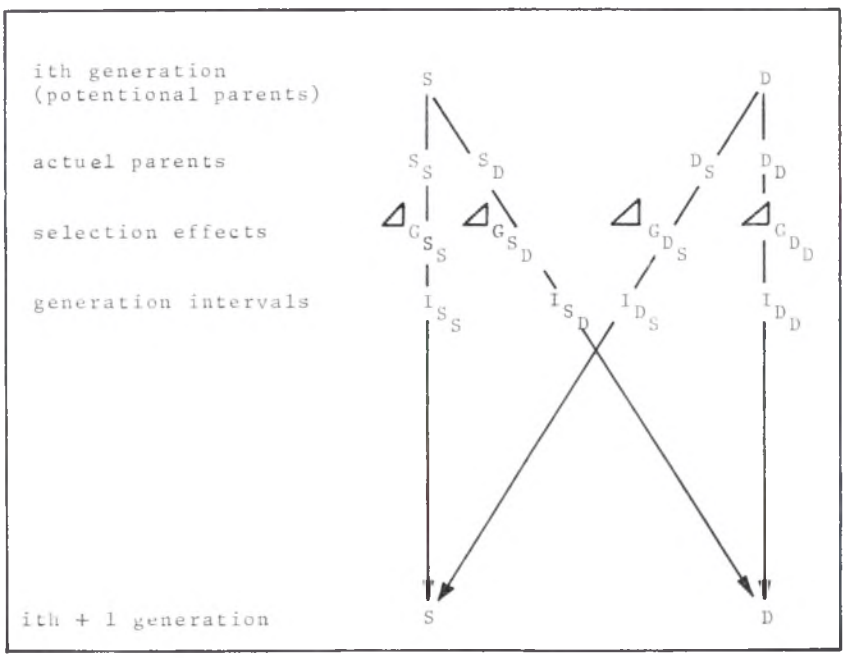
The estimation of genetic gain is based on the principles of directional selection in population genetics (LUSH, 1948; LERNER, 1950, 1958; FALCONER, 1960 and others). The measure of the effectiveness of selection is then the genetic gain per unit of time. The amount of genetic gain in this case is then

$$R = \frac{\Delta_G}{I}$$

where R is the amount of genetic gain per unit of time, Δ_G 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

Parental group	Selection effect	Generation interval
S_S	$\Delta_{G_{S_S}}$	I_{S_S}
S_D	$\Delta_{G_{S_D}}$	I_{S_D}
D_S	$\Delta_{G_{D_S}}$	I_{D_S}
S_D	$\Delta_{G_{D_D}}$	I_{D_D}

$$R = \frac{\Delta_{G_{S_S}} + \Delta_{G_{S_D}} + \Delta_{G_{D_S}} + \Delta_{G_{D_D}}}{I_{S_S} + I_{S_D} + I_{D_S} + I_{D_D}}$$

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 genetic gain for milk production per one year was estimated

$$R = \frac{215 + 112 + 240 + 33}{8 + 7.3 + 7.5 + 4.5} = \frac{600}{27.3} 21{,}98 \text{ Kg}$$

This value is not so far from an earlier estimation of 25.80 Kg found by SILER and NEDELOVÁ (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 3

THE VALUES OF SELECTION EFFECTS AND GENERATION INTERVALS FOR THE ESTIMATION OF THE TOTAL GENETIC GAIN IN MILK PRODUCTION

Parental group	$\triangle_G$ (kgs)	I
S_S	215	8,0
S_D	112	7,3
D_S	240	7,5
D_D	33	4,5
	600	27,3

TABLE 4

COMPARISON OF THE VALUES OF THE GENETIC GAIN PER ONE YEAR IN % OF THE AVERAGE MILK PRODUCTION BY VARIOUS AUTHORS

Author	Year	%
Robertson and Rendel	1950	1,5
Specht and Mc Gilliard	1960	2,0
Skjervold	1963	2,0
Syrstad	1966	0,7
Siler and Nedelová	1968	1,2
Siler and Sereda	1971	0,9

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 PODEBRADSKY (1972).

TABLE 5

COMPARISON OF THE PORCENTUAL VALUES OF INDIVIDUAL PARENTAL GROUPS ON THE TOTAL GENETIC GAIN

Author	Year	S_S	S_D	D_S	D_D
Robertson and Rendel	1950	43	18	33	16
Skjervold	1963	46	24	24	6
Syrstad	1966+	35	11	49	5
Syrstad	1966++	41	10	45	4
Siler and Sereda	1971	33	19	39	9

\+ 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 ampliamente, 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 Tchèque 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 réprésente 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

DICKERSON, H. E.; HAZEL, L. N. (1944): Effectiveness of selection on progeny performance as a supplement to earlier culling in livestock. *J. Agric. Res.*, 69:459.

FALCONER, D. S .(1960): *Introduction to quantitative genetics.* O. Boyd, Edinburgh and London.

FEWSON, D. (1936): Untersuchungen über die Effektivität verschiedener Selektionsmasnahmen unter besonderer Berücksichtigung der züchterischen Verbesserung der Milchmenge und des Fettgehalts beim Rind. *Ztschr. f. Tierz. und Zb.*, 79:101.

LERNER, I. M. (1950): *Population genetics and animal improvement.* University Press, Cambridge.

LERNER, I. M. (1958): *The genetic basis of selection.* New York.

LUSH, J. L. (1948): *The genetics of populations.* Mimeographed, Ames, Iowa.

MAHADEVAN, P. (1960): *Studies in herd analysis.* Ph. D. Thesis, Glasgow University.

MAHADEVAN, P. (1951): Genetic gain in dairy cattle through selection of dams of bulls. *Empire Jour. of Exper. Agric.*, 19, 291.

RENDEL, J. M.; ROBERTSON, A. (1950): Selection in a closed herd of dairy cattle. *J. Genetics*, 50:1-8.

RENDEL, J. M.; ROBERTSON, A.; ALTM, K. A. (1951): The extent of selection for milk yield in dairy catle. *Empire Journ. of Exper. Agric.*, 19:295.

ROBERTSON, A.; RENDEL, J. M. (1950): The use of progeny testing with artificial insemination in dairy cattle. *J. Genetics*, 50:21-31.

SKJERVOLD, H. (1963): The optimum size of progeny groups and optimum use of young bulls in A. I. breeding. *Acta Agr. Scand.*, 13:131.

SKJERVOLD, H. (1965): Die künstliche Besamung als bedeutendstes Hilfsmittel moderner Rinderzucht. *Der Tierzüchter*, 17:437.

SKJERVOLD, H. (1967): *Selection schemes in relation to artificial insemination.* Proceedings of the 9th Int. Congr. Anim. Prod., Edinburgh, 1966, Oliver and Boyd.

SPECHT, L. W.; MCGILLIARD, L. D. (1960): Rates of improvement by progeny testing in dairy herds of various sizes. *J. Dairy Sci.*, 43:63.

SYRSTAD, O. (1966): Studies on dairy herd records. III. Estimation of genetic change. *Acta Agr. Scand.*, 16:3.

SILER, R. (1963): The evaluation of the suitability of various methods of progeny testing in dairy cattle. *Vedecké práce VUZV v Uhrínevsi*, 6:243-259.

SILER, R. (1968): *Some notes on the application of CC method in cattle breeding in Czechoslovakia.* 9th Study Meeting of E.A.A.P., Commission of Animal Genetics, Dublin, Ireland.

SILER, R.; NEDELOVÁ, S. (1968): *Elaboration of general principles of evaluation breeding bulls on progeny testing for the estimation of genetic gain.* Research report., Inst. of Anim. Prod., Uhríneves.
SILER, R.; SEREDA, L. (1971): The estimation of genetic gain in milk production of Czech Pied cattle. *Zivocisná Vyroba,* 16:177-184.
VÁCHAL, J.; SEREDA, L.; PODEBRADSKY, Z. (1972): *Evaluation of the effect of selection of cows on the first lactation based on their own performance.* Research report, Inst. of Anim. Prod., Uhríneves.
VÁCHAL, J.; SILER, R. (1960): The verification of the suitability of the CC method for the estimation of breeding value of AI bulls in Czechoslovaquia. *Zivocisná Vyroba,* 5:751-766.