# SUMMARY

**The title of the doctoral thesis**: "Research on the establishment of selection indices of Holstein-Friesian cattle"

**Key words**: *selection indices, Holstein-Friesian breed, animal breeding*

Cattle breeding currently places great emphasis on raising the efficiency of breeding value estimation and breeding programs based on the economic efficiency of the important quantitative traits. In recent years, there has been a growing trend in the genetic potential of dairy cattle, and as a result, elite herds have been created with cows whose productive potential is quite high compared to a few decades ago. At the same time, the importance of the other traits has increased, becoming part of group traits such as: for adapting to technological conditions in farms, reproduction traits, longevity traits, cow health, conformation traits.

Introduction of more traits in the evaluation and selection procedure of bulls has been considered mandatory condition by many authors (Merk T., 2004; Van Raden P.M. et al. 2004). The dynamics of the selection process aimed at raising the productive potential of cattle, requires the introduction of systematic evaluation of animals and populations according to the important traits and the degree of realization of their genetic potential after the "genotype-environment" interaction. Due to international research, it has been concluded that the selection made according to the selection index method will give the best result for the improvement of the Holstein-Friesian breed in Europe, USA and Canada (Goncharenko I.V., 2010).

The main goal has been always been to achieve the maximum possible genetic gain according to the established economic direction. The effectiveness of the selection according to the selection indices depends on the level of the inherited genetic potential of each trait of interests, on the existing genetic correlations between the traits, but also on their economic efficiency.

Campbell J. R. and Marshall R.T., in their book from 1980, state that when introducing a trait into selection index structure, importance must be given to the following factors: ***the relative emphasis that was placed on each traits, genetic parameters and the direction of traits improvement***.

The selection of animals is based on the biological laws of the organism's functioning and the degree to which the genotype of an animal participates in the formation of the filial generation. The main goal always remains the controlled

modification of the genetic structure of the populations in the direction of raising the quantity and quality on animal production.

In the process of selecting the males and females that will make up the parent population, a major problem is the choice of useful traits and animals which have economically important traits that reach the minimum requirements imposed in breeding objective. Selection made by selection index theory designed by Hazel (1943) offers this possibility, namely the possibility of comparing animals based on their general value or, according to some authors, “aggregate genotype” (Hazel, 1943; Harris, 1970; Teepker, 1988). The genetic gain brought by the aggregate genotype consists in maximizing the correlation between it and the expected genotypic value. According to Harris (1970) the choice of traits used in the aggregate genotype, in the composition of the selection index, as well as their weight of participation depends on three aspects:

1. The actual contribution brought by the improvement of the traits on the production efficiency (profit);
2. Possibility of genetic improvement of traits (genetic variability);
3. Costs required for each traits pursued (labor, animal maintenance and time).

For the elaboration of this PhD Thesis, the drafting norms in force were observed, the paper being structured in two parts. ***The first part*** presents the bibliographic references on the approached issue and is composed of four chapters, and ***the second part*** is structured in five chapters in which are presented the steps of formation of the selection index for the Holstein-Friesian cattle breed from Romania.

Research from the literature review describes how was formed and spread the Holstein-Friesian breed worldwide, but also in Romania.

The study continues with the presentation of the elements from genetics that are needed to estimate the breeding value of animals. It also presents the method of selection indices for dairy cattle and the estimation methods for the economic values of the traits included in the composition of the aggregate genotype.

The aim of this study is to use the method of selection indices presented by Hazel and Lush in 1942 to estimate the breeding value of 61 Holstein-Friesian bulls and to design a national selection index that would allow their classification according to the value obtained after applying the calculation formula.

Also, a statistical processing of the studied data was performed, a multivariate analysis of variance was applied to study the inter-relationships between the traits included in the selection index and various factors, genetic parameters were estimated for the studied population, as well as the existing genotypic and phenotypic variances and covariances between the studied traits, the economic values of each trait included in the index formula were determined, and at the end an optimal selection index was developed for the Holstein-Friesian breed from Romania, which will have a practical use.

The biological material was represented by 61 Holstein-Friesian bulls, with 3 210 primiparous daughters maintained in 46 farms in 20 counties throughout Romania.

Initially, the following were calculated: *the mean, the standard deviation of the mean, the coefficient of variation, the minimum limit and the maximum limit found for each trait and sire separately*.

The difference for milk yield trait between analyzed bulls according to the productive performance of their daughters was between 9 857,88 kg for the daughters of the bull with code 52511 to 10 017,3 kg for the daughters of the bull with code 53971. The coefficient of variation varied between 12,65% and 37,73% indicating a very heterogeneous population for this trait. The minimum limit was between 3 036 kg for the bull with code 52505 and 8 323 kg for the bull with code 52738, and the maximum limit between 10 863 kg for the bull 52892 and 17 844 kg for the bull 52738.

For the trait fat yield the bull with the code 52505 registered an average of 291,74 kg, this representing also the minimum limit. The maximum limit was recorded by the bull with the code 52227, his daughters having an average of 422,61 kg of fat. And in this case the coefficient of variability indicated a heterogeneous population, the limits being between 15,40% and 34,24%. As in the case of milk yield, the bull with the code 52738 registered the upper limits for the minimum and maximum of fat yield trait, these being 315,15 kg (minimum limit) and 674,99 (maximum limit). And the lowest values were recorded by the bull with the code 53575 for the minimum limit, respectively 99,07 kg, and the bull with the code 53302 for the maximum limit (398,27 kg).

For the percentage of milk fat, the average of the daughters of the bulls ranged between 3,36% for the bull with code 53302 and 4,35% for the bull with the code 20155. The minimum limit included the extremes of 2,06% and 3,64%, and the maximum ranged from 4,01% to 6,56%. For this trait the population is very heterogeneous, the coefficient of variability ranged between 9,02% and 25,61%.

For the protein yield, the daughters of the bull with code 52738 registered an average of 365,31 kg, and those of the bull with the code 53629 had an average of 236,5 kg. Following the analysis, the coefficient of variability indicated a very heterogeneous population. The daughters of the bull with code 52738 registered the highest quantities regarding the estimates for the lower and upper limit, respectively 266,94 kg and 642,08 kg.

For the percentage of milk protein, the average of the daughters ranged between 3,09% for the bull with the code 53402 and 3,45% for the bull with the code 53658, these having a number quite close of the daughters, respectively 41 and 43. Only for this trait the coefficient of variability indicates a homogeneous population, the limits being between 3,99% and 10,35%. The maximum limit ranged from 3,38% to 4,21%. And the minimum between 1,96% and 3,16%.

Following the multivariate analysis of the variance, significant differences were found for four out of five characters. Similar results have been obtained in other specialized scientific papers (Missanjo, 2010; Imbayarwo-Chokosi, 1999). For the trait percentage of milk protein, the test indicated insignificant differences, being inferior the minimum threshold of 0.05. Also, the farm, the year and the calving season had a significant influence on all traits regarding the milk production of the daughters of the studied bulls. The results of the analysis allow us to use them in the calculation formula to determine the variances and covariances components for the studied animals.

After running the REMLF90 program, the genetic, phenotypic and residual variances and covariances were obtained for the five studied traits. The values used to determine the heritability coefficient and the correlation coefficients between the traits are: *additive variances* with values: for the milk yield 815 200, for the fat yield 1 012, for the protein yield 665,4, for the percentage of milk fat 0,07, and for the percentage of milk protein 0,01; the *phenotypic variances* had values: for the milk yield 221 1200, for the fat yield 3 730, for the protein yield 2 134.4, for the percentage of milk fat 0,210 and for the percentage of milk protein of 0,05.

The values obtained for the heritability coefficient ranged between 0,25 and 0,37. For the milk yield the registered value was of 0,37, for the fat yield the heritability coefficient registered the value of 0,27, and that of protein yield of 0,31, they being situated in the category of medium heritable traits.

And for the traits related to the quality of the milk, the heritability coefficient registered the value of 0,31 for the percentage of milk fat and 0,25 for the percentage of milk protein.

The estimated *genetic correlations* were positive and negative averages between the milk yield and the percentage of milk fat (-0,48), between the fat yield and the percentage of milk fat (0,23), the percentage of milk protein and fat yield (-0,26), but also the percentage of milk protein and the protein yield (-0,22).

Following the analysis of the *genetic correlation* between the studied traits, strong and positive correlations were found between the milk yield and the fat yield (0,74) or protein yield (0,93), between the protein yield and fat yield (0,77), but also between the percentage of milk protein and that of milk fat (0,51).

*A situation similar to the genetic correlation between the five quantitative traits was also observed in the case of phenotypic correlations*. Therefore, between the milk yield and fat yield, the value of 0,73 was obtained, between the milk yield and protein yield 0,89, between fat yield and protein yield there was a strong and positive phenotypic correlation of 0,82, and between the percentage of milk fat and fat yield the value was 0,53, and 0,54 between the percentage of milk fat and that of milk protein.

The phenotypic correlation between the milk yield and the percentage of milk fat was -0,15, being lower compared to the results found in the specialized literature. For the correlation between the milk yield and the percentage of milk protein, the value obtained was -0,22. The lowest value on the phenotypic correlation was obtained between the percentage of milk fat and the protein yield (0,09), highlighting the fact that the amount of protein positively influences, but to a small extent the trait of the percentage of milk fat.

After processing the data obtained from farms on the estimation of the economic values of the studied traits, negative values were obtained for four traits out of the five proposed to achieve the purpose of the doctoral thesis. The highest negative value is -13,1779 € / cow / year for the percentage milk fat. For the percentage of milk protein, the value obtained is -1,7362 € / cow / year. Values close to zero were obtained for the fat yield (-0,1425 € / cow / year) and the protein yield (-0,0188 € / cow / year).

Following the application of the calculation formula for the aggregate genotype, the following values are obtained regarding the partial regression coefficients of the genotype to the phenotype: ***for the milk yield = -0,07, for the fat yield = 0,9, for the percentage of milk fat = -101,804, for the protein yield = 1,598, and for the percentage of milk protein = -163,694***.

*And the formula for the aggregate genotype is*:

$$\mathbf{I_{TOTAL} = -0{,}0704L + 0{,}9006G - 101{,}8039G\% + 1{,}5987P - 163{,}6942\,P\%}$$

Subsequently, partial regression coefficients were also calculated for other index variants, called ***reduced indices***. This was done in order to verify the effect of either each character or several traits on the efficiency of the index with the largest number of traits. According to the theory, the efficiency or accuracy of the reduced index is expected to be lower than that of the optimum index ($I_{TOTAL}$), depending on the value of the omitted trait.

After determining the required partial regression coefficients, we proceeded to the steps of forming the indices according to the number of traits included and the calculation of the variance and accuracy for each type of index.

At the end, each index formula was analyzed separately in order to decide which of them is the most convenient for the proposed purpose.

*Therefore, the index comprising the five traits studied in the paper had the highest value on the accuracy of 67.9%*.

This result confirms that the formula obtained from the calculations can still be used to classify all bulls analyzed on the basis of their daughters' performance, as the formula includes all the milk production traits.

*Based on the aggregate genotype formula, the selection index values for each bull were calculated*.

*The analysis shows that 30 of the 61 studied bulls cannot meet, for various reasons, the requirements imposed when applying the methodology proposed in this* *paper, although in practice they are used for artificial insemination and are listed as breeding bulls.*

We assume that the negative value of the selection index obtained may be caused by the fact that the total number of their daughters is not known, that there is no evidence of the productive performance of all daughters for each bull, that the appreciation of each bull at the time of purchase of bull’s semen was done only on the basis of the presentation form according to the country of origin, etc.

For this reason, it is advisable to periodically evaluate the breeding bulls according to the performance of the offspring for milk production in the country, but also the cows used for artificial insemination, based on the B.L.U.P. methodology and the multi-trait selection index method.

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