SUMMARY

of the doctorat thesis entitled:

CONTRIBUTIONS TO THE DEVELOPMENT OF A BREEDING PROGRAM FOR THE "TELEORMAN BLACK-HEAD" SHEEP BREED, TO INCREASE THE PRODUCTION PERFORMANCES

PhD-student: **POPA Florin**

Scientific coordinator: ***Professor, PhD*** **GROSU Horia**

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This doctoral thesis is structured in two parts, of which the first part includes three chapters and the second part, consisting of eight chapters, which also includes the bibliography.

The first chapter, entitled "**PREVIOUS NATIONAL AND INTERNATIONAL RESEARCH ON THE DEVELOPMENT OF BREEDING PROGRAMMES FOR SHEEP, WITH SPECIAL REFERENCE TO PRODUCTION PERFORMANCE"** provides general information on the basic components of a breeding programme, with particular reference to sheep, on the status of official performance control, artificial insemination and the genetic evaluation system. The best breeding programs for dairy sheep, found in the Lacaune and Comisana breeds, are presented.

Second chapter "**OPTIMIZATION OF THE LINKS OF THE SELECTION PLAN FOR INCREASING PRODUCTION PERFORMANCE IN A SHEEP POPULATION",** focuses on the basic sequences of the selection plan that are subject to the optimization process, including: queen size and structure, average duration of use during breeding, testing capacity, selection intensity and selection method.

Chapter three presents the main methods used in the literature regarding the estimation of the economic value of the traits that fall within the objective of improving the investigated population.

In the second part of the doctoral thesis, in chapter 4, the purpose, objectives and biological material researched are presented.

The purpose of this doctoral thesis is to optimize the breeding program of the Tsigai sheep breed with Black Head of Teleorman, in the direction of increasing the performance of milk production traits. The achievement of this objective involves a series of optimizations at the level of the selection plan, with reference to: the size and structure of the queen of the investigated population, the average duration of use for reproduction, the testing capacity, the method of estimating the genetic parameters, the selection criterion, the method of predicting the breeding value, etc.

In order to achieve the proposed objective, it was necessary to know the current situation of the investigated population, regarding the phenotypic structure, expressed by the level of average performance for each trait and the associated statisticians (mean error, standard deviation, coefficient of variability, minimum and maximum limits).

By aggregating all these components, it was possible to optimize the breeding program in the analyzed sheep population, an aspect that maximizes both the total and separate genetic progress for each characteristic.

In the process of optimizing the breeding strategy, the following aspects were analyzed: knowing the phenotypic and genetic structure of the analyzed population, estimating the share of traits in the breeding objective, optimizing the selection criterion, optimizing the method of predicting the breeding value, optimizing the size and structure of the population, optimizing the average duration of use in reproduction, developing the breeding programoptimized in the analyzed population.

The study was carried out on animals of the Tsigai sheep breed with Black Head of Teleorman, belonging to S.C. OVIS CAP NEGRU from Dobroteşti, Teleorman County. The analysis included 1094 sheep, of which 58 fathers, 436 mothers and 600 daughters, in lactation I, with a total of 1973 performances. The average number of sheep performances is 3.29. The average family size of a father is 10.34 daughters/ram.

Three traits that express the quantitative side of milk production (milk, fat and protein) were analyzed. The phenotypic information for each trait was obtained following the official performance control, according to the ICAR methodology, by carrying out 3-4 milk production controls, after weaning the lambs, in the period 2017-2020.

In chapter five, entitled "**PHENOTYPIC CHARACTERIZATION OF THE ANALYZED POPULATION",** The vital statistics of the population are presented, for the three characters considered, carried out during the official performance control, in the period 2017-2020, of which four controls were carried out in 2017, two in 2018, four in 2019 and three in 2020.

The average performance of the milk quantity on the control day was 0.665 kg ± 0.019 kg, with variations between years, from 0.543 ± 0.012, at control no. 9, from 10/06/2019, to 0.908 ± 0.032, as recorded at control (C6) on 26/04/2018. The average coefficient of variability was 35.68%, with variations from 32.55% (C12 - 06/04/2020) to 43% (C3 - 12/04/2017).

The average performance of the amount of fat on the control day was 0.046 kg ± 0.001 kg, with variations between years, from 0.040 ± 0.001 (C 10 - 08/07/2019), to 0.060 ± 0.002 (C 6 - 26/04/2018). The average coefficient of variability was 34.98 %, with variations from 27.08 % (C 10 - 08/07/2019) to 47.44 % (C 4 - 04/05/2017). The amplitude of the amount of fat in milk ranged from 0.016 kg (C 7 - 15/04/2019) to 0.123 kg (C 6 - 26/04/2018).

The average protein performance on the control day was 0.0465 kg ± 0.0012 kg, with variations between controls, from 0.034 ± 0.001 (C 9 - 10/06/2019), to 0.065 ± 0.002 (C 6 - 26/04/2018). The relative variability of the quantity of milk measured on the control day was, on average, 35.53%, with variations from 28.49% (C 10 - 08/07/2019), to 44% (C 3 - 12/04/2017). The amplitude of the amount of milk protein ranged from 0.014 kg (C 5 - 03/04/2018) to 0.136 kg (C 6 - 26/04/2018).

The average performance achieved is within the normal limits of a sheep population with high genetic potential for milk production.

In Chapter Six, entitled '**ESTIMATION OF GENETIC PARAMETERS FOR MILK PRODUCTION TRAITS',** a fost evaluat determinismul genetic al caracterelor considerate, exprimat prin heritabilitate, repetabilitate și corelațiile genetice pentru fiecare caracter în parte, măsurat la diferite intervale de timp (controale lunare). Pentru estimarea componenților cauzali ai varianțelor și covarianțelor s-a utilizat metodologia BLUP.

Pentru cantitatea de lapte, înregistrată la fiecare control lunar, valorile heritabilității cantității de lapte au variat între 0,429, în cea de-a 50-a zi de lactație și 0,175, în cea de-a 190-a zi de lactație, cu o medie de 0,257. Valorile repetabilității au variat între 0,535, în cea de-a 50-a zi de lactație și 0,217, în cea de-a 190-a zi de lactație, cu o medie de 0,322. Valorile corelațiilor genetice între testele COP, efectuate în intervalul 50-190 zile sunt cuprinse între 0,77 și 0,86.

For the amount of fat in milk, recorded at each monthly check-up, the heritability values ranged from 0.360 on the 50th day of lactation to 0.296 on the 190th day of lactation, with an average of 0.303. Repeatability values ranged from 0.425 on the 50th day of lactation to 0.353 on the 190th day of lactation, with an average of 0.362. The values of genetic correlations between COP tests, performed between 50 and 190 days, range from 0.50 to 0.96.

For the amount of milk protein, recorded at each monthly control, the heritability values ranged from 0.573 on the 50th day of lactation to 0.159 on the 150th day of lactation, with an average of 0.298. Repeatability values ranged from

0.711 on the 50th day of lactation to 0.195 on the 150th day of lactation, with a mean of 0.369. The values of genetic correlations between COP tests, performed between 50 and 190 days, range from 0.66 to 0.96.

Chapter Seven, entitled '**ESTIMATION OF THE ECONOMIC VALUE FOR MILK PRODUCTION CHARACTERISTICS',** is devoted to determining the relative weight of each trait, in the objective of breeding. Considering the instability in time and space of the economic variables (costs/revenues), the method of standardized distances was used to achieve the proposed objective. This method has as inputs the biological variables (the current level of performance in the population, the heritability of each trait, the genetic and phenotypic correlations between the pairs of traits considered). Since the phenotypic information necessary to estimate these biological variables is associated at the level of the lactation period (the period from weaning of lambs to weaning of sheep), and not at the level of controls carried out within the same calendar month, the average performance of the traits and the related genetic parameters have been recalculated. As a method of statistical analysis, the BLUP methodology was used, associated with the individual animal model for three traits.

In this context, the average performance and levels of genetic parameters were as follows:

The average amount of milk for the milking period is 95.53 ± 0.60 kg milk, with a relative variability of 15.22%. The average amount of fat in milk is 6.77 ± 0.043 kg, with a relative variability of 15.60%. The average amount of milk protein is 6.45 ± 0.044 kg, with a relative variability of 16.90 %.

The heritability of the three traits recorded intermediate to low values, from 0.199 for the amount of protein and 0.218 for the amount of milk.

The amount of milk registered a genetic correlation of 0.844 with the amount of fat and 0.966 with the amount of protein. The amount of fat registered a genetic correlation of 0.877 with the amount of protein.

The values obtained are within the specific limits of a population of sheep with aptitudes for milk production.

Estimating the relative weight of characters also required establishing the level of performance perspective for each character. Assuming an increase of 8 % compared to the current level of performance, the following forward-looking targets have been set as follows: 102.8 kg for the quantity of milk; 7.26 kg for the amount of fat and 6.98 kg for the amount of protein.

Following the statistical analysis carried out, the values of the relative weights of the traits considered, respectively the importance to be given to them in the genetic selection activity, were obtained. Thus, the most important character in the selection turned out to be the amount of milk protein, followed by the amount of milk fat and, lastly, the amount of milk.

Chapter eight "**OPTIMIZATION OF THE SELECTION CRITERION FOR MILK PRODUCTION CHARACTERISTICS",** was dedicated to identifying the best combination of the three traits considered, a context in which four variants of criteria were imagined, namely: Selection index for two traits: the amount of milk (L) and the amount of fat (G); Selection index for two characters: amount of milk (L) and amount of protein (P); Two-character selection index (G and P) and Three-character selection index: (L, G, and P)

The results obtained highlighted the fact that the greatest genetic progress was obtained in variant no. 4 (0.3383 genetic standard deviation units), which includes all three traits: Milk, Fat and Protein.

Comparing the result obtained in variant 4 with the other three variants, it was observed that almost similar results were obtained by variant 2, which represented 99.85 % of the genetic effect offered by the control variant. This result is explained by the value of the more intense genetic correlation between the amount of milk and the amount of protein (0.966) and the maximum relative economic weight of the amount of protein (0.59).

In chapter nine, entitled '**PREDICTION OF THE IMPROVEMENT VALUE FOR MILK PRODUCTION TRAITS',** The objective was to compare two operational variants based on the BLUP methodology, applied to the Control Day model, with random regressions, in which the first variant included two characters (the amount of milk and the amount of protein during the milking period), and the second variant, three characters, during the milking period.

In order to choose the best operational option, the value of the rank correlation regarding the ranking of the same candidates for selection was estimated, based on the two selection criteria: the overall improvement value calculated on the basis of two characters and on three characters. The rank correlation value was 0.92, in which case either of the two operational variants can be used to rank the candidates for selection. 92 % of the candidates for selection are in the group of reproduction detainees, through both operational variants.

Chapter Ten, entitled "**OPTIMIZED BREEDING PROGRAM"** was dedicated to the development of an optimized variant of the program for the improvement of the Tigaie cu Cap Negru population of Teleorman.

To estimate the genetic progress, 5 variants of population sizes were imagined, from 1000 to 5000 females, each with 3 different structures of the size of the elite and test groups (40 % : 60 %; 50 % : 50 % and 60 % : 40 %).

The calculations were made for the amount of protein, taking into account the following values: heritability, 0.298; repeatability 0.369, birth rate 1.28; survival 0.85; Average duration of exploitation of rams in the elite group, 1 year, sex ratio 1:35.

For the natural mating reproduction system, the results obtained showed that the greatest genetic progress per generation, expressed in units of genetic standard

deviations (0.904), was ensured by the variant in which the optimal size of the active population is 3000 queen ewes, of which 40% represent the elite (1200 ewes) and 60% the testing (1800 ewes).

For the reproduction system in which artificial insemination is used, the previous calculation elements have been preserved, with the specification that a sex ratio of 1:250 is considered. The results revealed that the greatest genetic progress per generation, expressed in units of genetic standard deviations (**1,349**), was ensured by the variant in which the optimal size of the active population is 4000 queen ewes, of which 40% represent the elite (1600 ewes) and 60% the testing (2400 ewes).

Although the variant with 4000 queen sheep generated the maximum genetic progress (**1.349**), the variant with 3000 active sheep population was considered optimal, as it generates approximately the same genetic progress (**1.316**), but with 25% lower costs.

In order to optimize the reproduction life of rams, several plan variants have been imagined, which assume a value of this parameter of 4, 3, 2 and 1 year, respectively. Although a maximum value of the i/T ratio is obtained with an average exploitation life of 5 years for ewes and 1 year for rams (0.820), in practice the optimal variant of 4 years for ewes and 1 year for rams is recommended, which provides practically the same response (0.815), but expects a more realistic average exploitation life of females.

For the same annual testing capacity (979 daughters), the genetic progress per generation was optimized by considering different sizes of the father family (n), from 10 daughters/ram tested to 19 daughters/ram tested. As the testing capacity was constant, the number of rams tested annually ranged from 54 to 98. The results obtained highlighted the fact that the best combination between the size of the family of fathers and the number of fathers tested, with a genetic progress per generation of 1,317 standard genetic units, is variant no. 4, in which the annual testing capacity (979 daughters) is occupied by 75 families, each consisting of 13 daughters. Any other variant, with small but many families (variant 1), or with large but few families (variant 11), plus intermediate variants (2, 3, 5, ..., 10), generates a suboptimal genetic effect.

By selecting the variants that generate the maximum genetic progress, in terms of each link of the selection plan (queen size and structure, average duration of exploitation, testing capacity), the optimal variant of the breeding program for the Tsigai sheep breed with Black Head of Teleorman was developed, which generated an annual genetic progress of 0.188 units of genetic standard deviations, equivalent to an increase in the amount of milk protein of 1,7 % per year, or 0,094 kg/year.

To achieve the annual genetic progress, of 0.188 units of genetic standard deviations, the four selection paths had the following contribution:

- through the selection of mothers of mothers – **8** %,
- by selecting mothers of fathers – **32** %,
- by selecting fathers from fathers – **43** %,
- through the selection of fathers from mothers – **17**%.

It is noted that the most important selection pathways are fathers-to-fathers (**43**%) and mothers-to-fathers (**32**%), together accounting **for 75**% of the genetic progress achieved in the sheep population.

Among the recommendations resulting from the development of this doctoral thesis, the following can be retained for the breeding program of the Tsigai sheep breed with Black Head of Teleorman:

1.The size of the active population of the breed should be 3000 females, with a structure of 60 % in the test group and 40 % in the elite group.

2.The average duration of optimal breeding use of ewes, which maximizes the ratio between the intensity of selection and the generation interval (i/T) should be 4 years in females and one year in males.

1.The optimal annual testing capacity, which maximizes genetic progress, is 979 daughters, to have a structure made up of 75 paternal half-sister families, each consisting of 13 daughters.

2.For the genetic evaluation of the candidates for selection, it is recommended to use the BLUP methodology - applied to the Control Day model, with random regressions, for two traits (the amount of milk and the amount of milk protein).

Through the results obtained, this doctoral thesis brings a significant contribution to the optimization of breeding programs for sheep, in particular for the Tsigai sheep breed with Black Head of Teleorman.

Considering that so far, at national level, there are no optimized breeding programs for the Tsigai sheep breed with Black Head of Teleorman, the development of such an improvement strategy for the analyzed characters is an element of originality.