International Journal of Agricultural Technology 2024 Vol. 20(2):501-516
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Prediction model and breeding index to improve the evaluation of sheep selection based on washed wool yield

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Boiko, N. V., Korkh, I. V., Paliy, A. P., Pavlichenko, O. V., Levchenko, I. V. and Rubtsov, I. O. (2024). Prediction model and breeding index to improve the evaluation of sheep selection based on washed wool yield. International Journal of Agricultural Technology 20(2):501-516.

Abstract A multiple linear regression was determined the dependence of the prediction model on breeding traits. Based on the calculations of correlation coefficients, left only those characteristics whose values were significant according to Student's t-test and determined the final yield of washed wool to a greater extent are retained in this model: live weight of lambs, true length of wool and the area of staple contamination. It is emphasized that the proposed predictive equation is generally significant by Fisher's F criterion $(p < 0.001)$ and Student's t criterion $(p < 0.01)$, has a standard error $S = 3.408$, a rather high multiple correlation coefficient $(R = 0.997)$ and a significant coefficient of determination $(\widetilde{R}^2 = 0.971)$, adjusted for the number of degrees of freedom). It is described about 97% of the variability of the data actually obtained in the experiment, and the proportion of traits were not included in the equation accounts for only 3% of the variation in the effectiveness of obtaining the yield of washed wool. The verification of the constructed selection index to improve the evaluation of sheep selection by washed wool yield showed that ewes selected with a positive value of the constructed selection index had a higher live weight by 3.3%, true wool length by 31.1% and washed wool yield by 12.0%, but a smaller staple contamination zone by 34.7% than ewes formed in groups with negative parameters of the same selection index.

Keywords: Lamb, Ewe, Wool, Index, Mathematical model

Introduction

The profitability of sheep farms largely depends on the production and quality of wool. Wool is a highly versatile product that is in great demand by both producers and consumers, and it serves as the primary raw material for the light industry. It possesses several valuable physical properties that directly impact the comfort of the consumer (Hatcher *et al.,* 2010; Swan, 2010), such as thinness, length, strength, curliness, stretchability, elasticity, plasticity, luster, color, density, weight, moisture, hygroscopicity, coefficient of variation of fiber diameter, comfort factor, fiber curvature, fineness of

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spinning and durability (Swan *et al.,* 2008; Anderson *et al.,* 2009). However, in the current conditions of sheep breeding development, there are a number of unaccounted objective traits that have not been given sufficient attention until recently and that can be used to conduct effective breeding work to increase sheep productivity while improving the quality of the products obtained (Jafari, 2015). In the opinion of experts, one of the characteristics that directly influences the level of wool productivity of sheep, the technological properties of wool, and the price of its sale, among the existing varieties, is the yield of washed wool. It is expressed as a percentage of the ratio of the weight of pure fiber at conditioned moisture, taking into account residual components, to the original weight of unwashed wool (Westmoreland *et al.,* 2006; Memon *et al.,* 2018). The washed wool yield of sheep is affected by both biotic and abiotic factors (Khan *et al.,* 2012). It varies depending on the fleece's ability to resist mineral impurity contamination, its fat and sweat content and ratio, as well as recent changes in breeding and zootechnical methods. In particular, wool differences for this trait vary significantly depending on sheep breed (Korjenic *et al.,* 2015), age (Küçük *et al.,* 2000; Yılmaz and Denk, 2004; Al-Dabbagh, 2009), gender (Purvis and Franklin, 2005; Ansari-Renani, 2012), feeding regimen (Paganoni *et al.,* 2000), and other factors.

Given the rising significance of wool components in enhancing sheep productivity, researchers have increasingly employed various types of mathematical models, achieving high accuracy in describing and predicting their values. Accurately and promptly predicting wool quality, specifically its yield in washed fiber for individual groups of sheep, can provide valuable information for rational farm management decisions (Shahinfar and Kahn, 2018). In this context, forecasting becomes a reliable tool for achieving the desired outcome in production-related decisions. It allows the selection of animals based on informative breeding traits included in mathematical models and evaluates the relationships between them (Tedeschi and Menendez, 2020). The selected traits for evaluating future washed wool yield should be adequate for objective assessment. Fewer traits decrease the accuracy of a comprehensive definition, while an excessive number complicates the calculations. From the point of view of (Gurgel *et al.,* 2021), modeling can be used to predict with high accuracy, through correlated features, the consequences of sheep consumption of herbaceous plants, control the live weight of animals and determine the best time for their sale (Silva *et al.,* 2011; Chay-Canul *et al.,* 2019; Gurgel *et al.,* 2021; Sousa *et al.,* 2021), determine the weight of the carcass and main cuts before slaughter (Shehata, 2013; Castilhos *et al.,* 2018; Alves *et al.,* 2019; Costa *et al.,* 2020; Gomes *et al.,* 2021), justify future values of wool shearing and some physical and technical indicators of its quality (Erohin and Kizilova, 2008; Erohin *et al.,* 2010; Sushentsova, 2010; Mortimer *et al.,* 2010). However, the generalization of numerous sources of literature devoted to the study of the problem of improving the qualitative and quantitative indicators of wool productivity of sheep has not determine a unanimous opinion of experts on determining the dependence of the yield of washed wool on other breeding traits and has not developed effective methods for its improvement. Therefore, effective integration of all components considered during the implementation of a unified management information system and systematic quality control is necessary for the production of higher-quality products. As such, this work is both relevant and of practical importance.

The main objective was to establish a prediction model and a breeding index that can improve the evaluation of the selection of sheep on the basis of the yield of the washed wool and to validate its effectiveness.

Materials and methods

Ethics

The experiments carried out on animals align with the current legislation of Ukraine (Article 26 of the Law of Ukraine 5456-VI of 16.10.2012 "On Protection of Animals from Cruelty") as revised as of 04.08.2017 and the "General Ethical Principles for Animal Experiments" adopted by the First National Congress on Bioethics (Reznikov, 2003) and international bioethical standards (materials of the IV European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Purposes, Strasbourg, 1986) (Simmonds, 2017).

Location of the experiment

The breeding farm for Kharkiv intra-breed sheep of the fine-wool prekos breed was used as the basis for conducting the experimental part of the work. The breeding farm is a part of the Animal Husbandry Institute of the National Academy of Agrarian Sciences of Ukraine.

Animals

For the construction of the model for predicting the value of the yield of washed wool, 48 ewe lambs of the Kharkiv intra-breed type of fine-wool Prekos sheep were selected. To test the breeding selection based on the selection index, an experiment was conducted involving 46 ewes and 48 ewe lambs obtained from the same type of lambs. Group I included ewe lambs (n = 22) selected with a positive value of the constructed breeding index, and group II (n = 26) - with negative parameters. This indicated that the animals of the second group had a productivity potential lower than the average population value of the best individuals from the total sample selected on the basis of the constructed index. The difference in live weight, true wool length, and the size of the staple contamination zone was used to determine the effectiveness of the modeled selection.

Feeding and keeping

During the experiment, sheep were fed differentially, taking into account sex, physiological condition, and productivity. In terms of total nutritional value and digestible protein content per head, the diets provided good animal productivity and product quality. The average annual level of feeding was 5.1 c of energy feed units per ewe; group feeding. In the stall period, the average daily diet consisted of hay - 1.0-1.5 kg; straw - 1 kg; silage - 3-4 kg; mixed fodder - 0.3-0.5 kg, enriched with mineral and vitamin premix, which was introduced at the rate of 1% of its total weight and lick salt - 0.015-0.020 kg, which was constantly in the feeders. The total and protein nutritional value of the daily diet during this period averaged 1.5-2.1 energy feed units and 155-220 g of digestible protein per day. One energy feed unit accounted for 103.3-104.8 g of digestible protein. The sheep's diet during the grazing period consisted of pasture grass and concentrated feed. During the experiment, the experimental sheep were kept in the same conditions, in accordance with the generally accepted technology in sheep breeding. The technology of housing was stall-pasture, and watering was free-flowing from stationary troughs that were filled with clean water once a day.

Methods used in the research

The results of the experiment were analyzed using a set of generally accepted methods: systematic consideration (formulation of the introduction and discussion), generalization (interpretation of the results), zootechnical (productivity assessment), correlation and regression (identification of interdependencies between breeding traits) and mathematical modeling (development of a prognostic model and breeding index).

The main research methods

The live weight of the experimental animals was assessed by individual weighing before morning feeding and watering with an accuracy of ±0.5 kg. The natural length of wool was determined in its natural state by measuring the staple without disturbing its structure and straightening its tortuosity. The true length was determined by the length of the staple in the straightened state without stretching. Measurements were made with a millimeter ruler with a measurement accuracy of ±1 mm. The degree of contamination of the fleece was determined by linear measurements of the contaminated and washed areas of the staple, with a measurement accuracy of up to ±0.5 cm. The wool's tortuosity was studied by the number of curl arcs per centimeter and the nature of their distribution along the entire length of the staples. The fineness was determined by microscopy of wool sheared from the side at a magnification of 400 times and at the price of one division of the eyepiece-micrometer scale of the projection microscope-lancet type Nr.-1468 (made in Poland) - 2 µm. The final results of measuring 200 fibers of the main and control samples were displayed in micrometers. Wool productivity was taken into account by individual shearing of unwashed wool and weighing of fleeces, with an accuracy of measurement up to ±0.1 kg.

Initial data for building a mathematical model

To build a model for predicting the predicate (the value of the yield of washed wool (Y), the main features (predictors) of selection that justify it were chosen as live weight of ewe lambs in kg (X_1), true length of wool in cm (X_2), the size of the staple contamination zone in cm (X_3), staple tortuosity in pcs (X_4), natural wool length in cm (X_5), wool fineness in µm (X_6), unwashed wool weight in kg (X_7) and the size of the staple washout zone in cm (X_8). The selection of each of the limited number of informative traits (predictors) included in this model depended on their practical value and economic importance in wool production.

Data analysis

In order to model and develop effective breeding methods, stepwise multiple regression analysis was used to establish a predictive model and a breeding index of sheep breeding value based on washed wool yield. The relationship between the main traits was established by calculating correlation coefficients.

Results

Determination of the correlation between breeding traits included in the mathematical model

The study of correlations between the predictors characterizing wool quality and productivity of ewe lambs showed that their direction is mainly positive, and their value is medium and low. Instead, the highest and most positive correlation coefficient was found between the natural and true length of lamb wool, r = +0.962, which is of undoubted importance in breeding work with sheep. The direction of selection to some extent affected the magnitude and nature of the relationship between other predictors. Thus, an average and also positive level of correlation exists between the yield of washed wool and:

its true length - r = +0.575; live weight of experimental lambs – r = +0.544; natural length – r = +0.503, and tortuosity – r = +0.425. The relationship between the size of the unwashed wool cut and tortuosity was less close and weaker, r = +0.342. A direct correlation was also established between the yield of washed and the cut of unwashed wool, tortuosity, on the one hand, and the natural length of wool, on the other hand, and the live weight of lambs, tint and staple contamination zone, true length of wool and live weight of lambs, the level of which varied within almost the same range from r = +0.241 to r = +0.290. Regarding the correlation between the washed out staple area and the natural wool length, it should be noted that the obtained index is low, r = +0.128, but at the same time, it indicates the need for further direction of breeding work to improve the wool productivity of the Kharkiv intra-breed type of fine-wool Prekos sheep by combining the improvement of the natural wool length and gradual reduction of the size of the washed out staple zone by selecting animals with longer wool but relatively shorter staple lengths with washed out sweat residue. The weakest positive correlation was observed between the natural length of the wool and the size of the staple contamination zone, r = +0.001. At the same time, both direct and inverse correlations of the combination of individual predictors were found to be rather low, which is primarily due to the independent patterns of formation of some in relation to others. Long-term directed selection can significantly change not only the magnitude of these multiple correlations but also their nature.

Construction of a mathematical model for predicting the yield of washed wool in sheep

Based on the results of our research, we have built a multiple linear regression that determines the dependence of the predictive model (Y) on the variables X_1 - X_8. In general, it has the form of Equation 1:

$$Y = a_1 \times X_1 + a_2 \times X_2 + a_3 \times X_3 + a_4 \times X_4 + a_5 \times X_5 + a_6 \times X_6 + a_7 \times X_7 + a_8 \times X_8 + b \quad (1)$$

where a_1 a_8 – coefficients at X_1 X_8; b – constant.

Using a step-by-step procedure for excluding insignificant predictors, the next step was to determine the modeling coefficients based on the calculation of the system of mathematical equations of multiple linear regression 1 and their statistical significance. The results of this analysis show that, according to the actual data, according to the Student's t-test, the coefficients a_1 ($t_{facta_1} = 2.84$), a_2 ($t_{facta_2} = 2.56$) and a_3 ($t_{facta_3} = 2.46$) in the above equation are statistically significant (these actual t-test values were compared by the absolute value of the tabulated values with 39 degrees of freedom and a significance level of $p < 0.05$: $t_{tabl}(40; 0.05) \approx 2.02)$. Hereinafter, the number of degrees of freedom k was determined by the formula: k = n − p − 1 – the number of measurements minus the number of coefficients (p coefficients a_i, for X_i $(i = 1, 2,...p$ and one $b)$.

In the course of the calculation (after excluding all statistically insignificant predictors), it was found that the value of the multiple correlation coefficient was high $(R = 0.823)$. At the same time, the coefficient of determination (the degree of influence) of these factors on the formation of the predictor is equal to $R^2 = 0.678$, and when adjusted for the number of degrees of freedom, it is even lower $(\widetilde{R}^2 = 0.612)$.This indicates that the regression equation describes only about 61 % of the research data, although it is generally significant according to Fisher's F-criterion $(p < 0.001)$.

It should be noted that $\widetilde{R}^2 = 1 - \frac{(n-1)}{n-p-1} \times R^2$

The picture of the regression equation is improved by the assumption that the coefficient b is zero. For this regression, the value of the multiple correlation coefficient is quite high $(R = 0.997)$.

The coefficient of determination is equal to $R^2 = 0.994$ (adjusted for the number of degrees of freedom: $\widetilde{R}^2 = 0.968)$. In this case, the calculation data already indicate that the regression equation describes about 97% of the variability of the experimental data. It is generally significant according to Fisher's F-test $(p < 0.001)$, but only the coefficients of the equation a_1 $(t_{facta_1} = 3.15)$, a_2 $(t_{facta_2} = 2.92)$, a_3 $(t_{facta_3} = 2.38)$ and a_4 $(t_{facta_4} = 2.62)$ were significant according to Student's t-test (these actual values of the criterion were compared by the absolute value of the table values with 40 degrees of freedom and the level of significance $p < 0.05$: $t_{tabl}(40; 0.05) = 2.021$).

Based on these calculations, only those coefficients that are significant according to Student's t-test, at $p < 0.05$, and mostly determine the final yield of washed wool (Y), i.e. a_1, a_2, a_3, a_4, were left in the model of regression equation 1. Since then, the values of the multiple correlation coefficient and the determination coefficient have remained virtually unchanged, but the forecasting accuracy has increased and all regression coefficients have become significant by Student's t-test at the probability level $p < 0.01$ (they can be compared by the modulus with $t_{tabl}(44; 0.01) \approx 2.7$).

Determining the relationships between the predictors and further calculations helped not only to establish individual patterns, but also to derive a multiple regression equation (2) that predicts the value of the yield of washed wool (predictor) depending on the above predictors:

$$Y = 0.463 \times X_1 + 2.092 \times X_2 - 1.641 \times X_3 + 2.035 \times X_4, \qquad (2)$$

where 0.463; 2.092; 1.641; 2.035 – regression coefficients; Y – yield of washed wool, % (predictive trait); X_1 – live weight of ewe lambs, kg; X_2 – true length of wool, cm; X_3 – staple contamination zone, cm; X_4 – tortuosity, pieces per 1 cm.

This prediction equation is generally significant by Fisher's F-test $(p < 0.001)$ and Student's t-test $(p < 0.01)$, has a standard error $S = 3.408$, a fairly high multiple correlation coefficient $(R = 0.997)$ and a significant coefficient of determination $(\widetilde{R}^2 = 0.971)$, adjusted for the number of degrees of freedom. That is, it describes about 97% of the variability of the data actually obtained in the study, and the share of predictors not included in Equation 2 accounts for only 3% of the variation in the predictor performance.

Since the quality of sweat residue was determined by the point system and color, the fineness in the qualities, the shearing of washed wool and its elongation were determined by the calculation method, these predictors were not informative and were not taken into account when constructing the prediction model. At the same time, for other breeds and types of sheep, as well as the level of yield of washed wool, the proposed multiple regression equation should be adjusted for selection traits and the information from the newly created database should be used.

Verification of a mathematical model for predicting the yield of washed wool in sheep

The next step in the research was to analyze the verification of the prediction model. Comparison of the actual values of the yield of washed wool with the theoretically predicted results (according to Equation 2) and their standard prediction differences are presented in Table 1.

Table 1. Actually obtained values of the yield of washed wool, theoretically predicted results and their standard prediction differences (according to the developed model), %

Inventory number of the ewe lamb	Actual yield of washed wool	Predicted yield of washed wool	The difference prediction-fact +/–
629	35.00	37.47	-2.47
6314	34.30	38.47	-4.17
6111	34.70	37.41	-2.71
6160	31.00	31.22	-0.22
646	35.00	36.36	-1.36
6245	35.91	42.59	-6.68
624	35.00	37.53	-2.53
6126	32.00	36.50	-4.50
6229	35.10	37.95	-2.85
6115	37.00	38.29	-1.29
6248	35.00	30.38	+4.62

6142	34.20	33.58	-0.62
628	34.70	38.83	-4.13
6122	36.09	39.00	-2.91
6807	34.20	35.80	-1.60
6117	41.14	41.43	-0.29
6165	40.00	41.89	-1.89
6261	39.00	38.17	+0.83
6317	42.20	45.67	-3.47
6300	40.10	39.68	+0.42
6801	41.67	43.64	-1.97
6259	42.35	41.43	+0.92
6183	40.40	43.89	-3.49
6231	41.30	40.17	+1.13
6337	37.47	32.80	+4.67
6255	42.00	46.79	-4.79
669	41.00	40.81	+0.19
6262	42.56	44.91	-2.35
679	36.35	28.71	+7.64
663	41.40	45.27	-3.87
615	41.32	42.64	-1.32
686	40.24	39.16	+1.08
6179	43.10	41.96	+1.14
690	49.00	42.71	+6.29
6277	50.00	44.79	+5.21
6239	51.30	51.38	-0.08
6332	53.31	48.45	+4.86
640	47.41	46.84	+0.57
651	47.00	43.89	+3.11
680	43.64	45.52	-1.88
65	43.44	41.32	+2.12
6170	43.00	39.42	+3.58
6178	46.20	45.98	+0.22
6241	46.00	43.30	+2.70
6119	50.00	45.67	+4.33
636	50.08	45.61	+4.47
665	46.10	46.43	-0.33
6202	46.00	41.79	+4.21

It should be noted that the difference between the animals of the experimental sample in terms of the actual values of the yield of washed wool and the theoretically predicted results led to ambiguous differences between these indicators. However, they were within the measurement accuracy of the confidence interval (5%), which corresponds to the accuracy generally accepted in zootechnical research and, with a given confidence level, covers the entire range of changes in theoretically predicted results of forecasting the yield of washed wool in ewe lambs, given a certain value of the actual values obtained. At the same time, the actual yield of washed wool was on average 40.94 ± 0.80%, the predicted one - 40.91 ± 0.70%, with a correlation coefficient between them r = + 0.812.

Construction of a breeding index to improve the evaluation of sheep selection by the yield of washed wool

To determine the target standards (values to be achieved) and develop the breeding index I, we used the optimization method (simplex method), considering equation (2) as an objective function, and the average values of the corresponding predictors $\overline{X}_1 = 36.21$ kg; $\overline{X}_2 = 10.32$ cm; $\overline{X}_3 = 4.10$ cm and $\overline{X}_4 = 4.56$ pcs were selected after statistical processing of the primary experimental data. As a result of maximizing the objective function (2), the following values of the target standards were obtained: $X_{1c} = 45.0$ kg; $X_{2c} = 13.5$ cm; $X_{3c} = 3.0$ cm and $X_{4c} = 6.0$ pcs.

The equation of the breeding index has the general form (3):

$$I = k_1 \times (X_1 - \overline{X}_1) + k_2 \times (X_2 - X_2) + k_3 \times (X_3 - X_3) + k_4 \times (X_4 - \overline{X}_4), \quad (3)$$

where $\overline{X}_1, \overline{X}_2, \overline{X}_3$ i $\overline{X}_4$ – average values of parameters X_1, X_2, X_3 i X_4; k_1, k_2, k_3 i k_4 – the corresponding coefficients of the selection weight of the predictors X_1, X_2, X_3 i X_4.

That is, if the average values of the predictors of the experimental $\overline{X}_1 = 36.21$sample kg; $\overline{X}_2 = 10.32$ cm; $\overline{X}_3 = 4.10$ cm; $\overline{X}_4 = 4.56$ pcs are substituted into the formula of equation (3), the index value will be zero (lower bound), and the target standards $X_{1c} = 45.0$ kg; $X_{2c} = 13.5$ cm; $X_{3c} = 3.0$ cm and $X_{4c} = 6.0$ pcs it will be 100 scale units (upper bound).

Based on this, and keeping in mind that the values of the coefficients k_1, k_2, k_3 and k_4 should be proportional to the values of the corresponding coefficients a_1, a_2, a_3 and a_4 of the regression equation (2), we obtained the fundamental model of the breeding index in the form of equation (4):

$$I = 3.00 \times (X_1 - 36.21) + 13.52 \times (X_2 - 10.32) - 10.62 \times (X_3 - 4.10) + 13.16 \times (X_4 - 4.56) \quad (4)$$

All the priority predictors in this equation are the most informative, significant according to the criteria for testing statistical hypotheses (at the level of $p < 0.01$), and independent of each other.

Testing the effectiveness of the breeding index and modeling the breeding evaluation of sheep

First, using the mathematical and statistical methods described above, we obtained an expression for the selection index by the yield of washed wool in percent for all sheep, then, substituting the experimental data, we calculated it. At the same time, it turned out that the amount of tortuosity did not have a sufficient correlation with the yield of washed wool, and therefore this predictor was not taken into account in the index and only three were used: live weight, true wool length, and contamination zone. After appropriate refinements and calculations, the general equation of the breeding index took the form (5):

$$I = 1.855 \times (X_1 - 51.54) + 5.72 \times (X_2 - 10.84) + 24.32 \times (X_3 - 3.68) \quad (5)$$

where 1.855; 5.972; 24.32 – coefficients of selection weight of live mass, kg; the true length of their wool, cm; the size of the staple contamination zone, cm; X_1; X_2; X_3 – target standards; 51.54; 10.84; 3.68 – average values of the relevant traits.

All the coefficients of equation (5) are significant by the Student's t-test, at $p < 0.05$. The average values of the developed index and the effect of selection for its use for both ewes and ewe lambs are presented in Table 2.

Table 2. The results of testing the developed index and the selection effect

Group	I	X_1	X_2	X_3	*Y (yield of washed wool) in:*			
					ewes	n	Their daughters	**n**
I	27.53	52.33	12.23	2.88	63.47	23	43.97	**22**
II	**–30.03**	**50.68**	**9.33**	**4.41**	**51.45**	**23**	**38.38**	**26**

The processing of the obtained research results shows that the ewe lambs selected with a positive value of the constructed selection index had a higher live weight by 1.65 kg or 3.3%, true wool length by 2.9 cm or 31.1% and yield of washed wool by 12.0%, but a smaller staple contamination zone by 1.53 cm or 34.7% than the lambs formed into groups with negative parameters of the same selection index. When determining the effect of selection, it was found that the yield of washed wool in lambs obtained from ewes selected for the group with positive values of the selection index approached the peers with negative values: the difference was 5.59%, which confirms the high efficiency of the developed selection index.

Extrapolation of the obtained values of the yield of washed wool in experimental ewe lambs and their mothers using linear regression analysis

(Figures 1 and 2) revealed that almost all the results of determining the yield of washed wool fall within the confidence interval at the level of $p < 0{,}05$. This indicates the reliability of the obtained values Y_p.

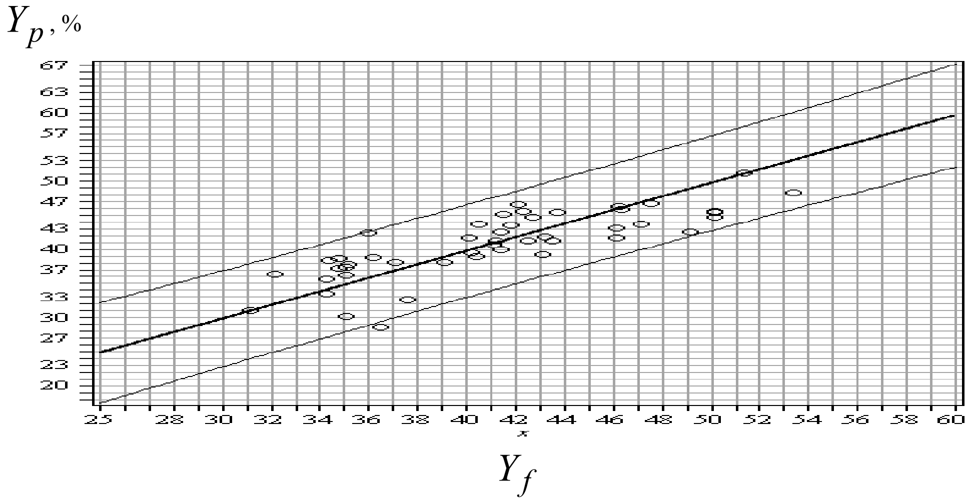

Figure 1. Values of the yield of washed wool in % for the experimental ewe lambs here and further: on the ordinate axis – predicted (Y_p) and on the abscissa axis – actual (Y_f). Confidence interval for $p < 0.05$. Regression line: $Y_{pr} = 0.9936 \times Y_{fact}$ $(R = 0.808)$

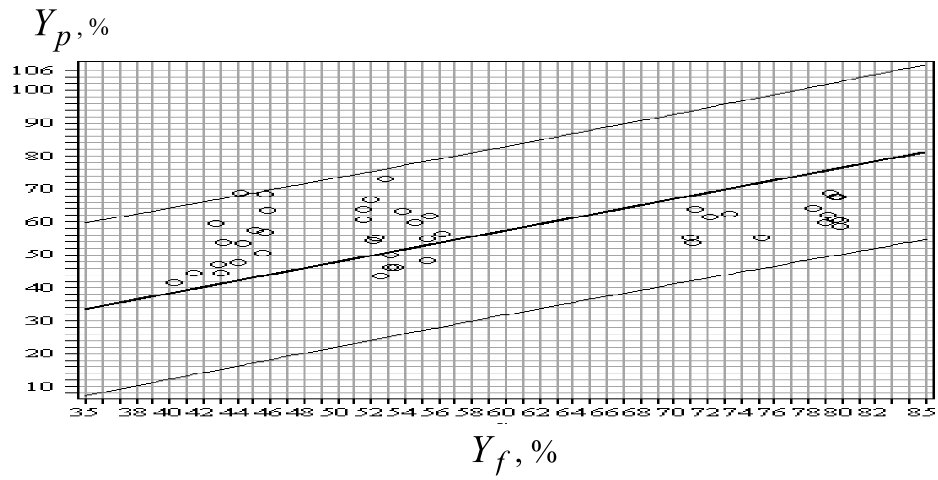

Figure 2. The value of the yield of washed wool in % for the experimental ewes. Confidence interval for $p < 0.05$. Regression line: $Y_{pr} = 0.9554 \times Y_{fact}$ $(R = 0.4388)$

In targeted breeding in sheep husbandry, the problem of evaluating sheep by a complex of traits, and in fact, the selection of the ancestors of lines and families, is acute. The presented results of the evaluation of ewes by the breeding index indicate the possibility of targeted influence on the breeding group of the experimental flock by selecting according to a single methodological principle, both in the breeding flock and, presumably, among the sire rams.

Discussion

The main goal of the livestock industry is to provide the population with quality products and raw materials (Nanka *et al.,* 2018; Paliy *et al.,* 2020). Interrelations between the main indicators of productivity and wool quality of sheep as a single complex of breeding selection revealed in the article have led to favorable conditions for the direct selection of traits for prediction of the yield of washed wool and have provided the basis for substantiation of the guaranteed parameters of genetic potential of the studied type of sheep in terms of yield of washed wool (Filipenko and Soroka, 2023; Korkh *et al.,* 2023). The study is fully consistent with the data obtained by other scientists (Tedeschi and Menendez, 2020).

By the methods of correlation and regression analysis, as well as by testing statistical hypotheses, the most informative, significant signs of sheep selection (live weight of lambs, true length of their wool and the area of staple contamination) were selected and a prediction model was obtained at the level of high confidence $(p < 0.01)$, which adequately and accurately reflects the future actual values of the yield of washed wool and the equation of multiple linear regression for the construction of a breeding index. In particular, the difference between the actually obtained and theoretically predicted values of the washed wool yield, at the level of significance $(p < 0.01)$, demonstrated the reliability of the developed breeding index, which is determined mainly by a successful, statistically sound selection of reasonable informative selection traits. Selection on the basis of positive values of the breeding index ensured significant efficiency of the process of improvement of individual breeding traits, compared to its negative values. The high importance of the use of methods for predicting economically useful traits in sheep is confirmed by the results and studies of other authors (Erohin and Kizilova, 2008; Erohin *et al.,* 2010; Shehata, 2013; Castilhos *et al.,* 2018; Alves *et al.,* 2019; Costa *et al.,* 2020; Gomes *et al.,* 2021).

Thus, based on the identified correlations between the main economically useful traits of lamb productivity, a mathematical model for predicting the yield of washed wool was developed, based on the use of a set of the most informative traits: live weight, true wool length, staple contamination zone and wool tortuosity. At the current stage of herd improvement, the selection of ewes using the developed index contributes to the maximum involvement of high-value animals in the breeding process, a more accurate evaluation of their wool productivity potential, and ensures timely culling of potentially low-productive animals.

Acknowledgments

The authors of the publication express their deep gratitude and appreciation to the Directorate and chief specialists of the Base Farm Rozdaibida Yu. O., Zaporozhan L. L., Pluhinii Z. P. for the opportunity to organize research, and to the Associate Professor of the Department of Information Systems, Design and Technologies in Animal Husbandry KhSZVA Hetmanets O. M. for methodological assistance in the design of mathematical models, valuable comments and useful suggestions made at various stages of discussion.

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(Received: 22 September 2023, Revised: 22 January 2024, Accepted: 9 March 2024)