DETERMINATION OF THE BREEDING VALUE OF STUDRAMS, TAKING INTO ACCOUNT THE INFLUENCE OF THE LEVEL OF FEEDING ON THE MANIFESTATION OF PRODUCTIVITY IN THEIR OFFSPRING

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The article presents the results of studies that were performed on the livestock of gimmers -14 months of age of the Kharkiv intra-breed type of the precos breed. In total, 516 gimmers heads were individually registered for Origin and productivity. Among them-409 heads of offspring of 5 studrams, the breeding value of which was determined by comparing the productivity indicators of the Daughters of individual sheep with the indicators of their peers, and-with the average indicators for the herd. All offspring obtained from studrams from artificial insemination of sheep in three adjacent years were evaluated. At the same time, their cultivation took place at different levels of annual feed consumption. Statistical processing, correlation-regression, and variance analysis were performed in the SPSS-22 software environment.

Studies have shown that with an increase in feed consumption by 4-6% per year, there is a likely increase in the average live weight for the herd from 6.7 to 11.6%, – by 15.1-16.1%, wool length – by 6.4–16.0 %. (p<0.001 in all cases), but this had a different effect on the disclosure of the potential of breeding traits in the offspring of individual sheep. So, if the genotype of studram No. 1823 turned out to be stable in terms of transmitting its hereditary qualities to offspring in changing conditions of providing them with food, then the genotype of studram No. 1625 and, especially, No. 1579 turned out to be plastic. In this regard, the indicators of rank correlation (R ± mr) of their score on the quality of offspring in adjacent years significantly differed and ranged from 0.600±0.462 to 0.900±0.252. in general, the indicators of feed consumption in the cultivation of offspring had reliable positive, average correlation (r) with the live weight of 0.439, clipping and wool length, respectively, 0.487 and 0.505. it is shown that the influence of genotypes of studrams (η^2) for live weight, woolclip and coat length in their daughters was 3.0, respectively; 4.5 and 8.3% (in all cases p < 0.001), while the influence of the annual feed consumption factor was significantly greater, 17.9; 26.4 and 26.2%, respectively. The interaction of two factors (the genotype of the Ram X feed consumption) in relation to the impact on the living mass of gimmers was significantly lower, and amounted to 2.8 %, but remained probable, p< 0.05. to predict the parameters of individual characteristics of offspring productivity, appropriate mathematical models are

proposed that take into account the complex influence of the genotype of the Ram and the level of feed consumption on them.

Keywords: studram, genotype, prediction model, offspring, feeding level, impact strength.

ВИЗНАЧЕННЯ ПЛЕМІННОЇ ЦІННОСТІ БАРАНІВ-ПЛІДНИКІВ З УРАХУВАННЯМ ВПЛИВУ РІВНЯ ГОДІВЛІ НА ПРОЯВ ПРОДУКТИВНОСТІ У ЇХНІХ ПОТОМКІВ

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У статті наведено результати досліджень, що були виконані на поголів'ї ярок -14-місячного віку харківського внутрішньопродного типу породи прекос. Всього в індивідуальному обліку походження і продуктивності перебувало 516 голів ярок. В їх числі - 409 голів потомків 5 баранів-плідників, племінну цінність яких визначали методом порівняння показників продуктивності доньок окремих баранів з показниками ровесниць, та – з середніми показниками по стаду. Оцінці підлягали усі потомки, одержані від баранів плідників від штучного осіменіння вівцематок у три суміжні роки. При цьому їх вирощування відбувалося за різних рівнів річних витрат кормів. Статистичну обробку, кореляційно-регресійний та дисперсійний аналіз здійснювали в програмному середовищі SPSS-22.

Дослідженнями встановлено, що за збільшення витрат кормів на 4-6 % за рік відзначається вірогідне підвищення середньої живої маси по стаду від 6,7 до 11,6 %, настрига вовни – на 15,1-16,1 %, довжини вовни – на 6,4–16,0 %. (p<0,001 в усіх випадках), але це по різному позначалося на розкритті потенціалу селекційних ознак у потомків окремих баранів. Так, якщо генотип барана № 1823 виявився стійким щодо передачі своїх спадкових якостей потомкам в мінливих умовах забезпечення їх кормами, то генотип барана № 1625 та, особливо, № 1579 виявився пластичним. У зв'язку з цим, показники рангової кореляції $(r \pm m_r)$ бальної їх оцінки за якістю потомства у суміжні роки істотно різнилися та складали від 0,600±0,462 до 0,900±0,252. В цілому ж показники витрат кормів при вирощуванні потомків мали достовірні додатні, середнього рівня кореляційні зв'язки (r) з живою масою 0,439, настригом та довжиною вовни відповідно 0,487 і 0,505. Показано, що вплив генотипів баранів-плідників (η^2) на живу масу, настриг та довжину вовни у їхніх доньок складав відповідно 3,0; 4,5 та 8,3 % (в усіх випадках p < 0,001), тоді як вплив фактора річних витрат кормів мав значно більшу силу, відповідно 17,9; 26,4 та 26,2 %. Взаємодія двох факторів (генотип плідника х витрати кормів) щодо впливу на живу масу ярок виявила значно нижчою, та склала 2,8 %, але залишалася вірогідною, p< 0,05. Для прогнозування параметрів окремих ознак продуктивності потомків запропоновані відповідні математичні

моделі, що враховують комплексний вплив на них генотипу плідника та рівня витрат кормів.

Ключові слова: баран-плідник, генотип, модель прогнозування, потомок, рівень годівлі, сила впливу.

Introduction. In the conditions of constant growth of current costs, and recently the instability of providing livestock feed due to the influence of sharp climate fluctuations, an important problem for the development of sheep breeding is the development of production systems that are resistant to this impact. One of its important components is the development of effective methods for creating genotypes of animals with increased resistance to extreme climate changes and the ability to convert feed resources, if they are deficient, into products. That is, under these conditions, the importance of breeding sheep genotypes increases, on the one hand, with a lower sensitivity to the impact of environmental factors on their body, and on the other – with a lower impact on the environment.

In this regard, according to McLaren A., Brotherstone S., Lambe N.R. et al. (2015), to assess the degree of interaction in the genotype – environment system and their consideration in production systems, an important task is to identify and quantify the effects of environmental factors and, based on them, study the relationships with certain breeding and adaptive characteristics of animals.

Nel C.L., Werf J. H. J., Rauw W.R., Cloete S.W.P. (2023) also emphasize the importance of solving the above problem and note that in relation to the sheep industry, it is less studied in contrast to pig or dairy cattle breeding, which develops through intensive production systems.

Among the mechanisms for reducing the influence of environmental factors on the state of production systems in the field of animal husbandry, a number of authors see the genetic selection of individuals who are most able to counteract this influence (Knap P.W.,2005; Rauw W.M., and Gomez-Raya L., 2015; Berghof T.V.L., Poppe M. and Mulder H.A., 2019).

At the same time, Falconer D.S.(1990) notes that antagonistic selection (selection of plus-options in a "bad" environment and vice versa of minus-options in a "good" environment reduces susceptibility to its influence, while synergistic selection (+ , or - viriants in a better or worse environment, respectively) increases this sensitivity.

Vdovychenko Yu.V., Kudryk N.A., Polska P.I. et al. (2018) the main methodological prerequisite for an objective assessment of studrams by genotype is considered, first of all, sufficient and full-fledged feeding and appropriate conditions for keeping their offspring in ontogenesis. In other words, it is necessary to provide maximum conditions for the implementation of synergistic selection. This is a methodological approach, comparing it with the above conclusion of Falconer D.S., can provide high-performance animals as a result of selection, but with a high sensitivity to environmental factors.

According to Jong G., Bijma P. (2002), the presence of a variance in the interaction between the animal genotype and the environment is the basis for selecting the level of sensitivity of the genotype to environmental diversity. Therefore, all known models of quantitative selection use the presence of covariance between phenotype and fitness. At the same time, genotypes that show high variability of phenotypes under changing environmental conditions are classified by these researchers as "plastic", while those that show low variability are classified as "stable" or "stable".

Colditz I.G. and B.C.Hine (2016) characterizes resistance as the ability of an animal organism to maintain productivity in a wide range of environmental conditions,

primarily without compromising reproduction functions, as well as health. in their opinion, the test indicator for assessing the stability of an organism can be the rate of Return of its variable indicators to their original (normal) state. The phenotypic stability of sheep and cattle at such critical technological moments as weaning young animals from their mothers is determined by them for further genotypic selection of individuals more resistant to this technological stress.

Rather M.A., Shanaz S., Ganai N.A. et al. (2020) examined the effect of the year of assessment and genotype of the studrams on the main indicators of young Development – live weight at birth, at 6 and 12 months of age, as well as the age of the first lamb and the period between lambs in daughters. Using a mixed least squares model and maximum likelihood, they revealed significant variability of traits over a significant period of their evaluation, and also established a highly likely influence of the studrams genotype on their manifestation in offspring. Unlike the above, Santos-Silva J., Mendes I.A, Bessa R.J.B. (2002) in an experiment on lambs weaned from sheep, it was found that the genotype of the father had little effect on the main indicators of meat productivity and quality of Lamb compared to the applied feeding system and live weight at slaughter. Research By Wang W., Zhang X., Wei H. et al. (2024) also prove the reliable effect of feeding lambs with concentrated feed in the pasture system of their fattening on some quality characteristics of the resulting Lamb.

Mallick P.K., Pourouchottamane R., Rajapandi S. et al. (2017) also note that in addition to the feeding factor, other non-genetic factors play an important role in realizing the genetic growth potential of Bharat merino lambs in India. At the same time, the analysis of variance proved that the year, gender and season of birth are reliably sources of variability in the live weight indicators of young animals in different periods of its development up to one year of age. Due to the positive correlations they found between live weight at 6 months of age and other age periods, this indicator is recommended to be used as a selection criterion for achieving progress in this breed of sheep in terms of live weight.

Research By S. Kramarenko, Luhovyi S., Balan D. et al. (2020) also attest to the significant impact of the year of lambing, breed, sheep genotype, maternal age, birth type, and sex of lambs on their birth weight and weaning from their mothers. According to their data, the influence of the Ram genotype on these characteristics of offspring ranges from 2.5 to 9.0 %.

Abebe A., Banarjee S., Goshmie S. et al. (2020) indicate that the effect of the sex factor of lambs was likely only in relation to the live weight of newborn lambs and was not associated with this indicator at weaning lambs and at 6 and 12 months of age. The influence of factors of the age of sheep and the type of birth of lambs was also not significant. At the same time, the season and year of birth significantly affected growth indicators in all age periods. In this regard, the breeding value of animals was significantly cut off by the years of their evaluation.

Along with this, Tortereau F., Marie-Etancelin C., Weisbecker J.-L. (2020). et al. it is noted that in conditions when feed costs are among the largest in the structure of total production costs in the field of sheep breeding, studrams are increasingly inclined to produce animals that consume less feed and at the same time retain high growth energy and meat productivity. They also note that the feed efficiency indicator is inherited by sheep in this area of productivity and, according to them, may not be genetically related to other characteristics of productivity. In addition, the researchers separately emphasize that sheep with a high conversion of feed into products is characterized by a lower level of methane emissions due to intestinal fermentation of feed. Therefore, they are

recommended to select studrams according to the criterion of the effectiveness of the use of feed by their offspring.

Confirming the great importance of indicators of the effectiveness of sheep feed use for the modern development of sheep breeding, Trapina I., Kairisa D. and Paramonova N. (2023) still note that the performance indicators of each Ram's offspring are very variable. Therefore, in their opinion, no marker accurately explains the variability of feeding performance indicators to be used in breeding programs aimed at improving them. In this regard, it is proposed to search for relationships between phenotypic effects and genotypic effects, which is located at the DNA level, on the effectiveness of sheep feed use in relation to Latvian dark-headed sheep.

Regarding the function of animal reproduction, Joshi P. (2022) among the factors that significantly affect the body's response to changes in environmental conditions, the level of feeding, photoperiod, behavioral responses and hierarchical status, as well as the genotype of animals are identified. At the same time, the level of energy supply to the body is more influential on the reproductive function of females than males.

Nel C.L., Werf J. H. J., Rauw W.R., Cloete S.W.P. (2023) pointing out certain difficulties in measuring the strength of environmental factors on certain indicators of the state of the animal body (health, physical fitness, product quality), they emphasize the need to combine existing methods for evaluating and selecting the best animal genotypes with the possibilities of genomic selection. A similar conclusion is reached and

Biriukova O., Polupan Yu., Melnyk Yu., et al. (2024), investigating the effect of the bug assessment method on improving individual characteristics of dairy cattle productivity. In addition, they note that the forecast of breeding value based on the results of genomic assessment is often overestimated, which indicates the need to adjust it by evaluating studrams for the quality of offspring using traditional methods.

Vashchenko P. A., Zhukorskyi O. M., Saenko A. M. et al. (2023) in the process of searching for links between the manifestation of productivity and the genotype of animals, as well as the nature of interaction with the environment, indicate its presence in individuals carrying the MC4R gene, which encodes the melanocortin receptor associated with the regulation of appetite and energy balance in the body with live weight and spy thickness in pigs of different ages. At the same time, they revealed a different degree of influence of the feeding factor and genotype on live weight due to the age of young animals. If at the age of 4 months the influence of only the type of feeding was reliable on this indicator, then at the age of 6 months the likely influence of the interaction of feeding factors and genotype was recorded. Under conditions of limited feeding, young pigs with AG alleles of this gene had the lowest live weight and had a thicker fat layer compared to peers with the GG genotype.

Currently, there are separate data on non-genomic inheritance of certain traits in animals in the literature sources. So, the Gross N study., Taylor T., Crenshaw T., Khatib H. (2020) reveal the genetic mechanisms of the influence of feeding rations of sheep of the polypay breed during prepubertal period on puberty and the development of offspring obtained from them. They proved that the diet of studrams is able to alter DNA methylation in influential genomic regions (genes associated with sexual development DAZAP1, CHD7, TAB1, MTMR2, CELSR1, MGAT1 and live weight DUOX2, DUOXA2) in sheep gametes, which caused differences in live weight and age of puberty in their offspring. See Also Tillquist N.M., Reed S.A., Reiter A.S et al. (2024) report that deficiencies in the feeding of pregnant females can negatively affect the reduction in the number of offspring born, its growth and metabolic processes. These negative consequences can also manifest themselves in the next generation. Research By Tillquist N.M., Kawaida M.Y., Reiter A.S. et al. (2025) also prove that limited (60%) and increased

(140% of NRC norms) feeding of suyagny sheep caused a slight decrease in the concentration of immunoglobulins (IG) in their colostrum and milk, and also manifested in their first-generation offspring as a decrease in the intensity of IG sorption. In the second generation, the established feature did not appear.

Taking into account the urgency of solving the problem of creating highly productive sheep genotypes resistant to the influence of negative environmental factors, as well as taking into account the complex nature of interaction between them, we set out to study the influence of a quantitative level of feeding, genotypes of sheep-parents and the complex effect of these factors on the manifestation of the main indicators of productivity in offspring and assess the degree of stability of sheep genotypes based on the reaction of their offspring to the influence of this factor.

Materials and methods of research. The study was performed on a number of sheep of the Kharkiv intra-breed type of the prekos breed of the breeding plant "Dpdg "Gontarovka" of Livestock farming Institute of National Academy of Agrarian Sciences of Ukraine. According to the quality of offspring, 5 main studrams of the "elite" class were evaluated, which were used in this herd for artificial insemination of sheep for three adjacent years. Sheep for insemination were randomly assigned to individual studrams, taking into account the quantity and quality of sperm received daily from them. And inseminated with fresh sperm in accordance with the requirements of the "instructions for artificial insemination of sheep and goats" (2002). Feed costs in the corresponding years of cultivation of the offspring obtained from them differed significantly and amounted, according to the official accounting statements of the farm (form 50-SG) in the first year – 4.55; the second – 4.73 and 5.02 centners of feed units per head per year. At the same time, the maintenance staff and technology of keeping sheep were stable.

The assessment of animals was carried out by expert and instrumental methods in accordance with the main provisions of the "Methodology for assessing breeding value and genetic changes in sheep populations of various areas of productivity" (2018) and the current sow 01.22.37-525: 2006 " studrams. Methods for evaluating your own productivity and genotype". All daughters of studrams were evaluated for a complex of the most important breeding traits at the age of 14 months.

Statistical processing of results, correlation-regression and variance analysis were performed in the "general linear model" software environment of the SPSS-22 statistical analysis package for PCs.

Research results. Studies have established that with an increase in the level of feeding when raising the offspring of the evaluated studrams, there is a corresponding increase in their productivity (table. 1). If we take as a basis for comparison the first year of the assessment, which accounted for the lowest level of feeding, then in the following year such productivity indicators as live weight, woolclip and its length increased on average for the gimmer*s* herd by 6.7; 16.1 and 16.0 % (p<0.001 in all cases). The difference in the same characteristics between animals in the second and third years of evaluation was also highly likely and amounted to 11.6, 15.1 and 6.4%, respectively (p<0.001). Changes in the level of feeding also had a positive effect on most other signs – the assessment of the pattern of fiber Convolution and the assessment of hair overgrowth of the back and belly in gimmer*s*. Indicators for assessing head overgrowth and coat thickness were more stable.

Due to an increase in the level of feeding, the reaction of genotypes of descendants of studram No. 1579 was the greatest in terms of changes in live weight and woolclip.

Table 1

Changes in productivity indicators for the herd and in the Daughters of individual studrams by the years of their assessments

Number of ram	Daughters, heads	Indicators for evaluating daughters by a set of characteristics (M±m)								
		heads hairiness, points	length wool, sm	waviness, points	fineness, microns	constitution assessment, points	wool hairiness of the sheep's, points		live weight, kg	wool-sclip, kg
							back	belly		
1	2	3	4	5	6	7	8	9	10	11
First year of evaluation										
1579	42	2,12±0,13	11,76±0,26	4,33±0,11	23,95±0,13	4,49±0,06	3,94±0,08	3,98±0,08	47,07±1,58	4,26±0,16
1625	23	1,74±0,17	11,43±0,28	4,17±0,16	23,91±0,11	4,58±0,09	4,07±0,10	3,93±0,09	53,74±1,57	4,36±0,23
1823	18	2,39±0,12	12,19±0,37	4,28±0,18	24,06±0,13	4,53±0,10	4,03±0,11	4,28±0,11	51,39±1,19	4,60±0,22
9510	17	2,00±0,17	11,47±0,37	3,94±0,13	23,88±0,15	4,44±0,09	3,79±0,10	3,79±0,09	53,94±1,28	4,04±0,21
4464	38	2,11±0,09	10,59±0,28	3,63±0,12	23,95±0,10	4,63±0,06	4,04±0,07	3,84±0,07	54,50±0,91	3,98±0,15
Others (2 heads)	9	1,78±0,22	12,17±0,55	4,00±0,29	24,11±0,11	4,67±0,14	3,94±0,15	3,89±0,18	53,11±1,89	4,40±0,43
Herd	147	2,05±0,06	11,45±0,14	4,05±0,06	23,96±0,05	4,55±0,03	3,98±0,04	3,95±0,04	51,73±0,66	4,23±0,08
Second year of evaluation										
1579	22	1,95±0,19	14,09±0,30	4,05±0,18	23,91±0,29	4,43±0,07	3,93±0,12	4,30±0,10	55,24±1,71	5,35±0,19
1625	37	1,70±0,14	12,84±0,27	4,27±0,14	23,62±0,21	4,49±0,07	4,12±0,07	4,22±0,07	55,10±1,26	4,68±0,13
1823	63	2,17±0,08	13,63±0,21	4,35±0,09	23,90±0,10	4,52±0,06	4,00±0,10	4,28±0,06	55,44±1,13	5,02±0,10
9510	19	2,26±0,13	12,66±0,36	4,05±0,20	23,32±0,23	4,37±0,11	3,84±0,11	4,08±0,09	53,94±1,51	4,51±0,25
4464	31	2,23±0,13	13,13±0,28	4,13±0,14	23,71±0,22	4,42±0,08	3,98±0,10	4,08±0,09	55,60±1,72	4,84±0,18
Others (5 heads)	33	2,09±0,13	13,03±0,22	4,24±0,15	23,55±0,17	4,41±0,08	3,79±0,09	3,89±0,08	55,33±1,40	4,98±0,18
Herd	205	2,08±0,05	13,28±0,11	4,23±0,06	23,71±0,08	4,46±0,03	3,97±0,04	4,6±0,03	55,20±0,59	4,91±0,06

Continuation of Table 1

1	2	3	4	5	6	7	8	9	10	11
Third year of evaluation										
1579	17	2,09±0,23	14,44±0,57	4,47±0,19	23,71±0,18	4,44±0,07	4,05±0,11	3,88±0,10	63,29±1,44	5,77±0,26
1625	30	1,83±0,15	15,13±0,40	4,37±0,16	24,07±0,16	4,55±0,06	4,22±0,08	4,22±0,09	61,33±1,29	5,52±0,19
1823	17	2,29±0,19	15,41±0,76	4,71±0,14	24,06±0,06	4,65±0,07	4,32±0,10	4,41±0,12	62,00±1,57	6,38±0,33
9510	14	1,43±0,31	14,46±0,30	4,64±0,17	23,71±0,19	4,54±0,10	4,07±0,12	3,89±0,11	60,51±2,02	5,35±0,29
4464	21	2,48±0,11	12,67±0,51	4,10±0,17	23,90±0,19	4,45±0,08	4,33±0,09	4,36±0,10	62,48±1,60	5,56±0,22
Others (4 heads)	68	2,10±0,10	13,70±0,31	4,22±0,09	24,12±0,12	4,57±0,04	4,29±0,05	4,21±0,06	61,25±0,77	5,59±0,13
Herd	167	2,06±0,07	14,14±0,20	4,34±0,06	24,00±0,07	4,54±0,03	4,25±0,03	4,19±0,04	61,60±0,51	5,65±0,09
Total estimate for three years										
1579	81	2,06±0,09	12,96±0,24	4,28±0,08	23,89±0,11	4,46±0,03	3,96±0,06	4,03±0,05	52,69±1,21[2]	4,87±0,13
1625	90	1,76±0,09[1]	13,24±0,24	4,28±0,09	23,84±0,11	4,53±0,04	4,13±0,04	4,14±0,05	56,82±0,84	4,88±0,11
1823	98	2,23±0,07	13,67±0,22[1-3]	4,40±0,07	23,97±0,07	4,56±0,04	4,07±0,05	4,30±0,05	55,83±0,86	5,18±0,11[2,3]
9510	50	1,94±0,12	12,76±0,26	4,18±0,11	23,62±0,12	4,44±0,06	3,89±0,06	3,93±0,06	55,78±0,99	4,59±0,16[3]
4464	90	2,23±0,07	11,95±0,23[1]	3,91±0,08	23,86±0,10	4,52±0,04	4,09±0,05	4,04±0,05	56,74±0,86	4,65±0,12
Others (11 heads)	107	2,17±0,09	12,79±0,22	4,16±0,10	23,75±0,11	4,46±0,50	3,99±0,07	4,04±0,07	57,39±1,04	5,09±0,14
Herd	516	2,07±0,03	13,04±0,10	4,21±0,03	23,87±0,04	4,51±0,02	4,06±0,02	4,11±0,02	56,29±0,38	4,95±0,05

Note: for woolclip -between No. 1823 and No. 4464 (3 - p<0.05) and No. 9510 (2-p<0.01) and between No. 9510 and The Herd average (p<0.05);
By live weight - between No. 1579 and No. 1625 and No. 4464 and The Herd average (2 p<0.01 in all cases);
By coat length-between No. 1823 and No. 4464 (1-p<0.001), No. 9510 (2-p<0.01) and No. 1579 (3 - p<0.05) and No. 4464 compared to the Herd average (1-p<0.001).
By heads hairiness -No. 1625 and No. 1823 and No. 4464 and against the Herd average (1-p<0.001).

According to these signs, there was an increase of almost 1.34 times. Approximately the same increase in the length of wool in the Daughters of Ram No. 1625, while in terms of woolclip and live weight – only in the range of 14-25%. Against the background of high feed costs, the realized potential of only wool productivity in the descendants of sheep No. 1823, No. 4464 increased by 39.1 and 39.6%, respectively, while the increase in other characteristics was in the range of only 14-26 %. These data indicate that an increase in total feed costs has different effects on unlocking the potential of certain breeding traits in the offspring of individual sheep. To a greater extent, this applies to wool cuts, to a lesser extent – to live weight. This feature is probably due to the belonging of sheep of the precos breed to the combined meat-wool direction of productivity, in which live weight is a breeding feature, which is realized in priority under different environmental conditions, while wool productivity for the formation of which the body spends more feed nutrients, requires an increase in the overall level of feeding.

In general, for three adjacent years of evaluation, the descendants of studram No. 1579 were 7.3% lower in live weight than the peers of the best Studram No. 1625 in terms of development of this trait (p<0.01). The live weight of the Daughters of this studram was also significantly lower compared to the indicators of the offspring of studram No. 4464 and from the average indicator for the herd, respectively, by 7.1% and 6.4 % (p<0.01 in both cases). In terms of hair cutting, the Daughters of sheep No. 9510 and 4464 were inferior to the offspring of the best in the development of this trait of Ram No. 1823 by 11.3 % (p<0.01) and 10.2 % (p<0.05), and the Daughters of Ram No. 9510 were also inferior to the Herd average by 7.3 % (p<0.05).

The difference between the" best "and" worst " in terms of coat length of gimmer daughters of rams No. 1823 and 4464 was 1.7 cm (or 12.6% for p<0.001). Daughters of sheep No. 9510 and 1579 were also inferior to offspring of sheep No. 1823 by 6.7 % (p<0.01) and 5.2 % (p<0.05), respectively. Also significantly "worse" against the indicator of the average length of wool in the herd were gimmers, the father of which was ram No. 4464 (by 8.4 %, at p<0.001).

Among other signs, attention is drawn to the lowest assessment of head overgrowth in the descendants of ram No. 1625. they were significantly inferior to their peers – the descendants of sheep No. 1823 and No. 4464 and the average value for the herd (p<0.001). Significantly better in the herd, and in comparison with the same age-descendants of Ram No. 9510 were the Daughters of Ram No. 1823 according to the assessment of belly overgrowth and wool convolutions (p<0.001).

Taking into account the significant number of breeding traits that were taken into account when evaluating the offspring obtained from sheep and the differences indicated above between individual groups of gimmers, we ranked each group of offspring by the value of these traits. The sum of points obtained in this case on all grounds allowed us to make a generalized assessment of each Ram. Results (Table. 2) show that in most respects the descendants of Ram No. 1823 had the highest ranks. At the same time, this is typical not only for a generalized three-year assessment of all offspring, but also for the results of assessment in individual years of their cultivation. That is, the genotype of the offspring of this ram can be considered to a certain extent more stable in terms of the effect of the feeding level factor on the phenotypic manifestation of productive signs. At the same time, the stability, but the lowest ranks for the years of evaluation of offspring and generally for three years was noted Ram No. 9510. this indicates its status as a "degrader" for most indicators of productivity of offspring. Daughters of Ram's No. 1579 and No. 1625 were relatively better compared to peers of other studrams at a lower level of feeding, while gimmers, whose father is Ram No. 4464, significantly increased the total rank score for improving feeding conditions during their cultivation (Table. 3).

Table 2

Results of ranking the average values of offspring indicators by years of evaluation of studrams

Number of Ram	Year of evaluation	Rank of descendants by attributes									total points for all attributes
		heads hairiness, points	length wool, sm	waviness, points	fineness, microns	constitution assessment, points	wool hairiness of the sheep's, points		live weight, kg	wool-sclip, kg	
							back	belly			
1579	1	2	3	1	3	5	4	2	6	4	30
	2	5	1	5	6	3	4	1	4	1	30
	3	4	4	3	1	6	6	6	1	2	33
	Σ	3	3	2	5	4	5	4	6	4	36
1625	1	6	5	3	2	3	1	3	3	3	29
	2	6	5	2	3	2	1	3	5	5	32
	3	5	2	4	4	3	3	3	4	5	33
	Σ	5	2	2	3	2	1	2	2	3	22
1823	1	1	1	2	4	4	3	1	5	1	22
	2	3	2	1	5	1	2	2	2	2	20
	3	2	1	1	3	1	2	1	3	1	15
	Σ	1	1	1	6	1	3	1	4	1	16
9510	1	4	4	5	1	6	5	6	2	5	38
	2	1	6	5	1	6	5	4	6	6	40
	3	6	3	2	1	4	5	5	6	6	38
	Σ	4	5	3	1	5	6	5	5	6	40
4464	1	3	6	6	3	2	2	5	1	6	34
	2	2	3	4	4	4	3	4	1	4	29
	3	1	6	6	2	5	1	2	2	4	29
	Σ	1	6	5	4	3	2	3	3	5	32
Others	1	5	2	4	5	1	4	4	4	2	31
	2	4	4	3	2	5	6	5	3	3	35
	3	3	5	5	5	2	4	4	5	3	33
	Σ	2	4	4	1	4	4	3	1	2	25

Table 3.

Sum of points and ranks of Studrams by indicators of evaluation of their daughters in adjacent years

Number of Ram	Results by years of offspring evaluation							
	first year		second year		third year		together for 3 year	
	total points	rank	sum of points	rank	sum of points	rank	sum of points	rank
1579	30	3	30	3	33	3	36	4
1625	29	2	32	4	33	3	22	2
1823	22	1	20	1	15	1	16	1
9510	38	5	40	5	38	4	40	5
4464	34	4	29	2	29	2	32	3
Others	31	-	35	-	33	-	25	

The above-mentioned features of productivity in the offspring of sheep by the years of their rearing under the influence of both the genotypes used in the selection of sheep and environmental factors caused from 60 to 90% of the coincidences of evaluation ranks (table. 4). At the same time, the highest rank correlation was found in studrams between the second and third years of their offspring's assessment (with a higher level of feeding compared to the first year).

Table 4.

Coefficients of rank correlations of sheep ratings (n=5) based on the productivity indicators of their daughters raised in years with different feeding levels

Indicators	Value of rank repeatability coefficients by year of assessment					
	1-2	1-3	2-3	1- total*	2- total*	3- total*
$(r \pm m_r)$	$0,600\pm$ $0,462$	$0,700\pm$ $0,412$	$0,900\pm$ $0,252^3$	$0,900\pm$ $0,252^3$	$0,700\pm$ $0,412$	$0,600\pm$ $0,462$
(tr_s)	1,30	1,70	3,57	3,57	1,70	1,30

*Note: ^{3}– probably, p<0,05; * overall score for 3 years*

It is characteristic that the highest rank relationship was between the overall (cumulative) assessment of offspring and the first year. That is, the worst level of feeding when growing spring crops most affected the generalized indicator of the rank assessment of sheep - studrams.

Obviously, this state of connections is due to the different number of offspring over the years in which they were raised and evaluated. So, despite the fact that over three adjacent years, most sheep (with the exception of Ram No. 9510) received and evaluated from 81 to 98 heads of daughters, their ratio for individual years was different. More than 52% of all offspring of Ram No. 1579 were raised in the first year, while more than 64% of Daughters of Ram No. 1823 were raised in the second year, and 42% of offspring of Ram No. 4464 were raised in the third year of evaluation. Consequently, the different proportion of daughters whose rearing occurred in years with low or high feeding levels accordingly affected the objectivity of the generalizing assessment for three years.

In this regard, using the "general linear model" procedure of the SPSS-22 statistical analysis package, we developed models for predicting the expected indicators

of woolclip, wool length and live weight of sheep based on estimates of the factors "studram" and "feed consumption". This made it possible to take into account the influence of the feeding level factor on the overall assessment of Rams - on the quality of offspring. The parameters of the developed model for wool cuts due to the influence of factors of the Ram's genotype and the level of feeding of its offspring are shown in Table 5.

Table 5.

Model for predicting the expected clipping of sheep wool (kg) based on estimates of the factors "Studram" and "feed consumption"

Factor characteristics	Value of factor characteristics	Fixed effect / regression coefficient		Level significance
		B	standard error	
	Free member	-10,510	1,323	0,000
Ram	№ 1579	0,455	0,176	0,010
	№ 1625	0,193	0,172	0,263
	№ 1823	0,600	0,170	0,000
	№ 4464	0,150	0,172	0,386
	№ 9510	0	-	-
Feed consumption/ year		3,178	0,277	0,000

This model satisfactorily (R^2 = 0.272; R^2 adj = 0.263) and reliably (p < 0.001) describes the main patterns that occur between the estimates of studrams and feed costs, on the one hand, and sheep woolclip , on the other.

It was also found that the feeding level factor was more influential on woolclip than the Ram genotype. Although in both cases, this effect was likely and amounted to η^2 = 4.5 % (p = 0.001) and η^2 = 24.6 % (p < 0.001), respectively.

In general, the woolclip in 14-month-old gimmers had a positive average strength, a significant correlation with the level of feed consumption during their cultivation (r =+ 0.487; p < 0.001).

Taking into account the developed model, the average indicators of clipping in the Daughters of individual sheep were adjusted for the influence of the feeding factor. The calculation results are shown in Table 6.

Table 6.

Adjusted for the impact of the feeding level of woolclips the Daughters of different sheep

Number of ram	woolclips of daughters, kg		95% difference confidence interval, kg	
	mathematical mean (m)	standard error (m)	lower limit	upper limit
1579	5,007	0,109	4,793	5,222
1625	4,746	0,104	4,542	4,949
1823	5,153	0,099	4,959	5,347
4464	4,702	0,103	4,500	4,905
9510	4,553	0,138	4,281	4,824

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By comparing the obtained adjusted values (Table. 7) and the average values of wool cuts shown in Table 3 revealed certain unlikely differences. In Ram's daughters No. 1579 and No. 1625, the difference between these values was 2.8% each. Moreover, in the descendants of the first ram, the adjusted indicator increased, and in the second – it was lower against pre-determined values. In the Daughters of other sheep, a similar difference was not significant, and ranged from 0.6 to 1.1% in the direction of increase.

Table 7.

Differences between estimates of adjusted average woolclip **values the Daughters of different sheep**

Ram No. - 1 (B1)	Ram No. - 2 (B2)	Difference between the strings of the Daughters of individual Studram, kg		Difference significance level	95% difference confidence interval, kg	
		average difference B1-B2	standard error	lower limit	lower limit	upper limit
1579	1625	0,262	0,151	0,084	-0,036	0,559
	1823	-0,145	0,147	0,324	-0,435	0,144
	4464	0,305*	0,150	0,042	0,011	0,599
	9510	0,455*	0,176	0,010	0,109	0,801
1625	1823	-0,407*	0,143	0,005	-0,688	-0,126
	4464	0,044	0,146	0,766	-0,244	0,331
	9510	0,193	0,172	0,263	-0,146	0,532
1823	4464	0,451*	0,143	0,002	0,170	0,731
	9510	0,600*	0,170	0,000	0,267	0,934
4464	9510	0,150	0,172	0,386	-0,189	0,488

It was found that the descendants of Ram No. 1823 in terms of wool cutting from 0.145 to 0.600 G exceeded their peers received from other studrams. At the same time, the advantage over the Daughters of Rams No. 9510; 4464 was likely. Adjusted values of strings in comparison with similar data in Table. 3 Increased the reliability values of the difference. In addition, due to taking into account the influence of the feeding factor, a significant advantage of Ram daughters No. 1823 over their peers, whose father is Ram No. 1625, was revealed.

The parameters of the developed model regarding the length of the coat due to the influence of factors of the breeder's genotype and the level of feeding of his offspring are shown in Table 8.

This model satisfactorily ($R^2 = 0.317$; R^2 adj = 0.309) and reliably ($p < 0.001$) describes the main patterns that occur between sheep parent estimates and feed costs, on the one hand, and sheep wool length, on the other.

It was also found that the factor of feed consumption during the cultivation of spring crops significantly, at the level of $\eta^2 = 26.2$ % ($p < 0.001$), affected the formation of their wool length indicator. In terms of strength, it turned out to be almost similar to the indicator of the effect on clipping. As for the influence of the sheep genotype, it on the length of hair in daughters, compared to the haircut, increased and amounted to $\eta^2 = 8.3$% and was also likely ($p < 0.001$). Compared to wool cutting, the correlation between wool length and feed costs during spring cultivation increased and amounted to r = +0.505 and turned out to be likely ($p < 0.001$).

Table 8.

Model for predicting the expected wool length (sm) of sheep based on estimates of the factors "Studram" and "feed consumption"

Factor characteristics	Vvalue of factor characteristics	Fixed effect / regression coefficient		Level significance
		B	**standard error**	
	Free member	-17,118	2,511	0,000
Ram	№ 1579	0,527	0,334	0,116
	№ 1625	0,292	0,327	0,374
	№ 1823	0,931	0,322	0,004
	№ 4464	-0,632	0,327	0,054
	№ 9510	0		
Feed consumption		6,290	0,526	0,000

Taking into account the developed model, the average coat length in the Daughters of individual sheep was adjusted for the influence of the feeding factor. The calculation results are shown in Table 9.

Table 9.

Coat length indicators adjusted for the influence of feeding levels the Daughters of different sheep

Studram	daughter's wool length		95% confidence interval, sm	
	mathematical mean (M)	standard error (m)	lower limit	upper limit
№ 1579	13,22	0,207	12,813	13,628
№ 1625	12,99	0,197	12,599	13,372
№ 1823	13,63	0,187	13,256	13,993
№ 4464	12,06	0,196	11,677	12,446
№ 9510	12,69	0,262	12,178	13,209

The adjusted values of wool length indicators for groups of Daughters of individual studrams were within 95% confidence intervals of reliable probability. At the same time, they changed in the offspring of RAM No. 1579 and No. 1625 due to the correction for the influence of the feeding level factor against the average data in Table. 3 by about 2%. As in the case of wool cutting, the offspring of the first Ram changed in the direction of growth, and the second – a decrease. In the remaining groups of offspring, changes were only in the range of 0.3-0.9 %.

When comparing the average adjusted values of wool length indicators in the Daughters of individual sheep, it was found (Table. 10) that the outsiders are the descendants of RAM No. 4464, who were inferior to their peers received from other studrams.

At the same time, the difference ranged from 5.2% to 13.0% and turned out to be significant with the Daughters of studrams No. 1823; 1579 and 1625 (p < 0.001), and with the Daughters of studrams No. 9510 – at the trend level.

Table 10.

Differences between estimates of adjusted average coat length values in Daughters of different sheep parents

Ram-father No. 1 (B1)	Ram-father no. 2 (B2)	difference between the length of hair in Daughters of sheep-parents, CM		significance level lower limit	95% confidence interval, sm	
		average difference B1-B2	standard error difference		lower limit	upper limit
1579	1625	0,235	0,287	0,413	-0,329	0,800
	1823	-0,404	0,280	0,149	-0,954	0,146
	4464	1,159*	0,284	0,000	0,600	1,717
	9510	0,527	0,334	0,116	-0,131	1,184
1625	1823	-0,639	0,271	0,019	-1,172	-0,106
	4464	0,923*	0,278	0,001	0,377	1,470
	9510	0,292	0,327	0,374	-0,352	0,935
1823	4464	1,563*	0,271	0,000	1,030	2,095
	9510	0,931*	0,322	0,004	0,298	1,564
4464	9510	-0,632	0,327	0,054	-1,275	0,012

The parameters of the developed model for predicting the live weight of due to the influence of factors of the Ram genotype, feeding level, as well as their interaction are shown in Table 11.

Table 11.

Model for predicting live weight in Daughters of different sheep based on estimates of the influence of factors "Studram", "feed consumption" and "Studram" × feed consumption"

Factor characteristics	value of factor characteristics	fixed effect / regression coefficient		Signifi-cance level
		B	standard error	
	Free member	-13,169	28,408	0,643
Ram	№ 1579	-98,700	36,131	0,007
	№ 1625	-11,822	35,592	0,740
	№ 1823	-38,219	38,739	0,324
	№ 4464	-9,424	35,530	0,791
	№ 9510	0		
Feed consumption		14,515	5,976	0,016
Ram × feed consumption	№ 1579 × feed consumption	20,517	7,633	0,007
	№ 1625 × feed consumption	2,600	7,470	0,728
	№ 1823 × feed consumption	8,071	8,153	0,323
	№ 4464 × feed consumption	2,287	7,491	0,760
	№ 9510 × feed consumption	0	-	-

This model satisfactorily ($R^2 = 0.232$; R^2 adj = 0.215) and reliably (p < 0.001) describes the main relationships that occur between the estimates of sheep parents and feed costs, on the one hand, and the live weight of sheep, on the other.

At the same time, the factor of feed consumption, as well as the clipping and length of wool, had a predominant effect on the manifestation of live weight in 14-month-old gimmers. Its value was $\eta^2 = 17.9\%$; and it was probable (p< 0.001). The influence of the sheep genotype and the interaction of factors "Studram" x "feed consumption" on the studied trait was approximately the same (respectively, $\eta^2 = 3.0\%$ and $\eta^2 = 2.8\%$) and was likely (p <0.05 in both cases).

Table 12.

Indicators of marginal average live weight values of Daughters of different sheep, adjusted for feed consumption

Studram	live weight of gimmers, kg		95% confidence interval	
	mathematical mean (M)	standard error (m)	lower limit	upper limit
№ 1579	54,16	0,890	52,412	55,913
№ 1625	56,12	0,844	54,465	57,782
№ 1823	55,66	0,790	54,102	57,209
№ 4464	57,04	0,827	55,413	58,665
№ 9510	55,62	1,106	53,448	57,798

The indicators of live weight values adjusted for feed consumption underwent the greatest changes (an increase against the given average values in Table. 3) only in the descendants of RAM No. 1579 – by 2.8 %. In the remaining groups of gimmers, these changes ranged from only 0.2 to 1.2%, mainly in the downward direction. As a result of the adjustment, the Daughters of Ram No. 1625 lost their priority position, and their difference of 3.6% with their peers, descendants of Ram No. 1579 became unlikely. The absence of a statistically likely difference in live weight, as well as in hair cutting and coat length revealed in this way can be considered natural, since these two studrams are complete siblings (born as part of same-sex twins).

But it was established that the largest in terms of live weight were the Daughters of Ram No. 4464. they exceeded their peers, whose parents were other sheep by 1.6-5.3 %. However, this advantage was only likely for the descendants of Ram No. 1579 (p<0.05). This feature of the descendants of Studram No. 4464 is natural, since it belonged to the merinolandschaf breed, the leading genetically determined feature of which is a large living weight.

It was also found that the correlation between the live weight of young sheep and feed costs during their rearing period is positive and average, r = 0.439; p < 0.001.

Discussion. Analyzing the scientific reports of many researchers given in the introductory part of the article, it should be noted that the level of feeding of farm animals of various species is considered by them among the most powerful paratypical factors affecting the implementation of genetically determined productivity indicators in animals. The methodological approaches we have chosen to solve the problem fully agree with the conclusions of McLaren A., Brotherstone S., Lambe N.R. et al. (2015), on the need for clear identification of environmental factors and quantitative assessment of their impact on animal productivity. As such a factor, we determined a quantitative indicator of the average annual feed consumption for the year in which young sheep were raised. As for productivity indicators, we have identified a wide range of characteristics, among which

the most important are live weight, clipping and coat length. In most studies, the above problem is considered mainly in relation to determining the impact on the live weight indicators of young sheep in different age periods (Mallick P.K., Pourouchottamane R., Rajapandi S. et al. (2017); Rather M.A., Shanaz S., Ganai N.A. et al. (2020); Abebe A., Banarjee S., Goshmie S. et al. (2020); Wang W., Zhang X., Wei H. et al. (2024)). Our research shows that the overall level of annual feed consumption is a more influential factor in the formation of the main breeding trait of spring precos breeds at the age of 14 months than the genotype of their parent sheep. The effect of feeding levels on the manifestation of live weight, clipping, and coat length in animals was likely and ranged from 17.9% to 26.2 % (p<0.001 for all traits). The share of influence of the father Ram genotype on the same indicators of offspring was significantly lower, and amounted to 3.0 % (live weight), 4.5 % (woolclip) and 8.3 % (wool length), respectively. The advantage of feeding factor influence over genotype influence determined by US is consistent with the scientific results of Santos-Silva J., Mendes I.A, Bessa R.J.B (2002). At the same time, although the influence of the factor of the genotype of the Studram was lower, it was also vigorid, which is consistent with the results of studies by Kramarenko S., Luhovyi S., Balan D. et al. (2020), Rather M.A., Shanaz S., Ganai N.A. et al. (2020), regarding the live weight of lambs in different age periods of their rearing. The probable effect of the interaction of feeding factors and genotype on the living mass of gimmers is also revealed by US, which is consistent with the results of Vashchenko P. A., Zhukorskyi O. M., Saenko A. M. et al. (2023), who, using the example of young pigs, note that such an impact is manifested at an older age of animals.

Significant variability in the results of evaluating studrams based on the performance indicators of their offspring, which was noted in their Rather m studies.A., Shanaz S., Ganai N.A. et al. (2020) and Trapina I., Kairisa D. and Paramonova N. (2023) is also confirmed by the low indicators of rank correlation of scores of offspring of individual sheep raised in years with different feeding levels. At the same time, adjusting the results of this assessment for the influence of the feeding factor allows us to identify both individual studrams whose genotype is stable against the influence of this factor, and studrams whose genotype is plastic. Studrams with genotypes that are resistant to the influence of feeding factors, through selection and widespread use, will contribute to the formation of a herd with less sensitivity to the influence of this factor and can be objects for further evaluation and identification of genes that are associated with the effectiveness of feed use, or with stress resistance to the influence of reduced feeding levels in sheep.

Conclusions.

1. An increase in the average annual feed consumption in the range of 4-6% per year provides a likely increase in the live weight of gimmers at the age of 14 months from 6.7 to 11.6 %, woolclip – by 15.1-16.1 %, wool length – by 6.4 – 16.0%. (p<0.001 in all cases), but it has a different effect on the disclosure of the potential of individual breeding traits in the offspring of individual sheep.

2. The different number of offspring obtained and evaluated from individual Studram, the rearing of which occurred in years with different annual feed costs, negatively affected the indicators of rank correlation (r ± mr) of their estimates. It ranged from 0.600±0.462 to 0.900±0.252 and was the highest in terms of the complex of signs of productivity of offspring whose cultivation in adjacent years occurred at an increased level of feeding.

3. It is established that the indicators of average annual feed consumption in the cultivation and evaluation of offspring have a positive, average correlation (r) with the main features of their productivity: live weight 0.439, clipping and wool length, respectively, 0.487 and 0.505 (reliable for all signs).

4. It is proved that the influence of genotypes of Studram (η^2) on the formation of live weight, clipping and wool length in their daughters was 3.0, 4.5 and 8.3%, respectively (in all cases p < 0.001), while the factor of annual feed consumption had a significantly greater impact force, respectively 17.9, 26.4 and 26.2% and was also highly likely. The interaction of these two factors (genotype x feed consumption) was significantly lower in its influence – 2.8 %, but remained probable, p< 0.05.

5. In order to predict the parameters of individual characteristics of offspring productivity, it is recommended to use appropriate mathematical models that take into account the complex influence of the Ram genotype and the level of feed consumption on them. The results obtained indicate that the genotype of Ram No. 1823 is stable in terms of transmitting its hereditary qualities to offspring in changing conditions of providing them with food, while the genotype of Ram No. 1625 and especially No. 1579 is plastic.

References

Abebe A., Banarjee S., Goshmie S., Bisrat A., Abebe A., Besufikad S., Zewdie T. and Gizaw S. (2020). Selection efficiency for growth performance of Menz sheep in a community-based breeding program. Livestock Research for Rural Development, 32 (9); http://www.lrrd.org/lrrd32/9/ascha32152.html (from 25.07.2025)

Berghof T.V.L., M.Poppe, and H.A. Mulder (2019). Opportunities to improve resilience in animal breeding programs. *Front. Gene.* Vol. 9; https://doi.org/10.3389/fgene.2018.00692

Biriukova O., Polupan Yu., Melnyk Yu., Kruhliak A., Kovalenko H., Kruhliak T., Makovska N. (2024). Analitychna zapyska «Vplyv metodu otsinky pleminnoi tsinnosti buhaiv na tempy polipshennia hospodarsky korysnykh oznak molochnoi khudoby» [Analytical note "The influence of the method of assessing the breeding value of bulls on the rate of improvement of economically useful traits of dairy cattle"]. Chubynske : IRHT im. M.V. Zubtsia NAAN, 24 s. (in Ukrainian) (from 25.07.2025) file:///C:/Users/user/Downloads/Anal.Bir.2024.pdf

Colditz I.G., Hine B.C. (2016). Resilience in farm animals: Biology, management, breeding and implications for animal welfare. *Anim. Prod. Sci.* 56:1961–1983; https://doi.org/10.1071/an15297

Falconer D.S. (1990). Selection in different environments: effects on environmental sensitivity (reaction norm) and on mean performance. Genetical Research. 56(1):57-70; doi:10.1017/S0016672300028883

Gross N., Taylor T., Crenshaw T., Khatib H. (2020). The Intergenerational Impacts of Paternal Diet on DNA Methylationand Offspring Phenotypes in Sheep. Front. Genet. 11:597943; https://doi.org/10.3389/fgene.2020.597943

Instruktsiia zi shtuchnoho osimeninnia ovets i kiz, zatverdzhena nakazom Ministerstva ahrarnoi politky Ukrainy vid 13.12.2002 r № 395 [Instructions for artificial insemination of sheep and goats, approved by order of the Ministry of Agrarian Policy of Ukraine dated 13.12.2002 No. 395]. (in Ukrainian). https://ips.ligazakon.net/document/REG7426?an=1279 (from 29.07.2025)

Jong G., Bijma P. (2002). Selection and phenotypic plasticity in evolutionary biology and animal breeding. Livestock Production Science. Vol. 78, Is. 3, 195-214; https://doi.org/10.1016/S0301-6226(02)00096-9

Joshi P. (2022). Nutrition and reproduction in sheep. Food & Agribusiness Management (FABM) 3(2): 48-52; http://doi.org/10.26480/fabm.02.2022.48.52

Knap P.W. (2005). Breeding robust pigs. *Australian Journal of Experimental Agriculture* 45(8) 763-773; https://doi.org/10.1071/EA05041

Kramarenko S., Luhovyi S., Balan D., Zemoglyadchuk K. (2020). The effects of breed, sire and environmental factors on the birth and weaning weight of lambs. *Ukrainian Black Sea Region Agrarian Science*, 24(4), 70-78; http://doi.org/10.31521/2313-092X/2020-4(108)-9

Mallick P.K., Pourouchottamane R., Rajapandi S., Thirumaran S. M. K., Venkataraman R., Nagarajan G., Rajendiran A. S. (2017). Influence of genetic and non - genetic factors on growth traits of Bharat Merino sheep in sub-temperate climate of Kodai hills of Tamil Nadu, India. *Indian Journal of Animal Research,* 51(2), 365-370; https://doi.org/10.18805/ijar.10979

Mc Laren A., Brotherstone S., Lambe N.R., Conington J., Mrode R., Bunger L. (2015).The effects of different farm environments on the performance of Texel sheep, *Animal,* Vol. 9, Is. 10: 1624-1634; https://doi.org/10.1017/S1751731115001123

Nel C. L., Werf J. H. J., Rauw W. R., Cloete S. W. P. (2023). Challenges and strategies for genetic selection of sheep better adapted to harsh environments, *Animal Frontiers*, Vol. 13, Is. 5: 43–52; https://doi.org/10.1093/af/vfad055

Rather M.A., Shanaz S., Ganai N.A., Hamadani A., Alam S., Khan N.N., Baba A., Raja T.A., and Bukhari S.(2020). Genetic and non-genetic factors affecting growth and reproduction traits in Kashmir Merino sheep. *Indian Journal of Animal Sciences* 90 (6): 950–953; https://doi.org/10.56093/ijans.v90i6.105014

Rauw W.M., and Gomez-Raya L. (2015). Genotype by environment interaction and breeding for robustness in livestock. *Front. Genet.* 6.: 1-15; https://doi.org/10.3389/fgene.2015.00310

Santos-Silva J., Mendes I.A, Bessa R.J.B (2002). The effect of genotype, feeding system and slaughter weight on the quality of light lambs: 1. Growth, carcass composition and meat quality. *Livestock Production Science,* Vol. 76, Is. 1–2: 17-25; https://doi.org/10.1016/S0301-6226(01)00334-7

Tillquist N.M., Kawaida M.Y., Reiter A.S., Bassani V.V., Bosco J.M., Bettencourt A.B., Gifford R.J., Engle T.E., Zinn S.A., Govoni K.E., Reed S.A. (2025).Effects of restricted- and over-feeding during gestation on colostrum and milk composition and offspring circulating immunoglobulin G concentrations in multiple generations of sheep. *Small Ruminant Research.* Vol. 243, 107423; https://doi.org/10.1016/j.smallrumres.2024.107423.

Tillquist N.M., Reed S.A., Reiter A.S., Kawaida M.Y., Lee E.C., Zinn S.A., Govoni K. E. (2024). Effects of poor maternal diet during gestation are detected in F2 offspring. *Translational Animal Science,* Vol. 8, txae055; https://doi.org/10.1093/tas/txae055

Tortereau F., Marie-Etancelin C., Weisbecker J.-L., Marcon D., Bouvier F., Moreno-Romieux C., François D. (2020). Genetic parameters for feed efficiency in Romane rams and responses to single-generation selection. *Animal,* Vol. 14, Is. 4, 681-687; https://doi.org/10.1017/S1751731119002544

Trapina I., Kairisa D. and Paramonova N. (2023). Comparison of sire rams of the Latvian Dark-Head breed according to feed efficiency indicators as the beginning of genomic breeding research. *Agronomy Research,* 21(S2), 598–610; https://doi.org/10.15159/AR.23.030

Vashchenko P. A., Zhukorskyi O. M., Saenko A. M., Khokhlov A. M., Usenko S. O., Krykhyna N. V., Sukhno T. V., Tsereniuk O. M. (2023). The influence of feeding level on the growth of pigs depending on their genotype. *Regulatory Mechanisms in Biosystems*, 14 (1), 112–117; https://doi.org/10.15421/022317

Vdovychenko Yu.V., Kudryk N.A., Polska P.I. et al. (2018). Metodolohiia otsinky pleminnoi tsinnosti ta henetychnykh zmin v populiatsii ovets riznykh napriamiv produktyvnosti [Methodology for assessing breeding value and genetic changes in sheep populations of different productivity areas]. Nova Kakhovka: PIEL: 79 s. (in Ukrainian).

Wang W., Zhang X., Wei H., Wang S., Ye Y., He L., Zhang K., Lu Y., Zhang Z. and Huang Y. (2024). Effects of Feeding Systems on the Growth Performance, Carcass Characteristics, and Meat Quality in Sheep: Meta-Analysis. *Animals*, *14*(18), 2738; https://doi.org/10.3390/ani14182738