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Piglet survival and pre-weaning mortality: The effect of breed, stability, and plasticity under varying housing and feeding conditions

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Abstract. The paper presents the results of a comparative analysis of the adaptive properties of Welsh and Landrace pigs based on three key economically useful traits: the number of piglets in the litter at weaning, piglet pre-weaning mortality during the suckling period, and piglet survival during the suckling period. The purpose of the study was to determine the level of stability and plasticity of the analysed economically useful traits in changing conditions of housing and feeding. In this case, the values of the studied traits in these six generations of piglets were used as environmental indices. The research was based on data on 822 litters of suckling piglets

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obtained in 2015-2024 from six generations of pigs. The animals were kept under traditional feeding and breeding conditions at Shubske Farming Enterprise LLC. The variability of the environment was formed under the influence of changes in feeding, technological, and organisational factors in the farm. To estimate the adaptive parameters, the Eberhart-Russell method was used, which determined the plasticity coefficient (b_i) and the stability index (S^2d_i) of the studied traits. Statistical processing was performed using the SPSS Statistics-22 package. The results obtained showed significant breed differences. Thus, Landrace pigs showed the best average values of all the indicators considered, in particular, a significantly higher survival rate of piglets ($p < 0.001$). However, Welsh pigs showed significantly greater plasticity in terms of survival ($b_i = 1.36$), indicating their increased sensitivity to changes in housing and feeding conditions, while in Landrace pigs this indicator was only $b_i = 0.57$. In terms of survival stability, Welsh pigs were also inferior, characterised by a higher residual variance ($S^2d_i = 58.48$ vs. 34.03 in Landrace). Based on the obtained data, a statistically significant regression model for assessing the survival of Welsh piglets was constructed ($p = 0.005$). The results of the study can be used to optimise breeding programmes and select breeds for specific production conditions

Keywords: suckling piglets; Landrace breed; Welsh breed; environment index; milk feed; regression

INTRODUCTION

The effectiveness of pig breeding is largely determined by a balanced selection of breeds that optimally meet specific production conditions and consumer market requirements. For the correct assessment of reproductive, productive, and adaptive traits of pigs from different genetic groups, it is also advisable to control a number of environmental conditions, in particular housing and feeding, including the state of technology at the farm level or external socio-economic factors in the country. This approach allows correctly assessing and predicting the effectiveness of using genetic groups in specific environmental conditions. This approach has been emphasized by several researchers. According to M. Aparicio *et al.* (2024), feeding sows during gestation and lactation, and primarily the balance of energy and nutrients in their diet, affects birth weight, milk production and colostrum quality, and consequently piglet survival. There is also evidence to support the effectiveness of measures that increase and stabilise early intake of feed other than mother's milk by piglets (e.g., the use of starter mixtures before and after weaning). In addition, according to M. Wensley *et al.* (2021), early introduction to starter feed is also important. Simultaneously, O. Korzh (2025) argued that along with the feeding system, the housing conditions also significantly affect the realisation of the genetic potential of pigs, which is expressed in their productivity. Deviations from recommended management practices, husbandry, feeding regimes, microclimatic parameters, and veterinary standards usually negatively affect the economically useful characteristics of animals. In turn, A. Kramarenko *et al.* (2023) conducted empirical studies of the causes of perinatal mortality and risk factors. The influence of farrowing order, piglet weight, parity, season and breed on the risk of stillbirths has been established. In addition, R. Shvachka (2021) showed the influence of local factors, such as climate, feeding and housing conditions, and farm structure, on the piglet survival. The researchers emphasised the expediency and necessity of adapting international approaches and recommendations (for example, regarding the optimal age of weaning, perinatal management measures) to local conditions.

The study by R. Zaalberg *et al.* (2022) showed that infectious factors such as enteritis, staphylococcal and viral infections, etc., significantly increase mortality risks. But the practices of implementing appropriate veterinary measures, such as vaccination and biosafety programmes, and early diagnosis of diseases, are important components of loss prevention, and therefore confirm their high feasibility and effectiveness. In addition, B. Tucker *et al.* (2021) noted that management and environmental factors play an equally important role. In particular, farrowing and perinatal management conditions can either promote good piglet survival (with a high level of care) or lead to significant losses in livestock numbers. It was also proven that clear control of temperature, hygiene of the farrowing site, cross-fostering of piglets, and access to colostrum reduce the pre-weaning mortality of piglets. Reviews of management practices emphasised that standardised perinatal care protocols are most effective in reducing the gap between breeds and farms. The age of weaning is also an important factor.

One of the significant problems of pig breeding, according to B. Tucker *et al.* (2021) and R. Zaalberg *et al.* (2022), remains high piglet mortality: under commercial conditions, it typically ranges from 8% to 20% depending on the country, breed, feeding and housing conditions, management, genetic potential of the animals, and other factors. This economically useful trait has a direct economic impact on the efficiency of pig farming, as it largely determines the overall productivity of the herd, and a reduction in piglet mortality results in lower production losses. Pre-weaning mortality also varies significantly between farms. Among the biological and genetic factors that more or less determine the value of the studied trait, the weight of piglets at birth, and their morphometric indicators also play an important role. Low birth weight is associated with poor thermoregulation, difficult access to colostrum, and increased mortality. However, simple morphometric indicators (chest circumference, torso length) can sometimes be more accurate predictors of viability than weight itself. Currently, in addition to birth weight, studies suggest considering complex morphometric indicators and early behavioural or physiological traits (skin temperature, behavioural responses) as more reliable predictors of survival. This helps to more accurately control the conditions for raising piglets (heat lamps, cross-fostering, supplementary feeding), identify risk groups at an earlier stage, and thus promptly intervene to provide them with appropriate care.

Thus, the study of indicators of pre-weaning piglet mortality and factors that affect it remains a relevant area of modern pig breeding. The key variables that determine the level of survival of young animals are considered to be the breed, genetic potential, feeding conditions, housing system, and biological characteristics of animals. Moreover, contemporary research in the field of pig breeding pays considerable attention not only to the analysis of average reproductive and productive traits, but also to their variability under different conditions of housing and feeding. Insufficient attention was paid to the analysis of stress resistance, plasticity, and stability of economically useful traits of pigs of different genetic groups. Therefore, the purpose of the study was to determine the level of stability and plasticity of the number of piglets in the litter at weaning, piglet mortality during the suckling period, and piglet survival during the suckling period under variable conditions of housing and feeding.

MATERIALS AND METHODS

The study used data on 822 litters of piglets from Shubske Farming Enterprise LLC, which belonged to the Welsh (444 litters) and Landrace (378 litters) breeds. The piglets were reared under conventional suckling management with their sows until two months of age, after which they were weaned. Information on the results of rearing was recorded during 2015-2024; during this time, 6 generations of pigs were studied. The conditions of housing and feeding during the controlled period changed under the influence of both on-farm (compound feed composition, state of the economy, etc.) and national (economic, military situation, etc.) factors. Concurrently, technological and organisational elements of production were improved. In the end, seasonal and climatic fluctuations also significantly affected the process of raising piglets. In order to assess the adaptive properties of sows of the compared breeds, a mathematical model was applied, which was proposed by K. Finlay & G. Wilkinson (1963). Later, this model was slightly improved and supplemented by S. Eberhart & W. Russel (1966). It was used by the authors to assess the plasticity and stability of agricultural plant varieties. Several authors have utilised this model to determine the adaptive capabilities of agricultural animal breeds. In particular, E.G. Camargo *et al*. (2020) used it to evaluate the plasticity and stability of litter size and uniformity in Landrace pigs. In general, the model defines parameters of plasticity and stability that can be used to describe the productivity of breeds, lines, families, crossbreeds, and other genetic groups of animals in a number of environments. In the final form in this paper, the Eberhart-Russell model appeared as follows:

$$Y_{ij} = \mu_i + b_i I_j + \delta_{ij}, \quad (1)$$

where Y_{ij} – average value of the economically useful trait of the i-th breed in the j-th environment; μ_i – average value of the economically useful trait of the i-th breed in all environments; b_i – regression coefficient, which measures the degree of reaction (plasticity) of the i-th breed to various environments; δ_{ij} – deviation from the regression of the i-th breed in the j-th environment; I_j – environment index (average value of the economically useful trait in the j-th environment).

Therefore, the Eberhart-Russell method was based on calculating the linear regression coefficient (b_i) of individual values of the studied trait (a dependent variable, for example, the number of piglets at weaning) on the environment index. As an index of the environment (predictor), the average indicators of the same studied trait were used, but separately for each generation of pigs (a total of 6 generations were controlled). In this case, the regression coefficient b_i indicates the level of plasticity of this feature in the analysed breed, and the residual variance S^2d_i indicates the level of stability, respectively. As effective evaluated economically useful traits in this study, "piglet mortality for the period from birth to weaning (heads)", "number of piglets at weaning (heads)", and "piglet survival rate during the suckling period (%)" were used.

The suckling period was considered as the time interval from the birth of piglets to their weaning.

Piglet survival was determined as the percentage ratio of the number of animals that survived to weaning to the number born alive. Piglet pre-weaning mortality was calculated by recording the number of dead animals for the entire suckling period. The pre-prepared data was processed using the SPSS Statistics-22 application software suite. This application used built-in regression and variance analysis procedures. For each breed, the values of the plasticity coefficients (b_i) and stability coefficients (S^2d_i) were determined, which were used for further comparison. For each calculated parameter, the standard error, t-criterion, p-level of significance, and 95% confidence intervals were determined. To this end, the values of the corresponding environment (generation) indices I_j for each economically useful trait being evaluated were first calculated and then added to the database. To do this, the SPSS procedure "Analyse → Compare Means → Means" was used, selecting the actual evaluated feature and the grouping factor of the environment – generation.

Regression assessment was performed for each breed separately by applying the "Analyse → Regression → Linear" procedure, indicating the estimated economic and useful trait as a dependent variable ("Dependent"), and the environment index – as an independent ("Independent"). The "Statistics" tab provided for activating the "Durbin-Watson", "Confidence intervals" and "R squared change" ratings. Therefore, using the SPSS application package, separate regression models were calculated for each breed, including the values of regression coefficients b_i and residual variances S^2D_i. To assess the degree of influence of factors in the analysis of variance, the η^2 indicator was used. The statistical significance levels of all indicators evaluated in the model were calculated and then checked. The results were considered statistically significant at $p < 0.05$. All animal handling procedures were fully compliant with European legislation (Council Directive 98/58/EC, 1998).

RESULTS AND DISCUSSION

Stability and plasticity of adaptive traits of piglets and their prediction

At the first stage of research, a series of analyses of variance (ANOVA) of the influence of the breed on such economically useful features as "piglet mortality for the period from birth to weaning (heads)", "number of piglets at weaning (heads)" and "piglet survival in the suckling period (%)" were conducted. The results are presented in Table 1.

Table 1. *Main statistical characteristics of the influence of breed on the economic traits of pigs of different breeds*

Breed	Statistical indicators	Economically useful traits		
		Number of piglets in the litter at weaning, heads	Survival rate of piglets during the suckling period, %	Piglet mortality for the period from birth to weaning, heads
Landrace	Number of litter	378	378	378
	Arithmetic mean	11.83	87.81	1.68
	Standard error of the arithmetic mean	0.06	0.30	0.05
	Standard deviation	1.13	5.83	0.88
Welsh	Number of litter	444	444	444
	Arithmetic mean	11.32	83.47	2.30
	Standard error of the arithmetic mean	0.06	0.36	0.06
	Standard deviation	1.20	7.66	1.18
Total	Number of litter	822	822	822
	Arithmetic mean	11.55	85.47	2.02
	Standard error of the arithmetic mean	0.04	0.25	0.04
	Standard deviation	1.19	7.21	1.10

Source: *developed by the authors based on the research presented in this paper*

It was found that the adaptive traits under study differed significantly depending on the breed. In particular, it can be stated that pigs of the Landrace breed were significantly better ($p < 0.001$) in all analysed characteristics compared to animals of the Welsh breed. However, the highest degree of influence of the breed ($\eta^2 = 9.0\%$) was recorded on the survival rate of piglets during the suckling period. Belonging to a particular breed can explain only 4.5% of the variability in the number of piglets in the litter at weaning and 8.0% of the variability in piglet mortality from birth to weaning. Notably, over time, for the most part, there was a tendency for some improvement in the analysed economically useful traits. However, a statistically significant effect of generation was found ($p = 0.014$) only in relation to the number of piglets in the litter at weaning (heads). The degree of this impact was $\eta^2 = 1.7\%$. Possible differences in the number of piglets in the litter during weaning (heads) were recorded between the maternal generation, on the one hand, and the third, fourth, or fifth generations, on the other, and between the first and fourth and first and fifth generations.

According to the Eberhart & Russell approach (1966) and its interpretation in animal husbandry (Shablia & Shablia, 2025), the regression coefficient (b_i) is a quantitative measure of genotype plasticity, reflecting the degree of change in the economically useful trait of animals in response to changes in environmental conditions. In the case of adaptive characteristics of piglets, this indicator determines the breed's response to changes in environmental parameters, primarily maintenance and feeding. If the plasticity index b_i of a particular breed or other genetic group is close to 1, it is characterised as medium plasticity, i.e., one in which the level of the studied economically useful trait fluctuates synchronously with fluctuations in conditions. Accordingly, the specified value of plasticity of the genetic group indicates satisfactory adaptability within the standard technological parameters of production. According to the values of $b_i > 1$, the breed (or genetic group) is classified as highly plastic, which indicates a pronounced sensitivity to changes in the conditions of keeping and feeding: an improvement in the environment in this case is accompanied by a significant improvement in the evaluated economically useful trait, while deterioration of conditions can lead to a noticeable deterioration of the trait. It is advisable to breed highly plastic genotypes in farms with good technological parameters, where conditions close to optimal for the manifestation of breeding inclinations of animals are created. When $b_i < 1$, the breed is characterised by low plasticity, which means relative stability of the economically useful trait regardless of fluctuations in environmental factors. Such animals are less demanding in terms of housing and feeding conditions, and also retain a certain level of the trait under study to a greater extent, even under stressful or unfavourable production conditions. In the course of the conducted studies, the presence of pronounced interbreeding differences in the plasticity indicator of the indicator "survival of piglets in the suckling period" was established (Fig. 1). As can be seen, Welsh piglets showed a more intense response to changes in conditions of keeping and feeding, which is reflected in the value of the regression coefficient $b_i = 1.36$, while in Landrace pigs this indicator was only $b_i = 0.57$.

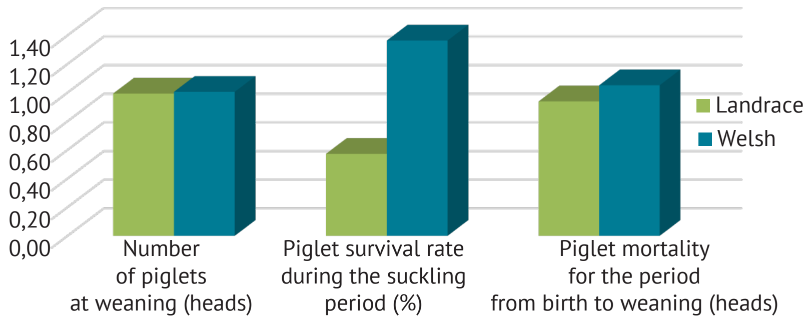

Figure 1. *Plasticity (b_i) of economically useful characteristics of Welsh and Landrace piglets*
Source: *developed by the author based on the research presented in this paper*

The data obtained indicate that Welsh pigs can be classified as highly plastic genotypes for the analysed trait, since the regression coefficient exceeds one. This means that the survival rate of piglets of this breed is significantly improved under conditions of optimal management, balanced feeding, and proper microclimate. However, under unfavourable conditions, Welsh pigs show a noticeable decrease in the survival rate of young animals, which indicates their increased sensitivity to external factors. Unlike Welsh pigs, Landrace pigs are characterised by low plasticity in terms of piglet survival before weaning. Thus, the regression coefficient is significantly lower than one, which indicates a weaker response to changes in environmental conditions. Thus, the survival rate of Landrace suckling piglets remains more stable even with fluctuations in the level of feeding, housing or microclimate, that is, this breed reacts less with this economically useful trait to both deterioration and improvement of conditions. This allows considering the survival rate of Landrace piglets as an indicator that fluctuates little with conditions, and the Landrace breed itself in this respect – as adapted more to extensive or unstable production systems, where the advantage is given to sustainable productivity, rather than maximum potential under favourable conditions.

Stability of adaptive traits of piglets and their prediction

But the Welsh breed, as a genotype that provides a certain survival rate of piglets from birth to weaning, is an appropriate choice for intensive growing technologies that involve a high level of feeding and care, because it is in such conditions that its genetic potential for this trait is most fully revealed. Comparative analysis of the regression lines of both breeds confirms these trends: Welsh pigs are characterised by a steeper slope of the regression line, which indicates greater reactivity to changes in the index of the environment, while Landrace pigs have a flatter line, which indicates less plasticity of the studied trait. Along with the regression coefficient (plasticity) b_i, an important element in assessing the response of genotypes to variable feeding and housing conditions (environment) is an indicator such as the stability of the trait under study. Within the Eberhart-Russell model, the stability of an economically useful trait is interpreted by the value of the residual variance of the analysed trait (S^2d_i), which characterises the degree of unpredictability of the genotype response (a certain breed of pigs in these studies) to changes in feeding and housing conditions.

The interpretation of this indicator is carried out according to the following principles: (1) low residual variance (S^2d_i) indicates a high stability of the trait, its relatively small individual deviations from the regression line, and therefore, the ability of the breed to maintain in general the relative proximity of individual values of the trait to those predicted by the regression model based on the indices of the environment. (2) High S^2d_i values, on the contrary, indicate low stability, which means increased variability in the genotype's response to external influences, more significant individual deviations of the trait from the regression line, and, accordingly, lower predictability of results under different technological conditions. Notably, the value of the residual variance S^2d_i depends on the measurement scales and the features of variation of the evaluated traits. Therefore, it is correct to conduct a comparative assessment of stability only when considering the same trait of animals of different genetic groups. That is why, within the scope of this study, comparing the stability of each of the economically useful traits separately for each breed is methodologically justified.

When it comes to estimating the stability (residual variance) of traits of different nature, it is advisable to use relative values of these traits or dimensionless coefficients to avoid distortions associated with the difference in the scale of variation. The analysis performed so far showed that Welsh suckling piglets were characterised by a higher residual survival variance ($S^2d_i = 58.48$) than Landrace pigs ($S^2d_i = 34.03$). This indicates greater individual deviations of the actual survival values of Welsh piglets from the regression line, and a lower level of predictability of this trait (Fig. 2).

Figure 2. *Stability (S^2d_i) of the survival rate (%) of suckling piglets of different breeds*

Source: *developed by the authors based on the research presented in this paper*

The data obtained indicate that the response of Welsh piglets to changes in environmental conditions is less stable. Their survival rate from birth to weaning shows wider fluctuations in response to changing feeding and housing conditions. This may indicate a more noticeable influence of uncontrolled factors on the development of the trait under study, or a lower resistance of the genotype to changing conditions. Consequently, Welsh suckling piglets are characterised by increased sensitivity and a significant amplitude of changes in the survival rate in response to changes in environmental conditions, which is accompanied by a noticeable variability of this economically useful trait. Considering the identified adaptive characteristics, a statistically reliable regression model was constructed to estimate the number of weaned piglets (heads) of the Welsh breed (Table 2). The model had a high significance ($p = 0.005$) and an average level of explanatory power ($R^2 = 0.017$).

Table 2. *Model for estimating the number of weaned piglets (heads) of the Welsh breed*

Predictor (x)	Regression coefficient			Student's t-test	Significance level p	95.0% confidence interval for b	
	Simple b (%/%)	Standard error b (%/%)	Standard β, (sy/sx)			Lower limit	Upper limit
Constant	-0.298	4.154		-0.072	0.943	-8.462	7.866
Environment index (generations), heads	1.006	0.360	0.132	2.797	0.005	0.299	1.712

Source: *developed by the authors based on the research presented in this paper*

The obtained parameters allow using this model as a tool for analysing the impact of changes in environmental conditions on the number of weaned Welsh piglets, and for predicting this trait in conditions of unstable technological factors. With regard to such an adaptive trait as "number of piglets in the litter at weaning, heads", the differences between the residual dispersions (stabilities) for the studied breeds were insignificant; they amounted to $S^2d_i = 1.41$ for Welsh pigs and $S^2d_i = 1.26$ for Landrace pigs. However, there were greater differences in terms of "piglet mortality from birth to weaning": $S^2d_i = 1.39$ for Welsh pigs and $S^2d_i = 0.77$ for Landrace pigs. Thus, it is possible to state more significant deviations of the analysed traits from the regression line for the Welsh breed compared to Landrace, which indicates their lower stability. However, it was not possible to develop reliable models for assessing characteristics such as "piglet survival during the suckling period" and "piglet mortality from birth to weaning" given the statistical parameters of the sample.

Comparison of the results obtained with data from other studies

Comparing the results with the data of other researchers, it is worth highlighting three aspects: firstly, it is the applicability and effectiveness of evaluation methods; secondly, the justification and correctness of attracting certain factors and economically useful traits to the model; thirdly, the actual results of evaluation. As for the estimation methods, it should be noted that the Eberhart-Russell model used in the study is a classic and simple way to estimate plasticity and stability on a single medium index. Modern reaction norm models (RNM) are an extension of the same idea and methodology to multidimensional environments, allowing for a deeper understanding, assessment, and prediction of the reaction of economically useful traits, taking into consideration the complex gradient of environmental factors.

According to P. Freitas *et al.* (2024), who examined the effect of a number of variables on the manifestation of the "genotype × environment" interaction in pigs, reaction norms help to better describe the variation of productive traits in genetic groups under different environmental conditions, if the interaction of the genotype with the environment is evaluated, including several traits or reaction norms in the model. According to the researchers, this may slightly improve the performance of the model, although to get an acceptable level of probability, it is usually necessary to significantly increase the sample size and improve its quality. Meanwhile, the "generations" used in these studies as environmental indices allow simultaneously assessing the complex impact of a wider range of environmental factors at the level of simpler models at an acceptable level of probability. H. Song *et al.* (2020) also showed that models of reaction norms, taking into consideration the "genotype × environment" interaction (G × E, which are conceptually equivalent to the Eberhart-Russell models), improve the prediction of genetically determined economically beneficial traits, such as the average daily gain and backfat thickness in genomic selection, demonstrating the practical implementation of the plasticity of genetic effects across environments.

In turn, H. Pham *et al.* (2025) proposed a simplified use as an environmental index of geographical and climatic conditions (with two gradations – "temperate" and "tropical humid" climate), especially for the reproductive characteristics of pigs, where the resistance of the genotype to environmental stress factors is key. Thus, these researchers use a model that is simpler than in the presented study, but emphasise its effectiveness. Therefore, it is more appropriate to use similar models with a minimum number of environmental indices to assess the plasticity and stability of genetic groups in well-defined contrasting gradations of conditions that change little over time. Testing by S.-Y. Chen *et al.* (2021) of compromise model organisation allowed the authors to conclude that it is advisable to use the so-called "quantitative environment gradient" to assess the environment. This environment index is an aggregate indicator that includes conditions of keeping, feeding, and management and, according to the researchers, allows determining how consistently genotypes of different genetic groups realise their potential under certain contrasting conditions. F. Tiezzi *et al.* (2020) suggest including directly into the models a set of several dozen environmental covariates obtained from public weather station records. This allows fully adjusting the results for the influence of a complex of climatic factors. Both of these approaches can also be used to deepen existing research, even if the volume of data is unprincipled.

Regarding the comparison of the results obtained in the presented studies of evaluating the actual indicators of plasticity and stability of various genetic groups with the conclusions of other authors, a certain similarity of the results can be stated. According to O. Tsereniuk *et al.* (2023), differences in plasticity and stability of different sows in the genetic groups of pigs of Landrace and Welsh breeds were found. In particular, significant fluctuations in the values of plasticity and stability of the indicator "number of weaned piglets" were demonstrated. According to the researchers, genetic factors and maternal effects are of great importance for pre-infant mortality in piglets. In particular, breed differences and maternal families affect the basic probability of piglet survival. Ultimately, some maternal families have higher milk production and better maternal behaviour, which increases the chances of survival of the offspring. However, estimating the average values of plasticity of this trait for all families, it is close to those established by current studies. These statements were supported by T. Chu *et al.* (2022) and K. Will *et al.* (2024), who argued that there was a significant genetic variation in pre-weaning mortality that poses both certain risks and the potential for breeding to improve these rates. In addition, J. Dekkers (2021) noted that breeding only for prolificacy without birth weight control can increase risks, which echoes the topic of this study, which aims to evaluate the expression of prolificacy during the suckling period. The researchers proposed to use multivariate and maternal models (animal models) to identify direct and maternal genetic effects on survival, which allow separately assessing the contribution of the offspring and mother.

These approaches are basic for breeding work and individual selection, but it is more appropriate to use the methods used in this paper to assess the response of a genetic group to changing conditions. This is exactly what E. Camargo *et al.* (2020) did, assessing the plasticity and stability of the size and uniformity of piglets in Landrace breed. In contrast to current research, K.-H. Lin *et al.* (2024) applied the reaction norm model to assess the effect of "genotype × environment" on Landrace reproductive traits under heat stress (temperature and humidity index), illustrating the plasticity and variability of genetic parameters under different microclimate conditions. This allowed assessing the adaptive potential of individual genetic groups of pigs, in particular, in relation to compensatory capabilities under stress factors. As in current studies, the findings of P. Shablia *et al.* (2025) showed that methods for assessing plasticity and stability should be actively used to predict reproducible and other economically useful traits. Thus, it has been established that the use of regression models based on fertility and preservation indicators allows breeds, lines, or families with high potential for heterosis to be identified.

CONCLUSIONS

It was found that the adaptive traits under study differed significantly depending on the breed. In particular, it can be stated that in general, pigs of the Landrace breed were significantly better ($p < 0.001$) in all analysed characteristics compared to animals of the Welsh breed. The highest degree of influence of the breed ($\eta^2 = 9.0\%$) was recorded on the survival rate of piglets during the suckling period. Belonging to a particular breed can explain only 4.5% of the variability in the number of piglets in the litter at weaning and 8.0% of the variability in piglet mortality from birth to weaning. Significant inter-breed differences were found in terms of the plasticity of the "piglet survival rate during the suckling period" indicator. As can be seen, Welsh piglets showed a more intense response of this trait to changes in conditions of housing and feeding, which is reflected in the value of the regression coefficient $b_i = 1.36$, while in Landrace piglets this indicator was only $b_i = 0.57$.

Welsh suckling piglets were characterised by a higher residual survival variance ($S^2d_i = 58.48$) than Landrace piglets ($S^2d_i = 34.03$). This indicates greater individual deviations of the actual survival values of Welsh piglets from the regression line, and a lower level of predictability of this trait. A statistically significant regression model was developed to estimate the number of weaned piglets (heads) of the Welsh breed. The model had a high significance ($p = 0.005$) and an average level of explanatory power ($R^2 = 0.017$). In further development of the presented studies, it is planned to evaluate other breeds and genetic groups of pigs for plasticity and stability of an expanded range of economically useful traits, using other organised environmental factors such as average piglet weight, age, air temperature, and daily weight gain. This will allow assessing the adaptive potential of genetic groups, in particular, their compensatory capabilities under the influence of stressful factors.

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Виживаність та відхід поросят до відлучення: вплив породи, стабільність і пластичність за змінних умов утримання й годівлі

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Анотація. У статті представлено результати порівняльного аналізу адаптаційних властивостей свиней порід уельс і ландрас за трьома ключовими господарсько-корисними ознаками: кількістю поросят у гнізді при відлученні, відходом поросят за підсисний період та виживаністю поросят у підсисний період. Метою дослідження було визначення рівня стабільності та пластичності аналізованих господарсько-корисних ознак у змінних умовах утримання й годівлі. При цьому значення досліджених ознак у цих шести поколіннях поросят було використано в якості індексів середовища. Матеріалом для досліджень слугували дані про 822 гнізда поросят-сисунів, отриманих у 2015-2024 роках від шести поколінь свиней. Тварин утримували в умовах традиційної технології годівлі й вирощування у ТОВ «ФГ «Шубське». Варіативність середовища формувалася під впливом змінювання годівельних, технологічних, і організаційних чинників у господарстві. Для оцінювання адаптаційних параметрів застосовано методику Ебергарта-Рассела, котра дозволила визначити коефіцієнт пластичності (b_i) та показник стабільності (S^2d_i) досліджуваних ознак. Статистичну обробку проведено з використанням пакета SPSS Statistics-22. Отримані результати засвідчили істотні породні відмінності. Так, ландраси продемонстрували кращі середні значення всіх розглянутих показників, зокрема достовірно вищу виживаність поросят ($p < 0,001$). Водночас поросята породи уельс виявили значно більшу пластичність за виживаністю ($b_i = 1,36$), що вказує на їх підвищену чутливість до змін умов утримання й годівлі, тоді як у ландрасів цей показник становив лише $b_i = 0,57$. За стабільністю виживаності уельси також поступалися, характеризуючись більшою залишковою дисперсією ($S^2d_i = 58,48$ проти 34,03 у ландрасів). На основі отриманих даних побудовано вірогідну регресійну модель оцінки виживаності поросят породи уельс ($p = 0,005$). Результати дослідження можуть бути використані для оптимізації селекційних програм та вибору порід під конкретні умови виробництва

Ключові слова: поросята-сисуни; порода ландрас; порода уельс; індекс середовища; молочні корми; регресія