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ТЕХНОЛОГІЯ ВИРОБНИЦТВА ТА ПЕРЕРОБКИ ПРОДУКЦІЇ ТВАРИННИЦТВА
TECHNOLOGY OF PRODUCTION AND PROCESSING OF LIVESTOCK PRODUCTS

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TESTING OF ENERGY-EFFICIENT FEEDING METHODS FOR BREEDING HERD PIGS UNDER CONDITIONS OF LIMITED FEED RESOURCES

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The study aimed to evaluate energy-saving feeding strategies for the main herd of pigs under conditions of limited feed resources, using the 'ideal protein' principle for boars and sows of various ages. **Methods.** The scientific and economic study was conducted in accordance with standard methods used in pig farming, involving first-litter sows of hybrid origin (F1 ½: Large White × Landrace) and terminal breeding boars. Control and experimental groups of animals were formed using the matched-pairs principle. Boars and sows in the control groups were fed standard balanced diets, whilst animals in the experimental groups were fed compound feed with a reduced crude protein content and an increased content of crystalline lysine, in accordance with the 'ideal protein' concept. Upon completion of the second lactation, sows in the control and experimental groups were fed identical standard diets. Reproductive performance and productive characteristics of the sows were assessed during farrowings I–IV. For breeding boars, feed intake was measured, body condition and reproductive capacity were assessed, and the survival rate of the breeding stock relative to the start of their use was determined. **Results**. An analysis of the reproductive capacity and productivity of sows under conditions of reduced protein intake, whilst optimising lysine levels by using a crystalline lysine supplement, revealed no significant deterioration or improvement in the parameters studied. However, for breeding boars, a crude protein deficiency, even when partially compensated for by lysine, had significantly more critical consequences, as spermatogenesis is one of the most amino acid-dependent biological processes in the pig's body. A significant deterioration was observed in sperm production parameters such as ejaculate volume and sperm concentration. **Conclusions.** Practical modelling and testing of energy-saving feeding strategies for the main herd of pigs (boars and sows of various ages) under conditions of limited feed resources have demonstrated that applying the 'ideal protein' principle to animals in these groups is entirely feasible, however, it should be regarded as a necessary measure for a short period – for example, one reproductive cycle of sows.
Keywords: pigs, feed shortage, energy-efficient feeding, crude protein, amino acid nutrition, reproduction, productivity, sows, breeding boars.

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Introduction. As is well known, modern pig production technology is based on three key components: genetics and breeding methods; feeding conditions; and housing conditions [1–3]. Moreover, considerable attention should be paid to the issue of feeding, as the influence of feeding on animal productivity accounts for 55–60 per cent, that of selection and breeding methods for 20–25 per cent, and that of housing conditions for 15–20 per cent; in other words, a balanced diet determines the realisation of the herd's inherent genetic potential on average and for each individual animal [4, 5].

Adverse environmental conditions during foetal development trigger an adaptive response in the foetus, known as 'foetal programming' (epigenetics), which can lead both to a lasting change in the organism's sensitivity to external factors and to permanent effects on the organism's phenotype. This forms the basis for the hypothesis that the offspring's transcriptome exhibits both short-term and long-term changes, depending on the mother's diet [6].

Research findings indicate that a significant restriction in protein intake during gestation and lactation substantially impairs the reproductive performance of sows. Indicators such as the percentage of sows showing signs of oestrus, the average number of days from weaning to the onset of oestrus, the average ovulation rate and the live weight of sows were significantly lower in animals with a low crude protein content in their diet. At the same time, this did not have a significant negative impact on conception rates or embryo survival up to 28 days post-insemination. Furthermore, the negative effect of a restricted crude protein level in the diet was more pronounced in replacement sows and sows undergoing testing compared with mature sows at their second farrowing and older. In the absence of an oestrous cycle in sows with a low crude protein content in their diet, oestrus and ovulation were induced by injections of hormonal preparations [7].

Ukrainian pig farms traditionally use standard cereal ingredients in their feed rations, such as wheat, barley, maize and, less commonly, rye and triticale. Each of these feed ingredients generally has both strengths and weaknesses when it comes to formulating appropriate pig diets, due to an imbalance in crude protein content and amino acid composition, which is insufficient to achieve high levels of productivity. Therefore, well-balanced rations must include high-protein components (peas, chickpeas, and high-protein industrial crops such as sunflower meal, soya meal and soya cake). Furthermore, modern approaches to diet optimisation involve the inclusion of a range of biologically active substances, such as macro- and micro-nutrients, vitamins, enzyme complexes, acidifiers in the form of organic acids, toxin adsorbents, and so on [5, 8, 9].

The current situation in the livestock sector, and in pig farming in particular, on a global scale, is driven by climate change in the form of global warming, which is leading to frequent droughts and low yields of a number of fodder and food crops. In Ukraine, this is compounded by military operations, which at the

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start of the war disrupted the basic logistics of supplying certain feed ingredients essential for high productivity, and consequently the composition of the feed base as a whole, as well as labour shortages, rising costs of fuel and lubricants, increases in other production costs, frequent further weakening of biosecurity in the sector, the occupation of territories, fluctuations in market prices for feed ingredients, and so on [10, 11]. All of the above requires modern technologists at pig production enterprises to promptly address a whole range of current pressing challenges aimed at developing and implementing various methods and approaches concerning key components of pig production technology, including genetics, breeding, selection, feeding conditions and husbandry [1, 2, 4, 12]. At the same time, given the current circumstances at pig farms, the issue of energy-efficient feeding remains crucial for ensuring an optimal level of productivity in the pig herd, which is what determines the relevance of the research we have selected.

The aim of the study was to evaluate energy-saving feeding strategies for the main herd of pigs under conditions of limited feed resources, applying the 'ideal protein' principle to boars and sows of various ages.

Materials and methods. The scientific and production study was conducted at the 'GSP' private enterprise in the Berezivka district of the Odesa region, using methods generally accepted in pig farming [13–15], on F1½ hybrid sows (Large White × Landrace) and breeding boars. Control and experimental groups of animals were formed using the matched-pair principle, taking into account the sows' origin, age, live weight, body condition, physiological status and productivity indicators based on the results of their first farrowing.

First-litter sows in the control group were fed standard diets from the time of insemination, whilst those in the experimental group were fed diets based on the 'ideal protein' principle, with their reproductive capacity and productive characteristics subsequently assessed up to the fourth farrowing. Upon completion of the second lactation, sows in both the control and experimental groups were fed identical standard diets, balanced according to key parameters, and were kept under identical housing conditions.

The sows were fed in accordance with the farm's established feeding procedures and the recommendations of scientific consultants from Wright Frank Ltd, who develop pig feed rations and supply a range of biologically active feed supplements.

The feeding rations for sows and breeding boars in the control groups were balanced using traditional protein components (sunflower meal, soya meal) and crystalline amino acids. Corresponding animals in the experimental groups were fed compound feeds with a reduced crude protein content and an increased level of crystalline lysine, in accordance with the 'ideal protein' concept. The metabolisable energy and other nutrient contents of the diets of the control and experimental groups met the physiological requirements of pregnant/lactating sows and breeding boars [9].

The body condition of sows was assessed visually on the 5th day after farrowing and at the time of weaning the piglets, using a 5-point scale. The reproductive performance of sows in terms of farrowing was assessed using indicators such as litter size (number of live piglets at farrowing) and litter

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weight (average live weight of a single piglet in the litter). The number of piglets at weaning at 28 days, the average litter live weight, the average live weight per piglet and the relative survival rate of piglets during the suckling period (%) were also determined.

After weaning the piglets, the duration of the empty period (in days) and the conception rate following the first insemination (as a percentage of those presented for insemination) were recorded for the sows. The productive longevity of the animals was also determined by calculating the survival rate of sows from farrowings II–IV as a percentage relative to the first farrowing.

For terminal breeding boars in the main herd (n = 3) and those under evaluation (n = 5), feed intake (kg/day) was determined, and body condition scores were assessed. Their reproductive capacity was also assessed using the sow insemination rate (%), litter size (number of piglets), and semen production parameters, such as ejaculate volume (ml) and the percentage of spermatozoa exhibiting rectilinear progressive motility. In addition, the survival rate of breeding boars relative to the start of use (%) was determined using methods generally accepted in pig farming [13–15].

All research was carried out in accordance with the well-established International Principles of the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes [16], as well as in accordance with Directive 2010/63/EU of the European Parliament and of the Council of the European Union of 22 September 2010 on the protection of animals used for scientific purposes [17].

The obtained digital data were analysed using methods of variational statistics [18, 19] with the aid of Microsoft Excel 2010 software. The significance of the differences between the indicators of the control and experimental groups of pigs was assessed using the Student's t-test (t, at $p < 0.05$; $p < 0.01$; $p < 0.001$ for significance levels I, II and III, respectively).

Research results and discussion. The current situation that has arisen since the start of the war in many pig-farming holdings across Ukraine has led to a partial or complete shortage of protein components in the diet. We therefore modelled this situation and proposed a solution using the 'ideal protein' model (Table 1), which involved the complete exclusion of protein ingredients from the feed rations for pregnant sows and breeding boars.

For lactating sows, we have kept 5.0 per cent each of peas and sunflower meal, and 3.5 per cent of soya meal in the diet. The rationale behind this necessary approach is to preserve as much of the diet's protein content as possible for its potential future use in feeding young pigs with a live weight of up to 25.0–30.0 kg (pre-starter and starter periods), as during this period the animals have increased requirements for protein content in their feed and the 'ideal protein' model does not meet these needs, which may have negative consequences for the animals' health and, consequently, for the productivity and survival rate of the young pigs.

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Table 1. The structure of compound feed for feeding the main herd of pigs, %

Ingridients	Groups of animals					
	control			experimental		
	sows		breeding boars	sows		breeding boars
	pregnant	lactating		pregnant	lactating	
Maize	15,0	15,0	25,0	15,0	15,0	25,5
Barley	33,5	12,5	25,0	36,8	22,0	30,0
Wheat	35,0	42,5	28,0	45,0	46,0	41,0
Peas	5,0	5,0	5,0	–	5,0	–
Soya meal	3,5	9,5	5,0	–	3,5	–
Sunflower meal	5,0	12,0	8,7	–	5,0	–
MPS[1]	0,85	0,95	0,95	0,85	0,9	0,95
Table salt	0,4	0,4	0,45	0,4	0,4	0,4
Chalk	1,05	1,1	1,05	1,05	1,0	1,05
Lizin	0,1	0,25	0,1	0,3	0,4	0,35
Clinofid	0,1	0,3	0,25	0,1	0,3	0,25
Nufocide	0,1	0,1	0,1	0,1	0,1	0,1
Lakta Wright premix	–	0,4	0,4	-	0,4	0,4
Jesta Wright premix	0,4			0,4		

Note: [1] – mineral-phosphorus supplement

Furthermore, the nutritional requirements of pregnant sows, unlike those of lactating sows, are relatively insignificant and only increase significantly during the final third of gestation, when foetal growth is most rapid. Therefore, 3–4 weeks before the scheduled farrowing, sows should be switched to compound feed intended for lactating sows, in accordance with current recommendations and the research findings of R. Susol and K. Garmatyuk [12].

As regards the nutritional requirements of breeding boars, it is worth noting that their requirements fall between those of pregnant sows and lactating sows [9].

Increasing the level of crystalline lysine in the diet of pregnant sows, based on the ‘ideal protein’ concept, had both positive and potentially negative consequences under farm conditions, as the diet of the experimental group differed significantly from that of the control group not only in terms of the source of lysine (Table 2), but also in terms of the total crude protein content and other essential amino acids (methionine, threonine, tryptophan). Furthermore, it is worth noting that the ‘ideal protein’ concept takes into account the requirements for amino acids such as valine and isoleucine.

However, the need to incorporate these amino acids into the diet is hampered by their unavailability on the Ukrainian market for feed additives on an industrial scale. Consequently, it is impossible to balance the diets of the sows in the experimental group for valine and isoleucine without using protein components in the feed; in other words, the feeding regime for the animals in the experimental group is a compromise solution.

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Table 2. Analysis of the diets of the tested pigs in the main herd

Indicator	Groups of animals					
	control			experimental		
	sows		breeding boars	sows		breeding boars
	pregnant	lactating		pregnant	lactating	
Metabolisable energy, MJ	13,26	13,20	13,21	13,31	13,34	13,38
Crude protein, %	14,01	17,33	14,98	11,25	14,12	10,95
Crude fat, %	2,45	2,54	2,67	2,33	2,36	2,51
Crude fibre, %	3,64	4,76	4,16	2,52	3,53	2,42
Crude ash, %	4,08	4,74	4,43	3,56	4,06	3,60
Lysine, %	0,63	0,92	0,70	0,60	0,85	0,65
Methionine, %	0,26	0,34	0,30	0,20	0,26	0,20
Methionine + cystine, %	0,52	0,63	0,56	0,43	0,51	0,43
Threonine, %	0,56	0,69	0,63	0,44	0,55	0,45
Tryptophan, %	0,17	0,22	0,19	0,13	0,17	0,13
Ca, %	0,80	0,88	0,84	0,78	0,80	0,82
P, %	0,63	0,72	0,68	0,57	0,64	0,59
Ca : P	1,26 :1	1,21 :1	1,23 :1	1,36 :1	1,25 :1	1,39 :1
Na, %	0,24	0,26	0,28	0,22	0,24	0,23
Lysine: Metabolisable energy	0,47 : 1	0,70 : 1	0,53 : 1	0,45 : 1	0,64 : 1	0,49 : 1

An analysis of the productivity of sows in the experimental groups (Table 3) showed that, overall, the productivity levels of the animals in the experimental group were similar to those of the control group. The results obtained demonstrated that feeding the pregnant sows in the experimental group a compound feed with a 2.76 % reduction in crude protein content compared with the control group led to an increase in the animals' appetite and, consequently, feed intake, for example, on the 85th day of gestation, by 0.23 kg or 7.9 % per day. This likely contributed to a trend towards an improvement in the body condition of the sows on the 5th day post-farrowing by 0.15 points or 4.3 %. However, in terms of litter size and litter weight, sows in the control group outperformed those in the experimental group by 0.3 piglets (2.3 per cent) and 0.04 kg (3.0 per cent) respectively, given the optimal levels of crude protein and amino acid composition in the compound feed.

A similar pattern was observed on day 28 following weaning, when sows in the control group significantly outperformed their counterparts in the experimental group in terms of litter live weight by 7.2 kg or 8.9 per cent ($p < 0.01$) and the average weight of the first piglet by 0.4 kg or 5.5 % ($p < 0.01$). Furthermore, at the time of weaning, sows in the control group showed a tendency to outperform those in the experimental group in terms of the number of piglets and piglet survival during the suckling period by 4.5 % and 1.8 %, respectively.

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Table 3. Analysis of the productivity of sows in the research groups (n =35), $\overline{X} \pm S_{\overline{X}}$

Indicator	Group of animals	
	control	experimental
Body condition on the 5th day after farrowing, points	3,46 ± 0,066	3,61 ± 0,054
Litter size, heads	12,9 ± 0,31	12,6 ± 0,33
Litter weight, kg	1,35 ± 0,011	1,31 ± 0,019
At weaning on day 28:		
– **Litter live weight, kg**	88,3 ± 2,05	81,1 ± 2,23**
– **Number of piglets, heads**	11,5 ± 0,27	11,0 ± 0,29
– **Average weight of the first piglet, kg**	7,7 ± 0,05	7,3 ± 0,05**
– **Survival rate of piglets, %**	89,1	87,3
Body condition of sows at the time of weaning, points	2,51 ± 0,059	2,32 ±0,061
Duration of the empty period, days	4,5 ± 0,18	3,6 ± 0,14
Conception rate following the first insemination, %	85,0	89,0
Survival rate of sows relative to their first farrowing by age, heads (%):		
– **II farrowing**	31 (91,4)	33 (94,3)
– **III farrowing**	28 (80,0)	29 (82,9)
– **IV farrowing**	26 (74,3)	27 (77,1)
– **V farrowing**	22 (62,9)	23 (65,7)
– **VI farrowing**	16 (45,7)	17 (48,6)

Note: – **p < 0,01

Concerning the body condition of sows at the time of weaning, a trend was observed whereby sows in the control group were 0.19 points, or 8.2 per cent, better than those in the experimental group. However, for the remaining indicators considered, a trend towards superiority was observed in the sows of the experimental group compared with the control group. Sows in this group showed signs of oestrus 0.9 days earlier after weaning the piglets and had a 4.0 per cent higher conception rate after the first insemination. This group also showed a trend towards better survival rates among sows following recovery, with appropriate protein and amino acid nutrition, as indicated by the results of the second, third, fourth, fifth and sixth farrowings, at 2.9–5.7 per cent, respectively. This can probably be explained by the stress experienced by sows due to restricted protein intake, which activates adaptive mechanisms of metabolic optimisation in such animals. This is confirmed by scientific studies [6, 7], which indicate that moderate restriction of protein intake, whilst maintaining a balanced diet in terms of essential amino acids, activates adaptive mechanisms of metabolic optimisation. These mechanisms involve a reduction in the metabolic load on the sows' bodies and, as a result, lead to a potential improvement in reproductive performance.

Consequently, the assessment of sows' reproductive performance under conditions of reduced protein intake, whilst optimising lysine levels through the use of a crystalline lysine supplement, revealed no significant deterioration or improvement in performance indicators; however, it was important for us to also assess the reproductive performance of breeding boars under similar conditions (Table 4).

A crude protein deficiency, against a background of partial compensation for lysine through the use of its synthetic crystalline form, is significantly more

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critical for breeding boars than for sows, as spermatogenesis is one of the most amino acid-dependent biological processes in the pig's body.

Table 4. Analysis of the performance of breeding boars in the research groups, $\overline{X} \pm S_{\overline{X}}$

Indicators	Group of animals	
	controlled	researched
Boars being tested (n = 5)		
Body condition score, points	3,5 ± 0,16	3,0 ± 0,15
Semen production parameters:		
Number of ejaculates assessed	45	43
Ejaculate volume, ml	210,0 ± 2,52	190,2 ±4,01***
Sperm concentration, billion/ml	0,28 ± 0,01	0,25 ± 0,01*
Proportion of sperm with rectilinear progressive motility, %	82,0	74,0
Fertilisation rate of sows, %	86,0	79,0
Litter size of sows, heads	12,8 ± 0,14	12,1 ± 0,18**
Survival rate of boars relative to the start of use, %:	100,0	80,0
Breeding boars in the main herd (n = 3)		
Body condition score, points	3,5 ± 0,18	3,2 ± 0,20
Semen production parameters:		
Number of ejaculates assessed	60	60
Ejaculate volume, ml	255,4 ± 3,11	241,9 ± 4,54*
Sperm concentration, billion/ml	0,34 ± 0,01	0,30 ± 0,01*
Proportion of spermatozoa with rectilinear progressive motility, %	86,0	80,0
Fertilisation rate of sows, %	88,0	83,0
Litter size of sows, heads	13,2 ± 0,16	12,6 ± 0,15**
Survival rate of boars relative to those transferred to the main herd, %:	100,0	67,0

*Note: – *p < 0,05; ** – p < 0,01; *** – p < 0,001*

An analysis of the performance of breeding boars in the research groups showed that the animals in the experimental group consumed 0.2 kg more feed, or 7.4 per cent more, than the breeding boars in the control group. This is likely due to an increased sense of hunger in the boars of this group, caused by reduced protein content and an imbalance in several essential amino acids (methionine, threonine, tryptophan, valine and isoleucine), which are at or below the lower limit of the normal range, whereas protein synthesis is limited not only by lysine but also by the balance (ratio) of all critical amino acids relative to lysine. The approach we adopted to feeding the breeding boars in the experimental group had a slight negative impact on live weight and body condition scores (the boars tested were 0.5 points, or 14.3 per cent, behind their counterparts in the control group). However, the negative impact of this feeding regime on semen quality proved to be significantly greater, leading, accordingly, to a deterioration in the reproductive function of stud bulls of various ages.

Based on the results of a visual assessment, we observed a certain trend whereby the breeding boars in the experimental group under examination showed a reduced rate of growth; they were characterised by a slightly poorer degree of carcass conformation and slightly weaker overall muscle development, against a background of a finer skeletal structure compared with the animals in the control group.

The ejaculate volume of the breeding rams in this experimental group was 19.8 ml, or 9.4 per cent ($p < 0.001$) lower than that of the control group, against

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a background of a decrease in sperm concentration by 0.03 billion/ml or 10.7 % ($p < 0.05$) and a reduction in the proportion of spermatozoa exhibiting rectilinear progressive motility by 8.0 %. As a result, the fertilisation rate of sows using semen from boars in the experimental group decreased by 7.0 %, and the number of piglets per litter decreased by 0.7 piglets or 5.5 % compared with the corresponding figures for animals in the control group. Furthermore, the survival rate of the boars in the experimental group was 20 per cent lower than their initial numbers at the start of the trial.

Regarding the breeding boars that were transferred to the main herd, the situation is as follows: the animals in the experimental group consumed 0.4 kg more feed, or 12.9 per cent more, than the breeding boars in the control group. The body condition scores of the breeding boars in the experimental group tended to be 0.3 points lower than those of their counterparts in the control group, representing 8.6 per cent.

The actual volume of ejaculate from breeding boars in the experimental group of the main herd was 13.5 ml, or 5.3 per cent ($p < 0.05$), lower than that of the breeding boars in the control group. A reduction in sperm concentration of 0.04 billion/ml or 11.8% ($p < 0.05$) was also observed in this group, along with a 6.0% decrease in the proportion of sperm exhibiting rectilinear progressive motility, a 5.0% reduction in the fertilisation rate of sows, and a reduction in the number of piglets per litter by 0.6 piglets, or 4.6 per cent, compared with the figures in the control group. Similarly to the boars under investigation, the survival rate of the breeding boars in the experimental group of the main herd, relative to their initial number at the time of transfer to the main herd, was 33 per cent lower.

Overall, our results regarding the specific adverse effect of crude protein deficiency, against a background of partial lysine compensation through the use of its synthetic form in pigs, demonstrate that this effect is more critical for breeding boars than for sows. Furthermore, it is worth noting that the use of the diets administered to the experimental groups, compared with the full-ration diet of the control groups, had a significantly more critical effect on the young breeding boars under study than on the boars in the main herd, as the young organism continues not only to grow (increase in muscle tissue, development of pronounced meat conformation) but also to develop (ongoing testicular development, establishment of the endocrine system’s status, and the process of spermatogenesis). In other words, a deficiency of crude protein in the diet of young breeding boars undergoing testing – even when an optimal amount of such an important essential amino acid as lysine is provided – leads to competition or an imbalance between ‘somatic growth’ and reproductive capacity [20].

On the other hand, we consider the experiment carried out as a necessary option for feeding animals during unforeseeable circumstances, such as martial law, and in situations where the proposed feeding principle and approach will be of short duration. In such cases, this feeding method can be regarded as entirely effective and promising. A prolonged deficiency of protein in the diet of young boars increases the risk of osteochondrosis and weakness of the skeleton and limbs in particular, which complicates the process of semen

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collection and subsequently leads to the development of immunodeficiency, the appearance of ulcers, hepatodystrophy and underdevelopment of the reproductive system [21]. As regards adult boars in the main herd, the application of this feeding regimen for a short period may reduce the rate of ammonia synthesis and, consequently, the load on the liver, decrease heat production, and lower the risk of hepatosis. In other words, for boars in the main herd, this may even be beneficial, but the key factor remains the impact on sperm production (maintaining normal sperm concentration against a background of a slight reduction in ejaculate volume, provided there is a moderate deficiency of crude protein and essential amino acids) and the duration of such a deficiency over time.

Conclusions. Practical modelling of the situation and testing of energy-saving feeding strategies for the main herd of pigs (boars and sows of various ages) under conditions of limited feed resources have demonstrated that applying the 'ideal protein' principle to animals in these groups is entirely feasible; however, it should be regarded as a necessary measure for a short period, for example, one reproductive cycle of sows.

Prospects for further research. A promising area for future research is a comprehensive study of the use of increased amounts of protein ingredients in compound feed under conditions of limited feed resources for pigs of different ages and physiological states.

REFERENCES

1. Арапакі, С., & Сусол, Р. (2025). Naukovo-metodychni zasady investytsiino-innovatsiinoho rozvytku svynarstva u rehioni: strukturni elementy, instrumenty ta indykatory rezultatyvnosti. [Development and implementation of energy-saving elements of pig fattening technology under conditions of limited feed resources]. *Ahrarnyi visnyk Prychornomoria* [Agrarian Bulletin of the Black Sea Littoral], *116*, 127–139 [in Ukrainian]. https://doi.org/10.37000/abbsl.2025.116.08

2. Zoria, O., Shostia, A., Vashchenko, P., Bezkrovnyi, O., & Malysh, O. (2026). Naukovo-metodychni zasady investytsiino-innovatsiinoho rozvytku svynarstva u rehioni: strukturni elementy, instrumenty ta indykatory rezultatyvnosti [Scientific and methodological principles of investment and innovative development of pig farming in the region: structural elements, tools and performance indicator]. *Ahrosvit* [AgroWorld]*, 4*, 40–50 [in Ukrainian]. https://doi.org/10.32702/2306-6792.2026.4.40

3. Khalak, V. I., Gutyj, B. V., & Bordun, O. M. (2024). Tryvalist produktyvnoho dovholittia svynomatok riznoho rivnia adaptatsii ta zhyttiezdatnosti [Duration of productive longevity of sows of different levels of adaptation and viability]. *Naukovo-tekhnichnyi biuleten Derzhavnoho naukovo-doslidnoho kontrolnoho instytutu veterynarnykh preparativ ta kormovykh dobavok i Instytutu biolohii tvaryn* [Scientific and Technical Bulletin of State Scientific Research Control Institute of Veterinary Medical Products and Fodder Additives and Institute of Animal Biology], *25*(1), 231–240 [in Ukrainian]. https://doi.org/10.36359/scivp.2024-25-1.29

4. Tsereniuk O. M., Akimov, & Kosov O. V. (2015). Povnotsinna hodivlia svynei [Comprehensive pig feeding]. *Suchasne tvarynnytstvo* [Modern livestock farming] [in Ukrainian]. URL: https://agro-business.com.ua/agro/suchasne-tvarynnytstvo/item/8097-povnotsinna-hodivlia-svynei.html (date of access: 01.05.26).

5. Lykhach, V., Bevz, N., Lykhach, A., Balanchuk, I., Faustov, R., & Shaposhnik, V. (2026). Influence of a garlic-based additive on performance parameters and intestinal morphology of replacement gilts under commercial conditions in Ukraine. *Veterinary World*, *19*(3), 1229–1245. https://doi.org/10.14202/vetworld.2026.1229-1245

6. Svajgr, A. J., Hammell, D. L., Degeeter, M. J., Hays, V. W., Cromwell, G. L., & Dutt, R. H. (1972). Reproductive Performance of Sows on a Protein-Restricted Diet. *J of*

ISSN 2786-7730 Print https://doi.org/10.37143/2786-7730-2026-7(85)1

Reproduction and Fertility, *30*(3), 455–458. https://doi.org/10.1530/jrf.0.0300455

7. Oster, M., Murani, E., Metges, C. C., Ponsuksili, S., & Wimmers, K. (2012). A low protein diet during pregnancy provokes a lasting shift of hepatic expression of genes related to cell cycle throughout ontogenesis in a porcine model. *BMC Genomics, 13,* 93. https://doi.org/10.1186/1471-2164-13-93

8. Praissinher, V., Propstmaier, H., & Shcherb, S. (2017). Efektyvna vidhodivlia z malym vmistom soi u kormi [Effective fattening with a low soy content in the feed]. *Agroexpert*, *7*(108), 94–96 [in Ukrainian].

9. Provatorov. H. V. et al. (2007). Normy hodivli, ratsiony i pozhyvnist kormiv dlia riznykh vydiv silskohospodarskykh tvaryn [Feeding guidelines, rations and nutritional value of feed for various types of farm animals]. Sumy: TOV «VTD «Universytetska knyha» [in Ukrainian].

10. Kotykova, O., Babych, M., Nadvynychnyy, S., & Pohorielova, O. (2025). Agriculture in Ukraine: Regional and Global Impacts of the war. *European Countryside, 17*(1), 204–227. https://doi.org/10.2478/euco-2025-0011

11. FAO report: agriculture remains a lifeline for rural families in war-affected Ukraine. *FAO.ORG* Retrieved from https://www.fao.org/newsroom/detail/fao-report--agriculture-remains-a-lifeline-for-rural-families-in-war-affected-ukraine/en?utm_source=chatgpt.com (date of access: 01.05.26).

12. Susol, R. L, Harmatiuk, K. V., & Khalak, V. I. (2018). Optymizatsiia systemy rozvedennia i hodivli svynei miasnoho napriamku produktyvnosti v umovakh pivdnia Ukrainy [Optimisation of the breeding and feeding system for pigs reared for meat production in southern Ukraine]. *Zernovi kultury* [Cereal crops], 2(12), 353–359 [in Ukrainian].

13. Rybalko, V. P., Berezovskyi, M. D., Bohdanov H. A. ta in. (2005). Suchasni metodyky doslidzhen u svynarstvi [Modern research methods in pig farming]. Poltava: Institute of Pig Breeding UAAN [in Ukrainian].

14. Soboliev, O. I., Nedashkivskyi, V. M., Petryshak, R. A. et al. (2022). Metodolohiia ta orhanizatsiia naukovykh doslidzhen u tvarynnytstvi [Methodology and Organisation of Scientific Research in Animal Husbandry. Bila Tserkva, 74–81 [in Ukrainian].

15. Ladyka. V. I., Khmelnychyi, L. M., Povod, M. H. et al. (2023). Tekhnolohiia vyrobnytstva ta pererobky produktsii tvarynnytstva [Technology for the production and processing of livestock products]. Odesa: Oldi+[in Ukrainian].

16. Yevropeiska konventsiia pro zakhyst khrebetnykh tvaryn, shcho vykorystovuiutsia dlia doslidnykh ta inshykh naukovykh tsilei (Strasburh, 18 ber. 1986 r.) [European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 18 March 1986)]. *Official website of the Verkhovna Rada of Ukraine: Ukrainian legislation*. Retrieved from https://zakon.rada.gov.ua/laws/show/994_137#Text (data of access: 25.06.2026).

17. Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes (Text with EEA relevance). *Official J. of the European Union.* 2010. L 276/33 (date of access: 25.06.2026).

18. Kovalenko, V. P. ta in. (2010). Biometrychnyi analiz minlyvosti oznak silskohospodarskykh tvaryn i ptytsi [Biometric analysis of trait variability in farm animals and poultry]. Kherson [in Ukrainian].

19. Kramarenko, S. S., Luhovyi, S. I., Lykhach, A. V., & Kramarenko, O. S. (2019). Analiz biometrychnykh danykh u rozvedenni ta selektsii tvaryn [Analysis of biometric data in animal breeding and selection]. Mykolaiv: MNAU [in Ukrainian].

20. Bo Ren, Xu Cheng, De Wu, Sheng-Yu Xu, Lian-Qiang Che, Zheng-Feng Fang, Gang Lv, Hong-Jun Dong, & Yan Lin. (2012). Effect of different amino acid patterns on semen quality of boars fed with low-protein diets. *Animal Reproduction Sci.*, *161*, 96–103. https://doi.org/10.1016/j.anireprosci.2015.08.010

СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

1. Сусол Р., Арапакі С. Розробка та впровадження елементів енергоощадної годівлі свиней в умовах обмежених кормових ресурсів під час військового стану. *Аграрний вісник Причорномор'я*. 2025. Вип. 116. С. 127–139. https://doi.org/10.37000/abbsl.2025.116.08

Arapaki S. S., Susol R. L. Testing of energy-efficient feeding methods for breeding herd pigs under conditions of limited feed resources

ISSN 2786-7730 Print https://doi.org/10.37143/2786-7730-2026-7(85)1

2. Зоря О., Шостя А., Ващенко П., Безкровний О., Малиш О. Науково-методичні засади інвестиційно- інноваційного розвитку свинарства у регіоні: структурні елементи, інструменти та індикатори результативності. *Агросвіт.* 2026. № 4. С. 40–50. https://doi.org/10.32702/2306-6792.2026.4.40

3. Халак В. І., Гутий Б. В., Бордун О. М. Тривалість продуктивного довголіття свиноматок різного рівня адаптації та життєздатності. *Науково-технічний бюлетень ДНДКІ ветеринарних препаратів та кормових добавок і Інституту біології тварин ДНДКІ ветпрепаратів та кормових добавок.* Вип. 25. №1. 2024. С. 231–240. https://doi.org/10.36359/scivp.2024-25-1.29

4. Церенюк О. М., Акімов, Косов О. В. Повноцінна годівля свиней. *Сучасне тваринництво*. 2015. 17 квіт. URL: https://agro-business.com.ua/agro/suchasne-tvarynnytstvo/item/8097-povnotsinna-hodivlia-svynei.html (дата звернення 01.05.26).

5. Lykhach V., Bevz N., Lykhach A., Balanchuk I., Faustov R., Shaposhnik V. Influence of a garlic-based additive on performance parameters and intestinal morphology of replacement gilts under commercial conditions in Ukraine. *Veterinary World*. 2026. 19(3): 1229–1245. https://doi.org/10.14202/vetworld.2026.1229-1245

6. Svajgr A. J., Hammell D. L., Degeeter M. J., Hays V. W., Cromwell G. L., Dutt R. H. Reproductive Performance of Sows on a Protein-Restricted Diet. *J. of Reproduction and Fertility*. 1972. Vol. 30. Iss. 3. P. 455–458. https://doi.org/10.1530/jrf.0.0300455

7. Oster M., Murani E., Metges C. C. et al. A low protein diet during pregnancy provokes a lasting shift of hepatic expression of genes related to cell cycle throughout ontogenesis in a porcine model. *BMC Genomics.*2012. Vol. 13. Article 93. https://doi.org/10.1186/1471-2164-13-93

8. Прайссінгер В., Пропстмайер Г., Щерб С. Ефективна відгодівля з малим вмістом сої у кормі. *Agroexpert.* 2017. № 7(108).С. 94–96.

9. Норми годівлі, раціони і поживність кормів для різних видів сільськогосподарських тварин: довідник / Г. В. Проваторов, В. І. Ладика, Л. В. Бондарчук та ін. Суми: ТОВ «ВТД «Універ. книга», 2007. 488 с.

10. Kotykova O., Babych M., Nadvynychnyy S., Pohorielova O. Agriculture in Ukraine: Regional and Global Impacts of the war. *European Countryside.* 2025. Vol. 17(1). P. 204–227. https://doi.org/10.2478/euco-2025-0011

11. FAO report: agriculture remains a lifeline for rural families in war-affected Ukraine. *FAO.ORG* URL: https://www.fao.org/newsroom/detail/fao-report--agriculture-remains-a-lifeline-for-rural-families-in-war-affected-ukraine/en?utm_source=chatgpt.com (date of access: 01.05.26).

12. Сусол Р. Л, Гарматюк К. В., Халак В. І. Оптимізація системи розведення і годівлі свиней м'ясного напрямку продуктивності в умовах півдня України. *Зернові культури.* 2018. Т. 2. № 12. С. 353–359.

13. Сучасні методики досліджень у свинарстві / В. П. Рибалко, М. Д. Березовський, Г. А. Богданов та ін. / Ін-т свинарства УААН. Полтава, 2005. 228 с.

14. Методологія та організація наукових досліджень у тваринництві: навч. посіб. / О. І. Соболєв, Недашківський В. М., Р. А. Петришак та ін.; за заг. ред. О. І. Соболєва. Біла Церква. 2022. С. 74–81.

15. Технологія виробництва та переробки продукції тваринництва / В. І. Ладика, Л. М. Хмельничий, М. Г. Повод та ін. ; за заг. ред. В. І. Ладики, Л. М. Хмельничого. Одеса: Олді+, 2023. 244 с.

16. Європейська конвенція про захист хребетних тварин, що використовуються для дослідних та інших наукових цілей (Страсбург, 18 бер. 1986 р.). О*фіц. сайт Верховної Ради України: законодавство України.* URL: https://zakon.rada.gov.ua/laws/show/994_137#Text (дата звернення: 25.06.2026).

17. Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes (Text with EEA relevance). *Official J. of the European Union.* 2010. L 276/33. (дата звернення: 25.06.2026).

18. Біометричний аналіз мінливості ознак сільськогосподарських тварин і птиці : навч. посіб. / В. П. Коваленко та ін. Херсон, 2010. 225 с.

19. Аналіз біометричних даних у розведенні та селекції тварин / С. С. Крамаренко, С. І. Луговий, А. В. Лихач, О. С. Крамаренко. Миколаїв: МНАУ, 2019. 211 с.

Arapaki S. S., Susol R. L. Testing of energy-efficient feeding methods for breeding herd pigs under conditions of limited feed resources

ISSN 2786-7730 Print https://doi.org/10.37143/2786-7730-2026-7(85)1

20. Bo Ren, Xu Cheng, De Wu, Sheng-Yu Xu, Lian-Qiang Che, Zheng-Feng Fang, Gang Lv, Hong-Jun Dong, Yan Lin. Effect of different amino acid patterns on semen quality of boars fed with low-protein diets. *Animal Reproduction Sci*. 2012. Vol. 161 P. 96–103. https://doi.org/10.1016/j.anireprosci.2015.08.010

АПРОБАЦІЯ ЕЛЕМЕНТІВ ЕНЕРГООЩАДНОЇ ГОДІВЛІ СВИНЕЙ ОСНОВНОГО СТАДА В УМОВАХ ОБМЕЖЕНИХ КОРМОВИХ РЕСУРСІВ

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***Мета** роботи полягала у проведенні апробації елементів енергоощадної годівлі свиней основного стада в умовах обмежених кормових ресурсів за використання принципу «ідеального протеїну» для кнурів і свиноматок різного віку. **Методи.** Науково-господарський дослід був проведений за загальноприйнятими у свинарстві методиками на свиноматках-першоопоросках гібридного походження F_1 ½ (велика біла + ландрас) та термінальних кнурах-плідниках. За принципом пар-аналогів були сформовані контрольні та дослідні групи тварин. Кнури й свиноматки контрольних груп отримували типові збалансовані раціони, а тваринам дослідних груп згодовували комбікорми зі зниженим рівнем сирого протеїну та підвищеним вмістом кристалічного лізину відповідно до концепції «ідеального протеїну». По завершенню II лактації свиноматки контрольної та дослідної груп отримували ідентичні типові раціони годівлі. Досліджували показники відтворювальної здатності й продуктивних характеристик свиноматок протягом I–IV опоросу. Для кнурів-плідників визначали рівень споживання корму, проводили оцінку кондицій тіла й відтворювальної здатності, а також визначали збереженість плідників відносно початку їх використання. **Результати.** Аналіз відтворювальної здатності та продуктивності свиноматок за умови зниженого рівня протеїнового живлення на фоні оптимізації рівня лізину внаслідок використання його добавки у кристалічній формі не виявив суттєвого погіршення або покращення досліджуваних показників. Проте для кнурів-плідників дефіцит сирого протеїну на фоні часткової його компенсації лізином мав значно критичніші наслідки, оскільки сперматогенез – це один із найбільш амінокислотозалежних біологічних процесів у організмі свиней. Спостерігалося суттєве погіршення таких показників спермопродукції як об'єм еякуляту й концентрація сперматозоїдів. **Висновки.** Фактичне моделювання та апробація елементів енергоощадної годівлі свиней основного стада (кнурів і свиноматок різного віку) в умовах обмежених кормових ресурсів довело, що використання принципу «ідеального протеїну» для тварин цих груп цілком можливе, проте його слід розглядати як вимушений захід протягом нетривалого часу – наприклад, одного репродуктивного циклу відтворення свиноматок.*

***Ключові слова:** свині, дефіцит кормів, енергоощадна годівля, сирий протеїн, амінокислотне живлення, відтворення, продуктивність, свиноматки, кнури-плідники*

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Використання штучного інтелекту (ШІ):
Автори рукопису засвідчують, що у процесі проведення дослідження та підготовки цього рукопису для виконання будь-яких завдань не використовували жодних інструментів або сервісів генеративного ШІ, перелічених у Таксономії делегування завдань генеративному ШІ (GAIDeT, 2025). Усі етапи роботи виконані виключно авторами.

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Мета *роботи полягала у проведенні апробації елементів енергоощадної годівлі свиней основного стада в умовах обмежених кормових ресурсів за використання принципу «ідеального протеїну» для кнурів і свиноматок різного віку.* ***Методи.*** *Науково-господарський дослід був проведений за загальноприйнятими у свинарстві методиками на свиноматках-першоопоросках гібридного походження F₁ ½ (велика біла + ландрас) та термінальних кнурах-плідниках. За принципом пар-аналогів були сформовані контрольні та дослідні групи тварин. Кнури й свиноматки контрольних груп отримували типові збалансовані раціони, а тваринам дослідних груп згодовували комбікорми зі зниженим рівнем сирого протеїну та підвищеним вмістом кристалічного лізину відповідно до концепції «ідеального протеїну». По завершенню II лактації свиноматки контрольної та дослідної груп отримували ідентичні типові раціони годівлі. Досліджували показники відтворювальної здатності й продуктивних характеристик свиноматок протягом I–IV опоросу. Для кнурів-плідників визначали рівень споживання корму, проводили оцінку кондицій тіла й відтворювальної здатності, а також визначали збереженість плідників відносно початку їх використання.* ***Результати.*** *Аналіз відтворювальної здатності та продуктивності свиноматок за умови зниженого рівня протеїнового живлення на фоні оптимізації рівня лізину внаслідок використання його добавки у кристалічній формі не виявив суттєвого погіршення або покращення досліджуваних показників. Проте для кнурів-плідників дефіцит сирого протеїну на фоні часткової його компенсації лізином мав значно критичніші наслідки, оскільки сперматогенез – це один із найбільш амінокислотозалежних біологічних процесів у організмі свиней. Спостерігалося суттєве погіршення таких показників спермопродукції як об'єм еякуляту й концентрація сперматозоїдів.* ***Висновки.*** *Фактичне моделювання та апробація елементів енергоощадної годівлі свиней основного стада (кнурів і свиноматок різного віку) в умовах обмежених кормових ресурсів довело, що використання принципу «ідеального протеїну» для тварин цих груп цілком можливе, проте його слід розглядати як вимушений захід протягом нетривалого часу – наприклад, одного репродуктивного циклу відтворення свиноматок.*

Ключові слова: *свині, дефіцит кормів, енергоощадна годівля, сирий протеїн, амінокислотне живлення, відтворення, продуктивність, свиноматки, кнури-плідники*

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The use of artificial intelligence (AI):
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