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editor@iajavs.com
iajavs.editor@gmail.com

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Piglets' productive quality and raising efficiency are affected by their initial placement weight.

Shyamala K[1], Aruna [2]

Abstract

This study analyzed the relationship between the piglets' birth weight and their subsequent daily growth rate, average feed intake, feed conversion, rearing cost indicators, and rearing cost structure. Rearing times were shown to reduce by 3.17% for piglets whose birth weight was more than 1.1 kg and by 15.81% for those whose birth weight was greater than 8 kg. Piglets' weights increased 2.03% when switched to fattening, and their average daily increases were 1.76 percentage points higher at 10.1 percentage points higher. Simultaneously, it led to a 1.46 percentage point and 7.28 percentage point decline in absolute growth. Piglets' average daily feed intake went up 8.43% and 18.07% when they were put into raising, while feed conversion went down 5.43% and 7.61%, respectively. There was no correlation between the piglets' average feed intake and their birth weight. The value of piglets increases by 6.22 and 19.88% for every kilogram above 7.0 kg that they weigh at birth throughout upbringing. However, the cost of raising a single pig remained almost the same across all groups when they were moved into the fattening phase, while it was higher for pigs weighing less than 7 kg at birth (2.28 and 2.36% more, respectively). While the initial setup weight increased, the cost of producing a single head fell by 2.77 and 20.12%, respectively. The cost of raising piglets whose birth weight was more than 8 kilograms was reduced by 17.84% compared to those whose birth weight was between 7 and 8 kilograms and by 20.12% compared to those whose birth weight was less than 7 kilograms. There was no discernible relationship between the initial live weight of piglets and the cost of feed used to develop that piglet to a final weight of 1 kilogram. Feed accounted for between 2.33 and 9.41% of total raising costs as piglets' live weights grew, but veterinary care expenses were independent of piglets' initial body weights. Piglets' birth weight probably affected their daily growth rate by 14.2%, but it had no appreciable effect on piglet survival or raising costs.

Keywords: rearing; piglets; gains; conservation; feed conversion; cost.

1. Introduction

Dmytruk and Klymenko (2006), Mykhalko (2021), and Tishchenko and colleagues (2023) all point to pig farming as a viable area of agricultural production that is continually evolving and necessitating ongoing research. Szymaska (2018), Povod et al. (2022a), the nutritional value of the diet (2022b), housing conditions (2023), rearing technology (2023), and factors related to the size and scale of pig farms (Szymaska, 2018; Kozenko et al. (2023); da Fonseca de Oliveira et al. (2023)) are just a few examples of the many factors that affect pig farming efficiency. Piglets' birth weight is only one of several important considerations before they enter the next technical stage of their upbringing (Huting et al., 2018; Martyshuk et al., 2020; 2023).

A significant rise in the fertility of pigs of different breeds led to an increase in the number of piglets born alive per sow, which in turn led to a decrease in the live weight of individual piglets at birth (Blavi et al., 2021; Farmer & Edwards, 2022) and, consequently, a global decrease in the weight of piglets at weaning (Valentim et al., 2021; Holman et al. While it is true that piglets born to smaller mothers tend to grow into smaller pigs overall, it is also known that pigs with a smaller birth weight tend to remain smaller even after being weaned and before being slaughtered (Schinckel et al., 2007; Koketsu et al., 2017). Season, sex, birth weight (Collins et al., 2017), weaning weight, and six-week-old pig weight are the most important factors in determining the pig's final weight after the fattening period (Paredeset al., 2012).

1.Assistant professor, Department of Pharmaceutical Analysis, Sri Venkateswara College of Pharmaceutical sciences , Vijayawada.
2. Assistant professor, Department of Pharmacology, Sri Venkateswara College of Pharmaceutical sciences , Vijayawada.

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According to the statements of many scientists (Leib- brandt et al., 1975; Jarvis et al., 2008; Kuzmenko, 2012), piglets with a lower weight, when placed for rearing, adapt worse to new conditions of group housing, later get used to eating dry feed and lose more weight of their body in thefirst days of rearing compared to animals that had a higher weight during this period. Generally, pigs with higher initial weight have certain advantages compared to their lighter counterparts (Huting et al., 2018; Shvachka et al., 2022). In particular, heavier pigs at the beginning of growing have a better feed conversion ratio, meaning they can absorb nutri- ents more efficiently and gain marketable weight faster (Wenk et al., 1980; Agostini et al., 2013). However, there was also widespread data (Schinckel et al., 2010) about the absence of a significant relationship between daily feed intake and the initial weight of piglets. It is widely believed that grower pigs with greater mass require less feed per unit of weight gain than lighter peers. This is, therefore, benefi- cial in terms of time to market as it can enable farmers to achieve better selling prices and reduce production costs associated with extended growing and fattening periods (Patience et al., 2015; Davoudkhani et al., 2020). However,it should be noted that the lower weight of piglets when theyare placed for rearing can have a multifaceted significant effect on indicators of live weight gains in the future during keeping before transfer to fattening (Quiniou et al., 2002), while not only not worsening the gains (Fix et al., 2010), and even improving them under certain conditions (Pelykhet al., 2012; Pelykh & Chernyshov, 2014). In particular, there were reports that, according to relative growth, pigs with lower live weight at two months of age had 3.04–

3.56 % higher relative growth at 4–6 months of age than individuals with higher live weight, which indicates their more compensatory growth. At the same time, sows with a lower initial weight and more uniform growth had higher indicators of relative and absolute growth than counterparts with a higher initial weight and uneven growth, which was caused by the evenness of the herd in terms of weight and intensity of growth in groups (Pelykh et al., 2014). According to published data (Jankowiak et al., 2020), thelow initial weight of piglets has a restraining effect on aver- age daily growth during rearing and further growth during fattening. Similar studies (Schinckel et al., 2007) describe that the relationship between initial piglet weight and age at slaughter weight was not linear and inverse. Namely, withan increase in weight by 0.1 kg, when piglets are transferred
to rearing at 20 days, the time for them to reach a slaughter weight of 125 kg was reduced by 3.48 days. Similar results were obtained by other scientists, who reported that piglets weaned with a weight of more than 6.4 kg have a higher chance of reaching the target slaughter weight at fattening
14.2 days earlier than their peers with a weight at the end of the suction period up to 6.4 kg. In addition, it was reported
that a reduced performance at fattening distinguished pigletswith a lower initial weight and, accordingly, a low slaughter weight of the carcass. Research has also shown in research (Povod et al., 2020) that heavier pigs may have a higher proportion of muscle tissue than lighter peers. An essential factor in the marketability and quality of pig meat is the growth of their muscles. Thus, starting the fattening process with an immense weight of pigs can positively influence the development of their muscles and the characteristics of the carcass later at the end of the fattening (Wu et al., 2017). At the same time, scientists report that piglets with a higher initial weight at rearing and later at slaughter had a greater fat thickness (Fix et al., 2010).

In addition, it is worth noting the scientists' data that pigs with higher initial weight have a better general state of health and higher resistance to diseases or deterioration of housing conditions than their lighter counterparts (Bai & Plastow, 2022). Pigs with higher weights at the start of growing have more robust immune systems and are often better prepared to deal with stressors and potential health problems, ultimately leading to better growth (Guy et al., 2012; VanderWaal & Deen, 2018). Moreover, piglets with low weight at the beginning of rearing differed in higher morbidity and mortality (Jankowiak et al., 2020). However, (Faccin et al., 2020) did not find a relationship between lower weight in piglets at the beginning of rearing and their mortality.

Thus, considering that the weight of piglets at weaning tends to a global decrease and significantly impacts the efficiency of further rearing of pigs during their rearing, the relevance of studying this impact remains high.

The research aims to identify the influence of the initial weight of piglets when placed on rearing on their productivi- ty and economic efficiency during rearing.

2. Materials and methods

The material of the study was the productivity and eco- nomic efficiency of rearing hybrid piglets of Danish breed- ing at different initial weights when placed on rearing.

The object of the study was the technological processes of raising hybrid piglets on 167 farms in the Kingdom of Denmark, which came from cross-breed sows of the Danish Landrace and Danish Yorkshire, which were inseminated with the sperm

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of terminal boars of the Danish Duroc. The research used data from open sources of the rating analysis of DB-Tjek pig farms for 2021 in the Kingdom of Denmark, conducted by the consulting firm Svine Rådgivningen. Data from randomly selected farms from this report were subject to analysis. To study the influence of the weight of piglets when placed on rearing, all experimental farms were dividedinto three groups

according to the weight of piglets when placed on rearing, according to the scheme shown in Table 1.

Table 1
Scheme of the experiment

Indicator	Research groups		
Group of enterprises	I	II	III
Live weight of piglets at the beginning of rearing	up to 7 kg	7–8 kg	higher 8 kg
The number of enterprises taken into account (n)	100	41	26

The first group consisted of 100 farms where piglets were raised for growing at a 5.5–6.9 kg weight. The second group included 41 farms, the weight of which was 7.0 to
8.0 kg. The third group had 26 pig farms; the weight of piglets when placed for rearing was 8.1–9.5 kg. The experi- ment studied animals' average daily and absolute weight gains, their preservation during rearing, average daily feed consumption and its costs per 1 kg of gain, the added cost ofrearing piglets, and the share of feed and veterinary care. The influence of the initial live weight factor on the leading productive and economic indicators of rearing piglets was determined using univariate variance analysis.

1. Results and discussion

Piglets put to rearing with a higher live weight were pre- dicted to have a higher growth rate. As follows from the table 2 average daily gains of piglets of the III group, which were raised for rearing with a live weight of more than 8 kg, had the highest average daily gains and probably exceeded by this indicator the animals of the II group by 38 g (8.23 %) ($P \leq 0.001$) and analogs from the I group by 46 g (10.13 %) ($P \leq 0.05$). At the same time, the piglets of the second group, which outweighed the analogs from the first group by 1 kg when placed for rearing, had almost no ad- vantage over them regarding average daily gains.

When placed on rearing, the different weights of piglets caused the unequal duration of this process for transfer tothe fattening of conditioned piglets. Thus, the animals of the I and II groups were in the room for rearing for almost eight weeks, while their analogs from the III group were less than seven weeks. This fact caused the difference in absolute gains in favor of the animals of the first group.

Table 2
Growth and preservation of piglets depending on the mass at the beginning of rearing

Indicator	Research groups		
	I	II	III
The number of considered enterprises (n)	100	41	26
Weight of piglets at the beginning of rearing, kg	6.26 ± 0.057	7.27 ± 0.051***	8.93 ± 0.156***
Duration of growing, days	55.7	53.9	46.9
Duration of growing, weeks	7.96	7.71	6.70
Weight of piglets at the end of the growth period, kg	31.6 ± 0.33	32.2 ± 0.39	32.4 ± 0.52*
Absolute growth, kg	25.3 ± 0.34	24.9 ± 0.39	23.5 ± 0.52*
Average daily increase, g	454 ± 4.61	462 ± 7.95*	500 ± 12.01***
Preservation of piglets during the growing period, %	97.65 ± 0.13	97.47 ± 0.31	98.3 ± 0.28*

Note: here and hereafter: * $P \leq 0.05$, ** $P \leq 0.01$,*** $P \leq 0.001$

Thus, the opposite pattern to the average daily growth was observed in absolute growth. They turned out to be the highest in the animals of the control group, which probably ($P \leq 0.05$) prevailed by this indicator of the analogs from theIII group by 1.84 kg (7.28 %) and peers from the II group by 1.47 kg (5.90 %). The difference in absolute gains between animals of the I and II groups was insignificant – 0.37 kg (1.46 %).

The live weight of piglets at the end of rearing was the highest among piglets of group III, which probably ($P \leq 0.05$) outweighed animals of group I

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by 0.83 kg (2.63 %) and tended to exceed this indicator over animals of group II by 0,19 kg (0.59 %). In turn, the most negligible mass at the end of rearing was established in animals of the I group, which were inferior to the analogs from the II group, 0.64 kg(2.03 %)

The shorter duration of raising piglets and their higher initial weight caused better survival in the animals of the third group. It was 0.80 % higher than II group analogs and
0.60 % higher than I group animals.Thus, an increase in the initial weight of piglets when placed on rearing caused a decrease in the duration of rear- ing by 3.17 % when it increased by 1.1 kg and 15.81 % when the weight increased above 8 kg, an increase in aver- age daily gains by 1.76 % and 10.13 %, an increase in the weight of piglets when transferred to fattening by 2.03 %and 2.63 %, respectively. At the same time, it caused a de- crease in absolute growth by 1.46 and 7.28 %

Piglets with a higher initial weight consumed relatively more feed. The lowest average daily feed consumption was observed in animals of the I group, which probably ($P \leq 0.01$) consumed less feed by 0.07 kg compared to the ana- logs of the II group and by 0.15 kg ($P \leq 0.001$) compared to the animals of the III group (table 3). At the same time, piglets of group III, which had the highest live weight when placed on rearing, consumed the most fodder in comparison to piglets and exceeded their counterparts of group II by 0.8 kg ($P \leq 0.01$).

Table 3
Feed consumption by piglets for rearing depends on their weight at the beginning of growth

Indicator	Research groups		
	I	II	III
Number of considered enterprises (n)	100	41	26
Average daily feed consumption, kg	0.76 ± 0.010	0.82 ± 0.016**	0.89 ± 0.013***
Feed outlay per 1 kg of growth, kg	1.67 ± 0.014	1.76 ± 0.021***	1.80 ± 0.040**
Feed outlay per animal, kg	42.2 ± 0.76	44.0 ± 0.94	42.3 ± 1.57

Note: here and hereafter: * $P \leq 0.05$, ** $P \leq 0.01$,*** $P \leq 0.001$

While the animals with the most negligible initial weight, when placed on the rearing, showed the best feed conversion in the experiment. They probably ($P \leq 0.001$) prevailed by 0.09 kg at the level of this characteristic of theanalogs from group II and by 0.13 kg of animals from groupIII ($P \leq 0.01$). In comparison, no probable difference in feed conversion was established between animals of the II and III groups. There was also no significant difference in the feedconsumed per full-grown piglet. However, there was a ten- dency to increase feed consumption by animals of the II group by 1.7–1.8 kg compared to the analogs of the I and III groups.

Thus, with an increase in the weight of piglets when placed on rearing, their average daily feed consumption increased by 8.43 and 18.07 %, but feed conversion wors- ened by 5.43 % and 7.61 %. Feed consumption per piglet during the rearing period did not depend on the initial live weight during rearing.

The economic results of work are the most important in- dicators of any pig enterprise's economic activity, as seen from the table. Four piglets of the 1st group had the lowest value when placed for rearing, which is explained by their lowest live weight. As the initial live weight increased, sodid the cost of the piglet. Thus, in the II group, it was higher by 6.22 % ($P \leq 0.001$), and in the III, by 19.88 % ($P \leq 0.05$) compared to the I group. Group III piglets also had a signifi-cantly higher value by 12.86 % ($P \leq 0.001$) when placed for rearing compared to group II counterparts. Whereas, when transferred to fattening, the cost of one piglet in the II andIII groups almost equaled and exceeded the cost of animals in the I group by 2.28 ($P \leq 0.01$) and 2.36 % ($P \leq 0.05$), respectively.

At the same time, the cost of growing one head, on the contrary, decreased with an increase in the initial weight when setting up for growing. Thus, it was 2.77 % lower in animals of the II group and 20.12 % lower in piglets of the III group compared to the analogs of the I group. The reduc- tion in the duration of the growing period, due to a larger initial mass, significantly reduced the costs of its implemen- tation. Thus, the cost of rearing piglets of the III groups, which had a mass at the time of production of more than 8 kg, was probably ($P \leq 0.001$) lower by 17.84 % than the analogs of the II group and by 20.12 % ($P \leq 0.001$) com- pared to the animals of the I groups.

It is known that the central part of the costs of raising piglets is the cost of feed. In our research, the highest costs for rearing one piglet were found in the II group and the lowest in animals of the III group. Piglets of the I

group consumed 1.27 % less feed for growing animals comparedto the counterparts of the II group, but more by 6.73 % compared to the animals of the III group. This is due to the different duration of raising piglets.

In turn, the feed cost for obtaining 1 kg of growth had a slightly different trend. The highest monetary

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costs for ob- taining 1 kg of growth were found in animals of the IIgroup, which spent 2.24 % more money obtaining a unit of growth compared to analogs of the III group and by 3.24 % compared to peers of the I group.

Table 4

Productive indicators depending on the weight at the beginning of growing

Indicator	Research groups		
	I	II	III
Number of considered enterprises (n)	100	41	26
The cost at the beginning of growing, DKK****	252.1 ± 1.74	267.8 ± 2.71***	302.3 ± 3.70*
Cost at the beginning of growing, UAH	1381.62	1467.54	1656.33
Cost at the end of growing, DKK	448.65 ± 2.39	458.9 ± 2.67**	459.3 ± 3.34*
Cost at the end of growing, UAH	2458.60	2514.77	2516.69
The cost of growing, DKK	196.5 ± 2.50	191.1 ± 3.04	157.0 ± 4.6***
The cost of growing, UAH			
The cost of feed for growing one piglet, DKK	109.7 ± 2.05	111.5 ± 1.97	102.8 ± 3.6
Feed consumption per 1 kg of growth, DKK	4.34 ± 0.063	4.48 ± 0.062	4.38 ± 0.064
Feed consumption per 1 kg of growth, UAH	23.78	24.55	24.00
The share of fodder in the cost of growing, %	56.16 ± 1.16	58.49 ± 1.05	65.57 ± 1.73***
Veterinary expenses for 1 animal, DKK	10.72 ± 0.92	18.47 ± 2.43***	8.78 ± 1.76
Veterinary expenses for 1 animal, UAH			
The share of medicines, veterinary preparations, and veterinarian services in the cost of growing, %	5.64 ± 0.55	9.74 ± 1.33***	5.81 ± 1.25

Note: here and hereafter: * $P \leq 0.05$, ** $P \leq 0.01$, *** $P \leq 0.001$; **** DKK – Danish Krone

The share of feed cost for rearing piglets increased with an increase in initial live weight. Thus, it was 4.15 % higher in animals of the II group and 16.76 % higher in piglets of the III group compared to the analogs of the I group. At the same time, the share of feed costs in rearing one piglet was
12.10 % higher in group III animals than in group II.

The expenses for veterinary drugs, vaccines, and ser- vices of a veterinarian were also higher in the II group. Theyexceeded similar expenses compared to animals of the Igroup by 41.96 % and the III group by 52.46 %. The minor expenses were for animals placed for rearing with a live weight of more than 8 kg. Thus, when raising one piglet in this group, the costs of treatment and veterinary care were probably ($P \leq 0.001$) lower by 18.10 % compared to the analogs of the I group and by 52.46 % compared to the ani- mals of the II group ($P \leq 0.001$). The share of veterinary expenses in rearing one piglet in the II group was the high-est. With high probability ($P \leq 0.001$), it exceeded the simi- lar share of costs in animals of group I (4.10 %) and in ana- logs of group III by 3.93 % ($P \leq 0.001$), almost twice.

Thus, with an increase in the initial live weight of pigletsin rearing above 7.0 and 8.0 kg, their value also increased by
6.22 and 19.88 %. Whereas, when transferred to fattening, the cost of one piglet in the II and III groups almost equaled and exceeded the cost of animals in the I group by 2.28 ($P \leq 0.01$) and 2.36 % ($P \leq 0.05$), respectively. At the same time, the cost of growing one head, on the contrary, decreased by 2.77 and 20.12 %, with an increase in the initial weight when setting up for growth. The cost of rearing piglets that weighed more than 8 kg at weaning was 17.84 % lower than the counterparts whose initial weight at rearing was 7–8 kg and by 20.12 % compared to animals whose live weight at the beginning of rearing was less than 7 kg. The cost of feed spent on growing one piglet and obtaining 1 kg of growth did not have a clear dependence on the initial live weight of piglets on growing. The share of feed in the cost of rearing one piglet increased with an increase in the live weight of piglets by 2.33 and 9.41 %, while the costs of veterinary care did not depend on the weight of piglets at the beginning of rearing.Using factorial analysis, we calculated the influence of the weight of piglets when setting up for rearing on the lead-ing productive indicators and the cost of rearing piglets. As can be seen from the table 5, when placed on rearing, the weight of piglets had a probable influence of 14.2 % on the average daily growth but did not significantly affect thepreservation of piglets and the cost of their rearing.

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Table 5
The influence of the live weight of piglets at the beginning of growing on productivity indicators

Indicators	Amount of squares	Middle square	F fact	Fcrit at α = 0,05	P-significance	HIP 0,05	% contribution to the total amount of sq.
Average daily increase							
General, Cy	103023.99						
Live mass, A	14664.63	7332	6.39	3.12	0.00271	18.473	14.2 %
Remainder, Cz	88359.36	1148					85.8 %
Conservation							
General, Cy	88.52						
Live mass, A	4.01	2.0	1.82	3.12	0.16820	0.571	4.5 %
Remainder, Cz	84.51	1.1					95.5 %
Cost							
General, Cy	32141.95	79					
Live mass, A	1731.38	2 866	2.19	3.12	0.11862	10.837	5.4 %
Remainder, Cz	30410.57	77 395					94.6 %

Having completed the analysis of experimental data, we concluded that the increase in the weight of piglets when placed on rearing did not result in an improvement in feed conversion, as reported by foreign scientists (Wenk et al., 1980; Agostini et al., 2013), but on the contrary, it deteriora-tion by 5.43 % and 7.61 %. It was also established that the initial weight of piglets on daily feed intake was influenced. Piglets with a higher initial weight consumed 8.43 % and 18.07 % more feed per day compared to their counterparts with a lower weight, which is contrary to the reports of otherresearchers (Schinckel et al., 2010), which indicated no significant relationship between daily feed intake and initial weight of piglets. Nevertheless, at the same time, we re- ceived confirmation of the data (Huting et al., 2018) thatwith a higher initial live weight of piglets during rearing, the experimental herd showed higher average daily gains by 1.76 % and 10.13 %, which was directly opposite to theconclusions of domestic authors (Pelykh et al., 2014), who spoke of higher both average daily and relative growth in piglets with a low initial weight at the beginning of rearing, which in turn was caused by the factor of nest alignment in terms of mass and growth intensity in groups.

In addition, we were able to establish that the cost of growing one head decreased by 2.77 % and 20.12 % with anincrease in the initial weight when setting up for growing, partially confirming the previously published data (Patience et al., 2015; Davoudkhani et al., 2020), that growing-out pigs with greater weight require less feed per unit of weight gain compared to lighter peers.

The placement of piglets for growing with a higher weight made it possible to reduce the period of stay in this technological group by 3.17 % – 15.81 % and earlier to transfer piglets to fattening with a higher weight by 2.03 % and 2.63 %, similar to how this was said by other research- ers (Schinckel et al., 2007), who, however, indicated slightly different terms, covering the time frame of the fattening period.The evaluation of costs related to veterinary and preven- tive measures showed a diverse but positive effect of the higher initial weight of piglets on their health status, similar to the findings (Guy et al., 2012; VanderWaal & Deen, 2018; Bai & Plastow, 2022). Having established a higher rate of survival in piglets with a higher initial weight relative to lighter peers, we did not confirm the results of foreign scientists (Faccin et al., 2020), who did not find a connec- tion between the lower weight of piglets at the beginning of rearing and their mortality when transferred to fattening.

3. Conclusions

It was found that with an increase in the initial liveweight of piglets on rearing above 7.0 and 8.0 kg, the rear- ing duration decreased, the average daily gains increased, and the average daily feed consumption and weight of pig- lets when transferred to fattening increased. At the same time, a decrease in absolute gains and deterioration of feed conversion were recorded. At the same time, feed consump- tion per piglet during the rearing period did not depend on the initial live weight during rearing.

It has been proven that with an increase in the initial live weight of piglets during rearing, their value for this period also increased, while when transferred to fattening, their value in all groups almost leveled off. At the same time, the cost of growing one head, on the contrary, decreased with anincrease in the initial weight when setting up for growing.

The feed share in the cost of rearing one piglet increased with the live weight of piglets, while the costs of veterinary care did not depend on the weight of piglets at the beginningof rearing.

The weight of piglets at the time of rearing had a proba- ble influence of 14.2 % on the average daily

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growth but did not significantly affect the preservation of piglets and the cost of their rearing.

Prospects for further research. A promising research di- rection will be studying the influence of the mass of pigletsat the beginning of rearing on their fattening indicators and the quality of carcasses.

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