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THE INFLUENCE OF THE SIZE OF THE PIG FARM ON THE PRODUCTIVITY OF PIGLETS AND THE EFFICIENCY OF THEIR BREEDING

Mykola POVOD[1], Olena IZHBOLDINA[2], Oleksandr MYKHALKO[1], Bogdan GUTYJ[3], Victor SHUPLYK[4], Tetyana VERBELCHUK[5], Valeriy BORSHCHENKO[5]

[1]Sumy National Agrarian University, 160 H. Kondratiiev Steet, Sumy, Ukraine
[2]Dnipropetrovsk State Agrarian University, Department of Livestock Production Technology, 25 S. Efremov Street, 49600, Dnipro, Ukraine
[3]Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies, 50 Pekarska Street, Lviv, Ukraine
[4]Podillia State University,12 Shevchenko Street, Kamianets-Podilskyi, Khmelnytskyi region, Ukraine
[5]Polissia National University, 7 Stary Bulvar, Zhytomyr, Ukraine

Corresponding author email: snau.cz@ukr.net

Abstract

The article investigated the productivity of Danish-bred piglets during rearing in small and medium-sized pig farms and large industrial complexes, as well as the effectiveness and components of rearing costs and the influence of pig farm size on them. In small pig farms, it was found that piglet survival rate during rearing was 0.24-0.45% higher and growth intensity was 3.15-5.46% higher during this period. The absolute gains were 0.59-2.50% higher and the weight of piglets at transition to fattening was 4.53-8.50% higher than in medium and large size farms, respectively. At the same time, animals in large farms had 4.15% lower birth weight, 3.17% absolute and 2.19% average daily gains and 1.60% lower weight of animals at transition to fattening compared to medium size farms. It has been shown that the most effective feed was used by animals reared in medium capacity farms. The feed cost per piglet was lowest for animals reared on medium-sized farms, 9.67% lower than for animals reared on small farms during this period, and 9.70% lower than for animals reared on large pig farms.

Key words: *cost price, feed conversion, growth, piglets, rearing.*

INTRODUCTION

Pig farming plays a critical role in global food production (Ruckli et al., 2022), and pigs are a valuable source of meat and provide a significant portion of global pork production (Rauw et al., 2020). At the same time, the efficiency of production depends on many factors, such as the age and initial weight of pigs at the time of placing them for rearing (Shvachka, 2023), the duration of the rearing period (Nechmilov, 2019), housing conditions during this period, the size of the group of piglets in the machine, floor space, and the feeding front for one piglet and another.

The livestock sector is rapidly industrialized, especially in developing countries (Mirle, 2012). According to reports (Povod, 2021), pig farms in Ukraine are usually divided into small farms with up to 6,000 animals, medium farms with 6,000 to 15,000 animals, and large pig complexes with a capacity of more than 15,000 animals. Today, there are 1,700 pig complexes operating in Ukraine, in which there are 3.7 million pigs, and only 95 enterprises have more than 5,000 pigs (Myhalko, 2021). According to the known data (Dudin et al., 2013; Voloshchuk et al., 2014), large industrial enterprises use the latest achievements of science and technology, which allow more rational use of space and material resources, and carry out narrow specialization of production processes with the involvement of narrowly qualified specialists who have more important skills in the competitive process The concentration and specialization of pork production, which was accompanied by the introduction of industrial technology for pig farming, contributed to a significant reduction in labor costs for pig maintenance due to the automation of production processes (Povod &

Shpetny, 2018; Tsereniuk, 2017). Of the two possible directions of pig farming development: extensive and intensive - intensive is the most important. Intensification of pig farming is a development path in which, due to the increase in the cost per animal and a more complete and rational use of the means of production, an increase in the productivity of the animals and, consequently, an increase in pork sales is achieved and, therefore, an increase in pork production (Tsereniuk, 2017). Intensive pig production offers many advantages in terms of animal health, food safety, hygiene and biosecurity as well as some welfare aspects compared to extensive production (Maes et al., 2019). According to reports (Povod, 2022), the industrialisation of pork production on small farms increased the production of products per 1 m2 of production area by 2.22 times and the production of pork per worker by 1.44 times, while in medium-sized farms this production per 1 m^2 of production area increased by 2.01 times and in large farms by 3.17 times, while the gross production of products per worker increased by 3.54 times in medium-sized farms and by 4.61 times in large industrial complexes. There are different opinions about the welfare and productivity of piglets when they are kept in pig farms with different capacities. Thus, according to data (Nechmilov, 2019; Windhorst, 1998), it is known about the improvement of productive indicators in piglets due to the use of industrial technology at large industrial complexes due to the creation of more comfortable conditions for their keeping.

At the same time, there are a number of publications (Shpetny & Povod, 2016; Shpetny & Povod, 2018; Shpetny, 2019) claiming that large group housing of piglets is usually used in industrial complexes where staff attention to the animals decreases and their safety and productivity deteriorates. While other authors point out that piglet productivity does not depend on the capacity of the farm and focus on the technological aspects of husbandry, including the intensity of pig growth (Lebret, 2008). It is known that pig growth depends on their genetic affiliation (Šprysl et al., 2005), feeding systems (Rauw et al., 2017; Nechmilov, 2019), health (Cornelison et al., 2018), housing conditions (Povod & Shpetny, 2016; Lykhach, 2015) and production process management methods (da Fonseca de Oliveira et al., 2023).

Thus, farm size can influence pig growth and feed consumption through various factors related to management, resources and infrastructure. Larger farms often use more specialized management methods and trained personnel (Oosthuizen & Janovsky, 1981) to deal with specific tasks, such as nutritionists, veterinarians, and farm managers. This can lead to more efficient and effective management strategies, including optimized feeding programs and better monitoring of pig rearing. Consequently, well-managed large farms can achieve high growth rates and feed efficiency compared to farms with medium and small pig herds (Izmaylov et al., 2022; Makara et al., 2019).

In addition, large farms usually have more space to raise pigs, and sufficient space allows pigs to move freely, increase their physical activity, and behave more naturally. When pigs have sufficient space, they are less likely to suffer crowding and compete for resources, which can cause stress in some herds and stunt growth (Chidgey, 2023; Nielsen et al., 2022). In addition, larger farms may be able to house pigs separately at different growth stages, which optimizes conditions and promotes growth. Another factor somewhat related to farm size and pig housing technology is group size (Spoolder et al., 1999). It can indirectly influence pig growth during the rearing period through social tensions in the herd. It has been proven that pigs are social animals that naturally form a social hierarchy (Signoret et al., 1975; Tong et al., 2019). However, contrary to what has been said, there is an opinion that individual pigs in small groups have more opportunities to establish their social status, keep it stable longer, and consequently reduce competition for resources such as food and water and minimize hierarchical reorganization of the herd. This can lead to higher growth rates because pigs are exposed to less stress and can access resources more easily and expend less energy and hierarchy struggles (Lykhach et al., 2020; Riedel et al., 2012; Rhim, 2012).

All of the above factors can have varying degrees of influence on small and medium-sized farms and large industrial pig breeding complexes. Therefore, taking into account the above information, the study of the influence of the size

of the pig enterprise and the initial weight of piglets when growing them is relevant and timely.

Our hypothesis is that increasing the number of pigs per farm and as a consequence of its size will increase the productivity of pigs.

The objective of our experiment was to determine the effect of farm size on pig productivity, feed conversion, and farm economic efficiency.

MATERIALS AND METHODS

The material for the study was the productive qualities and economic indicators during the rearing of hybrid pigs obtained from crossbred sows of the Danish Landrace and the Danish breed Large White, inseminated with semen from boars of the terminal lines of the Danish Duroc. The object of the study was the technological processes in 80 farms in the Kingdom of Denmark. Data from open sources of the rating analysis of DB-Tjek pig farms for 2021 in the Kingdom of Denmark, conducted by the consultancy Svine Rådgivningen, were used for the analysis. The data to be studied were randomly selected from this report. In order to investigate the influence of farm size, all pig farms studied were divided into three groups according to the extent of annual rearing of piglets.

The first group included small farms with an annual production of 6,000 to 15,000 piglets, the second group included medium-sized pig farms with an annual production of 15,001 to 30,000 piglets, and the third group included pig farms complexes with an annual production of more than 30,000 pigs. Based on the data in this report, the growth intensity of piglets and their preservation during rearing, daily consumption and consumption of feed per 1 kg of growth, costs of rearing piglets and their components were analyzed. A single-factor analysis of variance was used to determine the effect of farm size on the main productivity parameters of piglet rearing and the economic indicators of the farm.

RESULTS AND DISCUSSIONS

As shown in Table 1, the weight of piglets when placed on rearing depended on the size of the pig farm. At 7.6 kg, it was highest in small pig farms. As the size of the farm increased, the weight of piglets when they were put into the nursery decreased. Thus, it was lower by 0.32 kg (4.53%) in medium-sized farms and by 0.60 kg (8.5%) in large pig farms than in small farms ($p<0.05$). At the same time, the weight of piglets at birth in large farms was 0.28 kg or 4.15% lower than in medium farms. The greater mass of piglets at the beginning of rearing contributed to their higher growth energy. Thus, animals raised on small hog farms during this period were likely to have higher average daily gains by 15.9 g (3.35%) ($p<0.05$) compared to peers raised on medium farms and by 29.9 g (5.46%) ($p<0.01$) compared to analogues raised on large hog farms at this time. While the average daily gains of the animals of the third group turned out to be 10.0 g or 2.19% worse compared to the analogues of the second group.

Table 1. Growth rates of piglets depending on the size of the pig farm

Indicators	I Group (6000-15000 pigs per year)	II Group (15001-30000 pigs per year)	III Group (more than 30000 pigs per year)	p-value
Number of pig farms taken into account (n)	28	32	20	-
Weight of piglets at the beginning of rearing, kg	7.0 ± 0.29^{a}	6.7 ± 0.23^{ab}	6.4 ± 0.10^{b}	<0.05
Average daily increase, g	473.7 ± 5.92^{a}	457.9 ± 7.26^{ab}	447.9 ± 6.51^{b}	<0.01
Absolute growth, kg	25.2 ± 0.46^{a}	24.5 ± 0.37^{a}	25.3 ± 0.57^{a}	>0.05
Weight of piglets at the end of rearing period, kg	32.2 ± 0.43^{a}	31.3 ± 0.38^{a}	31.8 ± 0.50^{a}	>0.05
Preservation of piglets during rearing period, %	97.8 ± 0.16^{a}	97.6 ± 0.21^{a}	97.4 ± 0.26^{a}	>0.05

Note: Different lowercase letters (a, b) indicate statistical differences between the columns.

Taking into account the almost identical period of piglet rearing in all the complexes, the absolute growth of the piglets during this period was naturally higher in the animals of the first group, which, according to this indicator, exceeded the analogues of the second group by 0.63 kg (2.5%) and those of the third group by 0.15 kg (0.59%). The piglets of the third group

had the highest indicators of absolute growth, exceeding the analogues of the second group by 0.78 kg (3.17%) and the analogues of the first group by 0.15 kg (0.59%) by this indicator. Taking into account the higher initial mass at the time of rearing and the greater absolute growth during rearing, the weight of the piglets at the end of rearing was naturally higher on small pig farms. Thus, this indicator was 32.28 kg for the animals in the second group, 0.95 kg (2.94%) for the animals in the third group and 0.45 kg (1.35%) for the animals in the third group compared to the control group. At the end of rearing, the piglets of the third group were 0.50 kg (1.60%) heavier compared to the peers of the second group.

It was also found that small pig farms had a slightly better survival rate of piglets during the growth period compared to medium and large farms.

Thus, small farms were found to have 0.24-0.45% better survival rate of piglets during rearing and 3.15-5.46% higher growth intensity during this period, 0.59-2.50% higher absolute gains and 4.53-8.50% higher weight of piglets at transition to fattening compared to medium and large farms, respectively.

At the same time, animals from large farms had 4.15% lower birth weight of piglets, 3.17% higher absolute growth, 2.19% higher average daily growth and 1.60% lower weight of animals at the transition to fattening compared to medium farms.

When analyzing the efficiency of feed use (Table 2), it was established that piglets raised on small pig farms consumed about 0.04 kg (4.44%) more feed than their counterparts raised during this period on medium-sized farms and by 0.06 kg (7.78%) more than their peers who grew up on large pig farms. In turn, the latter animals consumed 0.03 kg (3.49%) more feed compared to animals that were raised on medium-sized farms at that time.

Table 2. Efficiency of use of fodder depending on the size of the pig farm

Indicators	I Group (6000-15000 pigs per year)	II Group (15001-30000 pigs per year)	III Group (more than 30000 pigs per year)	p-value
Number of pig farms taken into account (n)	28	32	20	-
Average daily feed consumption, kg	0.8±0.014[a]	0.7±0.010[a]	0.7±0.011[a]	>0.05
Feed consumption per 1 kg of growth, kg	1.7±0.02[a]	1.6±0.02[a]	1.6±0.03[a]	>0.05
Feed consumption per head, kg	43.5±0.92[a]	41.8±0.81[a]	42.9±1.36[a]	>0.05
Feed consumption per head, DKK	114.1±2.50[a]	103.1±1.8[b]	113.1±3.22[a]	<0.001
Feed consumption per 1 kg of growth, DKK	4.5±0.073[a]	4.2±0.050[b]	4.4±0.101[a]	<0.001

Note: Different lowercase letters (a, b) indicate statistical differences between the columns; DKK - Danish krone

Higher average daily feed intake, despite higher growth energy, resulted in poorer feed conversion in the animals of the first group. Thus, it was 0.03 kg (1.59%) higher than in the animals of the second and third groups. Taking into account the different absolute growth of animals in complexes with different capacity, feed consumption per head was highest in piglets of the first group and lowest in animals of the second group. The difference was 1.71 kg or 3.93%. Piglets raised in large industrial complexes consumed 1.08 kg (2.59%) more feed per head compared to their counterparts raised in medium-sized farms at that time, and 0.63 kg (1.44%) less compared to their peers raised in small farms. Accordingly, the cost of feed to raise an animal was lowest for the piglets raised on medium-sized farms, based on the cost of one kilogram of feed. This figure was probably 11.04 Danish kroner (9.67%) lower than for low capacity farms and 10.00 Danish kroner (9.70%) lower than for large pig farms. The feed cost of raising a piglet on large pig farms was again only 1.04 Danish kroner, or 0.91%, compared to animals on small pig farms.

Feed costs for achieving one kilogram of growth were lowest for animals in the second group. Thus, they were 0.33 Danish kroner (7.28%) lower than this indicator in the animals of the first group and 0.26 Danish kroner (6.19%) lower than in the animals of the third group.

In this way, the feed was used most effectively by animals in farms with medium capacity. They have a 3.93% lower amount of feed per head compared to the animals raised in small pig farms at that time and 2.59% lower compared to the

animals raised in large pig farms at that time. Feed cost per piglet was lowest for animals from medium-sized farms, 9.67% lower than for animals from small farms, and 9.70% lower than for animals from large pig farms. Mean cost per 1 kg of piglet gain was lowest in medium capacity farms, i.e. 6.19% better than the same indicator in large farms and 7.28% better than in small farms.

The most important indicator of pork production is its economic efficiency. Table 3 shows the costs of raising piglets and their main components in farms with different capacities. As can be seen from this table, the cost of piglets used for rearing is highest in small farms due to their higher live weight. In contrast, the price of a pig taken out of rearing was already highest in large farms and lowest in medium farms. This also caused a different cost of raising one head of piglets. Thus, the lowest cost per piglet was found on small pig farms, and it increased with the growth of the farm's capacity. Thus, on medium-sized pig farms, it turned out to be 4.70 Danish kroners (2.71%) higher compared to small ones. At the same time, the cost of rearing in large pig farms was 4.71 Danish kroners (2.45%) higher compared to this indicator in medium-sized farms and 9.40 Danish kroners (5.03%) in comparison with small pig farms.

Table 3. Efficiency of growing piglets depending on the size of the pig farm

Indicators	I Group (6000-15000 pigs per year)	II Group (15001-30000 pigs per year)	III Group (more than 30000 pigs per year)	p-value
Number of pig farms taken into account (n)	28	32	20	-
The cost of 1 head at the beginning of breeding, DKK	264.1±4.20[a]	259.1±3.81[a]	260.0±2.73[a]	>0.05
Cost of 1 head when transferred for fattening, DKK	451.1±3.66[a]	450.8±2.94[a]	456.5±2.01[a]	>0.05
The cost of raising one head, DKK	187.0±4.46[a]	191.7±3.66[a]	196.4±2.68[a]	>0.05
The share of feed in the cost of raising 1 head, %	61.7±1.62[a]	54.0±0.89[b]	57.7±1.80[a]	<0.001
Part of veterinary costs for breeding 1 head, DKK	12.2±1.79[a]	11.9±1.51[a]	13.67±1.53[a]	>0.05

Note: Different lowercase letters (a, b) indicate statistical differences between the columns; DKK - Danish krone

The cost structure for rearing pigs on farms with different capacities proved to be different. However, feed accounted for the largest share of rearing costs. For example, on small pig farms, feed accounted for 61.7% of the cost structure for rearing a piglet, while on large pig farms and medium-sized farms, the share of feed in the cost of rearing a piglet was 4.0 and 3.69% lower, respectively, compared to small farms. We also examined the share of medicines and veterinary services in the total costs of rearing piglets. Medium-sized farms also scored the best on this indicator, as the share of veterinary costs was 0.31 and 1.75% lower, respectively, compared to small farms and large pig complexes.

Thus, the cost of rearing a piglet was lowest on small farms, 2.51% lower than on medium farms and 5.03% lower than on large complexes.

The share of feed in the cost of rearing piglets was 7.64% lower in medium capacity farms than in small farms and 3.69% lower than in large pig farms. The percentage of medicines, veterinary drugs and services of a veterinarian was 1.44% in large pig farms compared to small farms and 1.75% compared to medium capacity farms.

Using a factorial analysis of variance, a probable influence of 8.2% of farm capacity on piglet growth intensity during rearing was found (Figure 1).

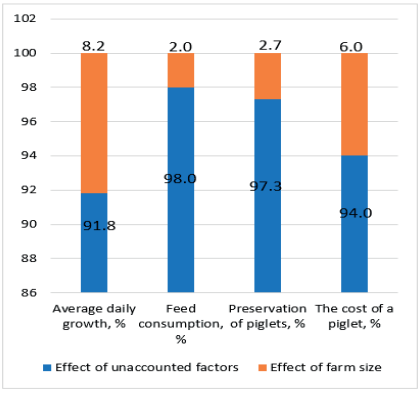

Figure 1. The influence of the size of the pig farm on average daily gains, survival of piglets, feed conversion and the cost of raising one piglet

In contrast, the influence on conservation and feed consumption per 1 kg of growth was significantly lower and unlikely at 2.7 and 2.0%, respectively.

Also unlikely was the influence of the capacity of the pig complex on the cost of rearing a piglet at a value of 6.0%. Thus, the capacity of the pig complex had a probable influence of 8.2% on average daily gains and an improbable influence on the cost price of piglets, their conservation and feed conversion (Table 4).

Table 4. Results of one-factor variance analysis

Indicators	SS	MS	F	F crit (α = 0.05)	P-value	HIP 0.05
Average daily growth						
Total, Cy	101442.99					
Size of the pig farm, A	8300.60	4150	3.39	3.12	0.03901	19.215
Unaccounted for factors, Cz	93142.39	1226				
Feed consumption						
Total, Cy	1.00					
Size of the pig farm, A	0.02	0.0101	0.78	3.12	0.45982	0.062
Unaccounted for factors, Cz	0.98	0.0129				
Preservation of piglets						
Total, Cy	88.38					
Size of the pig farm, A	2.39	1.2	1.05	3.12	0.35349	0.584
Unaccounted for factors, Cz	86.00	1.1				
The cost of a piglet						
Total, Cy	32141.95					
Size of the pig farm, A	1934.45	967	2.47	3.12	0.09165	10.801
Unaccounted for factors, Cz	30207.50	392				

Comparing the results of our research with the reports (Nechmilov, 2019; Windhorst, 1998; Izmaylov et al., 2022; Makara et al., 2019) indicating improvement of productive indicators in piglets due to the use of industrial technology in large industrial complexes, we note a deterioration of average daily gains in piglets kept in large farms compared to medium and small farms. Moreover, our results did not agree with the other conclusions (Tsereniuk, 2017), which spoke of an improvement in the productivity of pigs when the size of the farm was increased and, accordingly, the number of pigs kept there was increased. We found an increase in productivity in medium-sized farms and a decrease in productivity in farms with the largest number of livestock, which is consistent with the results (Shpetny & Povod, 2016; Shpetny & Povod, 2018; Shpetny 2019), but contradicts the data (Lebret, 2008), which found the absence of a significant effect of farm size on the productive characteristics of pigs. However, there were reports (Shpetny, 2019) where the author focused on the deterioration of the conservation index with the increase in the size of the farm and the number of pigs on it, which we could not confirm in our experiment.

Moreover, our results of the analysis of feed costs in farms of different sizes do not agree with the data (Izmaylov et al., 2022; Makara et al., 2019) reporting that large farms can have higher feed efficiency than farms with medium and small livestock. Swine On the contrary, we found that feeds are used more efficiently on medium-sized farms than on large and small farms and on swine farms.

CONCLUSIONS

It was found that in small pig farms, piglets are better maintained during rearing, their growth intensity during this period is higher, absolute gains are greater, and piglets have a higher weight at the transition to fattening than in medium and large farms.

Feed was used most effectively by animals in medium capacity farms. They have the lowest amount of feed per animal and the lowest feed cost, both per piglet and per 1 kg gain.

The cost of raising one piglet was the lowest on small farms, while its fodder and veterinary costs were on farms of medium capacity.

The size of the pig complex had a probable effect of 8.2% on average daily gains and did not affect

the cost price of piglets, their preservation and feed conversion.

Our hypothesis of increasing pig productivity with increasing farm size was only partially true for medium-sized pig farms, but not for large-sized ones.

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