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# Rearing of newborn piglets in nests classified by their weight

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## ABSTRACT

Usually, the first to be born are larger piglets. They occupy the front nipples of the sow, which produce more milk. Small piglets are born later, and they have posterior low-milk nipples. Our research aims to study the possibility of the redistribution of nests of newborn piglets depending on their weight. Crossbred sows obtained from crossing sows of a large white breed with the board of the Landrace breed were selected for the experiment. Newborn piglets were weaned from their natural sows, and new nests were formed, in which all piglets were only large, medium, or small. Before the experiment started, the small piglets' weight was less than that of the control by 10.1%, and after 60 days of our research, it was 6.5%. The safety of small piglets was 73.5%, which is lower than in other groups by 0.8-3.0%. The maximum milk content was in sows feeding medium-sized piglets, and the shortest - was in sows feeding small piglets. The formation of new nests of piglets, depending on their weight, allows us to grow large and small piglets, which die under normal conditions.

**Keywords:** Newborn piglets, Feeding, Sow milk, Nests, Weight.
**Article type:** Research Article.

## INTRODUCTION

The mammary gland of a sow usually consists of 12-16 lobes. Each lobe develops and functions independently and does not depend on the neighboring ones. The milk release occurs during the lactation reflex from the teats, which are directly irritated by piglets. Without systematic irritation of the teats with suckling and secreting, the mammary gland is exposed to rapid involution. Part of the alveoli mammary gland is not released from the secretion and undergoes destruction (involution). In unused lobes, milk consistency changes, blocking milk ducts and provoking inflammation (Trukhachev *et al.* 2015). The unoccupied teats of the udder stop functioning, become smaller, and dry up. Furthermore, in the following parity, they may become less productive or stop functioning. The sows with partly functional udder are unable to grow large litter. There are approximately ten newborn piglets in one group. After birth, the piglets enter a complicated social and physical environment. The littermates share the exact source of feeding (udder), whereas social interactions, including aggressive ones, are quite intensive and require energy. The littermates compete for a teat after birth (De Passillé *et al.* 1988; JankoSko 2014). It is especially relevant when the hyper-prolific sow has more piglets in the litter than functional teats (Schmitt *et al.* 2018). Some farmers allow sows to feed more piglets than the number of their functional teats, limiting the use of farrowing crates (Kobek-Kjeldager *et al.* 2020). Thus, it is evident that littermates have to compete for limited access to food resources. Access to colostrum and milk is essential for survival; newborn piglets have to reach the sow's udder soon after birth and continue feeding throughout the increasing lactation period (Alonso-Spilsbury *et al.* 2004). However, large litters (≥ 14 piglets) have potential problems for the well-being of the litter and the sow. This can lead to a high level of fighting for the udder, a decrease in suckling milk by piglets, and a greater risk of teat injuries (Rutherford *et al.* 2011). On the other hand, if the number of piglets is less than the number of functioning teats for the first 12-14 hours after farrowing, more is needed to maintain lactation. Alterations in gene transcription can accompany the mammary involution. The involution process is reversible within one day postpartum but not if a mammary gland stays non-suckling for 3 days. Mammary glands that undergo involution early in lactation do not show further involution in the post-weaning peri (Farmer 2019). The aim is to research nests formed with newborn piglets homogenized to birth weight and transferred onto the foster sows fitted to the number of their functional teats.

## MATERIALS AND METHODS

The research was held in a hog farm located in the Krasnoyarsk region of the Russian Federation. The experiment on the principle of analogy was conducted on hybrid sows obtained by crossing breeding sows of the Large White breed and breeding boar Landrace. All sows had one farrow each. The average live weight of sows before the first insemination was 132 kg. The age of the first farrowing sows was 303 days. The sows' feeding, housing, and nursing conditions were identical and consistent with the scientifically substantiated norms of the All-Russian Institute of Animal Husbandry adopted in the Russian Federation. The nests of newborn piglets with a sow in each were formed according to the principle of analog—breed, age, etc. For the experiment, four groups of newborn piglets were formed, with five nests in each group. It was important for the newly formed nests to be accepted by the foster sows. The sows could easily distinguish the foster piglets by smell, so they did not feed them and allowed them to stay close. Thus, the piglets had to have the same smell, so the sows could not distinguish their piglets from the cross-fostered ones. For this purpose, all the piglets of the experimental groups were weaned after the farrowing from their mothers, put into the box, and sprayed with a special fluid "ASD-3" (Erokhin *et al.* 2020) and kept together for up to 30 minutes, then transferred onto the sows, which accepted all of them. All the piglets were weighed and divided into 4 categories before transferring. The average number of piglets per sow in each group was n. The 1-test (control = $T_1$) group consisted of piglets raised under their birth mothers without transplants (n = 11.7). The 2-experimental group ($T_2$) consisted of large/heavy piglets 1.600-2.100 kg (n = 11.3), in the 3-experimental group ($T_3$): medium/average piglets 1.300-1.599 kg (n = 12.0), and in the 4-experimental group ($T_4$): small/undersized piglets 0.990-1.299kg (n = 11.3). According to their weight, the suckling pigs were transferred onto the foster sow farrowed on the same day, coinciding with the number of its functional teats. Thus, new nests of similar-weight piglets were formed and fostered in the foster sows. The number of lactating teats in sows of the experimental groups was determined during the first feeding. For this purpose, the number of teats from which drops or streams of colostrum were secreted from the teats occupied and unoccupied by the piglets was counted. The piglets were supervised from birth until weaning at the age of 60 days. The animals were kept in brick pigsties, in individual, atypical, converted crates with a total area of 7 $m^2$, divided into a zone for resting and feeding piglets of 1.5 $m^2$ and a zone for keeping sows with piglets of 5.5 $m^2$. The recreation floor had a wooden covering. The piglet's compartment was equipped with a heating lamp. On the front side of the crate was an external fence with a piglet feeder and a large feeder for the sow. On the backside was a slotted floor, under which was a groove with the manure conveyor. The conditions for keeping animals in all groups were identical. The microclimate parameters corresponded to the recommended standards. Piglets began to be accustomed to the pre-starter "Provimi" from the 5-day age. The feeding of experimental animals was carried out using standard full-fledged compound feed according to the technology adopted on the farm. Diets were formulated to meet or exceed NRC (2012). For the experiment, one-litter sows were selected with high reflexes of maternal behavior, peace, and capability of feeding all piglets. The date of the farrowing of foster ones corresponded to the time of birth of the cross-fostering piglets. The sows were not fixed. Piglets were not distributed on teats and were kept in nests with the sow in the same sector. Criteria such as hyper-prolific (p), milk yield (kg), live weight (kg), survival of piglets (%), and economic efficiency (in rubles) were considered. A hyper-prolificacy of sows was calculated right after farrowing by counting the amount of live-born piglets. The milk yield of sows was determined at 21 days of litter weight. The accuracy of the differences between the groups was determined using a student's t-test. Statistical analysis was performed using the Statistical Analysis Systems, statistical software package version 9.4 (SAS Institute Inc., 1989).

## RESULTS AND DISCUSSION

Live weight is the most evident indicator of animal growth and development, and it can change dramatically with regard to age, rearing strategy, and other factors. The research revealed that cross-fostering reflected the dynamics of the piglets' live weight (Table 1).

**Table 1.** The dynamics of piglets' live weight (kg).

| Group | Age (days) | | | |
|---|---|---|---|---|
| | **After birth** | **21** | **40** | **60** |
| 1–test (Control) | 1.620 ± 0.043 | 4.290 ± 0.205 | 8.112 ± 0.333 | 15.592 ± 0.425 |
| 2–experiment ($T_2$) | 1.761 ± 0.025** | 4.416 ± 0.163 | 8.152 ± 0.321 | 15.192 ± 0.362 |
| 3–experiment ($T_3$) | 1.456 ± 0.015*** | 4.679 ± 0.231 | 8.612 ± 0.423 | 15.730 ± 0.412 |
| 4–experiment ($T_4$) | 1.175 ± 0.021*** | 3.585 ± 0.161** | 7.477 ± 0.307 | 14.580 ± 0.287* |

During the period of forming nests, the live weight of new-born pigs in the control group ($T_1$) was lower than second group ($T_2$) by 8.7% ($p > 0.99$) and higher than in the third by 10.1% ($p > 0.999$) and in the fourth group by 27.5% ($p > 0.999$). However, at 21-day age, there were changes in the dynamics of the live weight of suckling piglets. Thus, the heaviest-born piglets collected in $T_2$ grew worse than their mates in the $T_3$ by 5.6%. This tendency continued until the end of the experiment, and upon reaching 60-day age, the live weight of the suckers of $T_2$ was less than in the control group and $T_3$ by 2.6 and 3.4%, respectively. Initially, the live weight of the newborn piglets in $T_4$ was the lowest compared to other groups by 19.3 - 33.3%, and after 60 days of research, the differences narrowed to 4.0 - 7.3%.

Fig. 1 shows the dynamics of average daily weight gain.

Piglets in $T_3$ in control dates had maximum average daily gain and exceeded the control group's result by 2.1% before weaning. Heavy (group 2) and undersized birth weight piglets (group 4) had a slow growth rate, staying behind their mates in the test group by 3.8-5.8%. To choose reliable growth criteria, it is necessary to proceed from the concepts of absolute and relative growth accepted in biology and animal husbandry and correlated with live weight and growth.

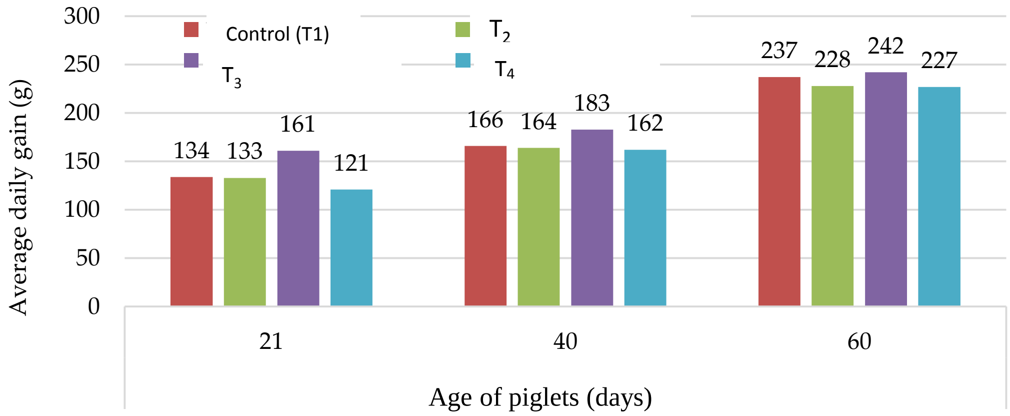


**Fig. 1.** Average daily gain (g).

Therefore, the absolute growth, rate of increase in live weight, and relative growth of suckling piglets were calculated to provide comprehensive characteristics of their growth. The results are shown in Table 2.

**Table 2.** Absolute weight gain, rate of increase in live weight, and relative growth.

| Age, days | Group | | | |
|---|---|---|---|---|
| | **Control (1st test)** | **$T_2$ (2nd experiment)** | **$T_3$ (3rd experiment)** | **$T_4$ (4th experiment)** |
| **Weight gain (kg)** | | | | |
| For 60 days | 13.972 | 13.431 | 14.274 | 13.405 |
| Rate of increase in live weight (times) | | | | |
| On the 21st day | 2.6 | 2.5 | 3.2 | 3.1 |
| On the 40th day | 5.0 | 4.6 | 5.9 | 6.4 |
| On the 60th day | 9.6 | 8.6 | 10.8 | 12.4 |
| Relative growth (%) | | | | |
| On the 21st day | 165 | 151 | 221 | 205 |
| On the 40th day | 401 | 363 | 491 | 536 |
| On the 60th day | 862 | 763 | 980 | 1141 |

The absolute weight gain of piglets in $T_3$ exceeded the analog numbers of the control group ($T_1$) by 2.2%. In the case of undersized piglets in $T_4$ at 40 and 60 days of age, the rate of increasing live weight exceeded the number in the other groups by 1.6-3.8 times, with relative growth of 161-378%.
The relative growth of pigs compared with an average of live weight was calculated according to the formula S. Brody (Fig. 2).

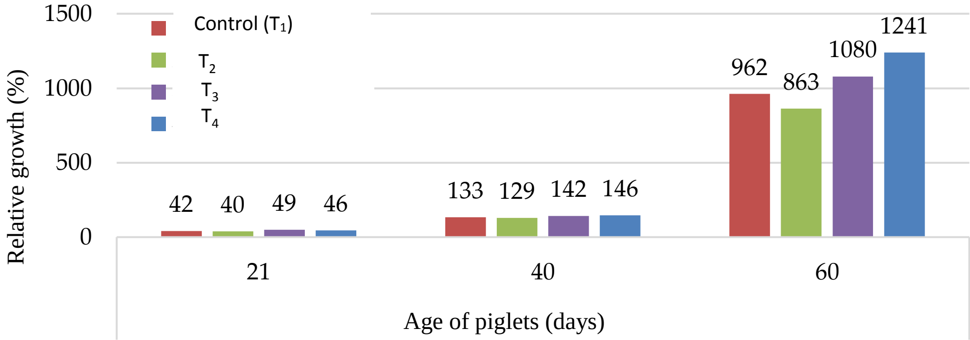


**Fig. 2.** Relative growth of piglets.

The relative growth of piglets $T_4$ was 8% higher than in the control group ($T_1$) and 4-12% higher than in the experimental groups ($T_2$, $T_3$, and $T_4$) . The intensity of growth is presented in Fig. 3. The diagram allows us to follow the changes in the growing intensity of piglets at certain stages of the suckling period. The piglets in $T_4$ grew most intensively, prevailing their mates from other groups by 161-378%. Even the smallest piglets with a similar weight on cross-fostering grow and develop intensively.

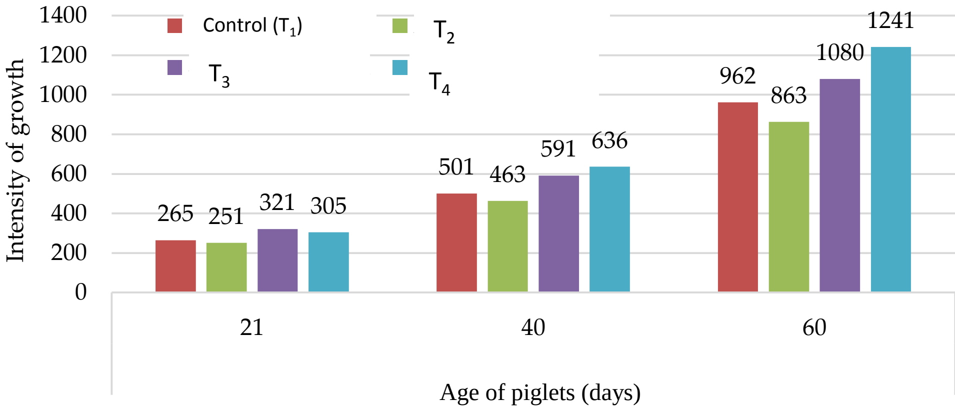


**Fig. 3.** The intensity of growth.

The heaviest piglets are born among the first and, as a rule, become leaders and have a high weight rate before weaning. Piglets occupying subordinate places get low-milk teats, and later after weaning, they get the worst places at feeders and for resting. This affects their productivity and viability. Various diseases caused by technological errors can be the main reason for newborn piglets' mortality before weaning and their decrease in growth. It is necessary to organize comfortable conditions after the farrowing and in their first days of life to prevent such risk. In our research, the main reasons for mortality were crushing and diarrhea (unknown etiology; Table 3). The rearing of piglets in the $2^{nd}$ and $3^{rd}$ groups ($T_2$ and $T_3$) positively affected piglets' viability and improved the control numbers by 0.7-2.2%. Probably this is because large and medium size suckers had higher viability and resistance to adverse environmental factors. The milk yield of sows is a very important indicator characterizing the intensity of suckling. It depends on the piglets' weight and quantity in the nest at the age of 21 days. It determines the survival of suckling piglets, their live weight at weaning, and the weight of the nest, characterizing the ability of piglets to massage the udder and suck out milk completely. All piglets were weighed at 21 days of age to determine the milk yield capacity of sows (Table 4). The sows in $T_3$ had the highest number, and the test result improved by 15.7%. The minimum milk yield was in $T_4$. The number was lower than in the test group by 29.4%. Reliable differences were not found. Considering that information about the importance of suckle colostrum for newborn piglets with different weights is not known (Carney-Hinkle *et al.* 2013), and we did not find any data about conducting the experiment of cross-fostering piglets homogenized in weight and divided according to the functional teats of foster-sows, we decided to conduct this research.

**Table 3.** Viability of piglets (%).

| Group | Loss | | Alive (%) |
|---|---|---|---|
| | goals | % | |
| 1–test (Control = $T_1$) | 15 | 25.7 | 74.3 |
| 2–experiment ($T_2$) | 13 | 23.5 | 76.5 |
| 3–experiment ($T_3$) | 15 | 25.0 | 75.0 |
| 4–experiment ($T_4$) | 15 | 26.5 | 73.5 |

**Table 4.** Lactation of sows (kg).

| Group | Number of piglets in the nest at the 21st day | Milk yield of sows (kg) |
|---|---|---|
| 1–test (Control = $T_1$) | 10.7 | 45.8 ± 4.83 |
| 2–experiment ($T_2$) | 10.7 | 41.2 ± 4.26 |
| 3–experiment ($T_3$) | 11.3 | 53.0 ± 6.45 |
| 4–experiment ($T_4$) | 9.0 | 32.3 ± 4.50 |

The aim of this study was to maintain the method of rearing piglets that can improve the development of mammary glands while saving and growing undersized newborn piglets. It is known that suckling milk and colostrum from each lobe prevents consistency, blocks milk ducts, and causes inflammation in the mammary gland. This allows the development of mammary glands for the next farrows. Indeed, when a mammary gland does not produce milk in the first parity, it can stop functioning at all or have diminished development and lower milk yield for feeding the piglets in the next parities. Our opinion conforms with the opinion of Farmer (2019), proving that the action of a teat being suckled affects mammary development in the ongoing lactation and impacts mammogenesis in the following lactation. Indeed, when a mammary gland is not suckled in the first parturition, it has a diminished development and lower milk yield in the second. Furthermore, it was shown that suckling of a teat for the first 2 days postpartum of primiparous sows is sufficient to ensure optimal mammary development and milk yield from that mammary gland in the next lactation. The behavior of nursing piglets in early lactation is also affected by whether or not a teat was previously used. Such knowledge of biology in lactation is essential to develop the best-adapted strategies for the currently used hyper-prolific sow breed and to optimize the growth rate of their piglets (Farmer 2019). The strategy of dividing newborn piglets into nests and obtaining the number of functional teats of sows is crucial. It influences the functioning of mammary glands and provides enough milk and colostrum for each piglet and their viability. The quantity of piglets should be correlated to the number of functional teats. This is the only possible way to increase and keep the milk yield of sows up to the end. Alexopoulos *et al.* (2018) insist that udder assessment for functional teats should occur at farrowing, with the number of fostered piglets not exceeding the number of teats. Primiparous sows should receive as many piglets as the udder allows to maximize mammary stimulation, although older parities should be assessed for rearing ability. Colostrum and milk are the only available food for newborns. If a newborn piglet misses one or some feedings, it gets weaker, decreases in growth, and cannot compete with littermates for a source of food. It is necessary to provide each newborn piglet with its teat of sow. It is known that colostrum intake provides piglets with heat, digestible energy, and immunity (Alexopoulos 2018). So, colostrum intake is one of the main sources of passive immunity and allows a slight weight gain. It is important to obtain enough colostrum to ensure piglets' survival (Quesnel *et al.* 2012; Charneca *et al.* 2021). Rooke *et al.* (2002) confirmed that piglets' viability depends on consuming colostrum during the 24-48 hours after birth. Colostrum provides them with immunoglobulin and helps increase their passive immune system, stimulate their digestive system (Farmer *et al*. 2019), and improve their thermoregulation ability (Herpin *et al.* 2002; Ferrari *et al.* 2014). Colostrum is a source of immunoglobulins, mostly IgG and energy, to avoid hypoglycemia and hypothermia of piglets (Herpin 2002; Rooke *et al.* 2002; Ferrari *et al.* 2014). The minimum volume of colostrum per piglet is suggested to be 200 g (Skok *et al.* 2014). Thus, the colostrum intake is crucial for piglet growth and survival (Quesnel *et al.* 2012). Suckling is accompanied by intense fighting among littermates, especially during the first days after farrowing (Skok *et al.* 2014). However, it is known that the largest piglets are born at the beginning of farrowing and occupy the high-yield milk teats. As a rule, these teats are located closer to the sow's head. Undersized and weak piglets get the last and low-milk teats. The observations made by Janko Skok and Dejan Škorjanc (2014) have shown that breastfeeding is a coordinated process that

usually begins with the beginning of lactation. Once it is established, the cohesion of suckling in the group persists throughout lactation, even when the stability of the teat order is disturbed. This statement allows us to conclude that undersized/small piglets do not have the opportunity to take possession of another, more milk teat subsequently. A small piglet has relatively few opportunities to survive when most of its littermates have a large weight, but it can live and develop normally if its mates have the same weight. Compared with their heavy littermates, the undersized piglets are at a disadvantage in access to the mammary glands. Therefore, they consume less colostrum (Ferrari *et al.* 2014; Declerck *et al. 2017*), leading to higher pre-weaning mortality rates (Le Dividich 1999; Zeng *et al.* 2019). Our research confirms it. Thus, the lactation of sows feeding the undersized/small piglets was less than in the control group by 29.4%, in the 2nd group (large) by 21.6%, in the 3rd group by 39.1%. According to the opinions of scientists Muns *et al.* (2013), Charneca *et al.* (2015), Le Dividich *et al.* (2017), and Zeng *et al.* (2019), undersized/small newborn piglets have higher pre-weaning mortality rates. This conclusion was reached after observing the growing piglets without cross-fostering into homogenous nests.
In our research, when new nests of piglets were formed depending on their live weight, it was found that in the nests with small piglets at birth (group 4 - experimental group), the number of piglets that died was, on average, 15 per group or 3 per nest. The same amount was in the control group and the third experimental group (average in piglet weight). Therefore, the experiment demonstrated that forming three categories of groups according to weight allows small/undersized piglets, too, which in ordinary conditions leads to mortality. Our statement is correlated with Herpin's (2002) opinion, which claimed that light/small piglets had a lower energy reserve and a lower ability to thermoregulate. Therefore, they needed more time for the first suckling and were less competitive for teats than heavier/large piglets (Le Dividich 1999; Rooke *et al.* 2002). Thus, considering the physiological immaturity of light/undersized piglets and their need for longer suckling, it is necessary to rear undersized/light piglets separately from piglets of large and medium size after the farrowing. Otherwise, the light/undersized piglets will consume less colostrum and milk. The lower birth weight of dead piglets confirms the assumption that piglets with lower birth weight and lower viability than who consume colostrum are more likely to die from crushing or health problems due to lower energy and IgG levels (Le Dividich 1999). The low mortality rate observed in a group of piglets with high birth weight regardless of their colostrum intake reveals the importance of weight for piglet survival (Herpin *et al.* 2002), however in practice, the piglets in the nest have different weights. By a large fluctuation in weight, piglets do not have equal competition for the teats during hourly suckling, whereas light/undersized piglets do not participate and perish because of malnutrition. The heterogeneity of birth weight (BW0) is an essential trait of sow productivity. The BW0 of piglets within a litter usually ranges from 18 to 26% (Zeng *et al.* 2019; Moreira *et al.* 2020). Within-litter variation in BW0 is positively correlated with pre-weaning mortality (Wolf *et al.* 2008) and variation in weaning weight (Muns *et al.* 2014). High within-litter variation in BW0 is associated with a greater proportion of low BW0 piglets in the litter (Quesnel *et al*. 2008). Low birth weight piglets have less glycogen reserve at birth (Vanden *et al.* 2019) and have a larger surface area to volume ratio, making them more susceptible to hypothermia and hypoglycemia during the first 24 h of postnatal life (Baxter *et al.* 2008). Pigs with a low weight birth have the lowest growth results and the lowest rate (%) of lean meat at weight slaughter. Low birth weight correlates with a low rate of viability and lower rates of postpartum growth (Trukhachev *et al.* 2016). Most piglets with a low birth weight have a low number of muscle fibers, which is differentiated during prenatal myogenesis for genetic or maternal reasons, and these piglets with a low birth weight with a reduced number of fibers are not able to demonstrate postpartum catch-up growth (Rehfeldt *et al.* 2006). The stronger neonatal competitors /litter mates/ can receive more colostrum and milk at an early age. Nevertheless, a certain order in sucking is important because it reduces exaggerated fights for teats and minimizes the risk of missing the suckling (De Passillé *et al.* 1988). Many studies are dedicated to improving the survival rate of newborn piglets and the dairy performance of sows (Declerck 2017; Oliviero *et al.* 2019; Gourley *et al.* 2020; Charneca *et al.* 2021; Farmer *et al.* 2021; Peltoniemi *et al.* 2021). However, forming nests with newborn piglets classified by their weight category - only large or only medium, or only small piglets in one nest - has several advantages: 1) it makes it possible to keep and raise not only large but also small piglets; 2) it makes possible to better develop the mammary gland of sows.

## CONCLUSION

Thus, the formation of new nests of newborn piglets homogeneous to their live weight fostered onto sows due to the number of their functional teats allowed to save and grow not only large but also small piglets, which normally do not survive and have a high rate mortality at the first week of life.

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