The influence of the technology of keeping sows on their productive and maternal qualities

Igor Miroshnichenko[1*], *Sergey* Tresnitskiy[2], *Anatoliy* Tresnitskiy[2], *Anastasya* Kochetkova[2], and *Andrei* Rudenko[3]

[1]Lugansk State Agrarian University named after K.E. Voroshilov, campus LGAU, Lugansk, 291008, Russia
[2] Don State Technical University, sq. Gagarin, 1, Rostov-on-Don, 344003, Russia
[3]Federal State Budgetary Educational Institution of Higher Education Russian Biotechnological University, 125080, Volokolamskoe shosse, 11, Moscow, Russia

Abstract. The article discusses the issues of productivity of sows depending on the technology of their maintenance and breeding methods. It was found that the technology of cultivation and breeding methods do not affect the multiplicity of sows, but have an effect on the individual weight of piglets at 21 and 35 days, as well as the weight of the nest at weaning. According to the complex indicator of reproductive qualities (KPVC), the best indicators are characterized by sows that are kept with a single-phase technology using non-replaceable litter. **Keywords:** Technology of keeping, sows, large white, pregnancy, feed, safety, large-fruited, "Maxtor" synthetic line

1 Introduction

Since the beginning of the 1970s, pork production technology has been introduced in European countries, the USA, Canada and European countries, based on the use of year-round, flow-rhythmic production in capital specialized premises using a controlled microclimate, lattice floors and manure removal. This technology made it possible to concentrate production as much as possible, achieve high specialization and increase its efficiency. But at the same time, negative trends were also observed - deterioration of animal health and product quality due to unnatural content, environmental pollution from pig farming waste. Currently, a large part of society opposes the cultivation of pigs in conditions of intensive animal husbandry, not only because of the decrease in welfare, but also because of the negative environmental consequences. A significant advantage of extensive outdoor housing systems is that they allow pigs to exhibit their natural behavior, which limits or even excludes the development of abnormal or aggressive behavior [1].

Therefore, one of the options for improving the conditions of animal husbandry and increasing the efficiency of pork production is the introduction of resource- and energy-saving production technologies. This, along with reducing the cost of pork, will improve its quality, and, accordingly, its competitiveness and reduce the environmental pressure factor.

* Corresponding author: assassins29@mail.ru

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At the same time, experts found that modern technology has disrupted to a certain extent the relationship of the pig's body with the environment with traditional conditions of keeping and feeding [4, 5, 6, 7].

In the last two decades, alternative pork production technologies have been successfully tested and used in Europe, Canada, the USA, Japan, and Australia. They are based on the use of converted large-area premises or the construction of light, cheap hangar-type premises for keeping pigs of different sex and age groups using a deep layer of organic litter. This makes it possible to significantly reduce the cost of direct investment in construction, reduce the cost of manure cleaning, use heat from biological processes flowing in the thickness of the litter, reduce environmental pollution from production waste and at the same time increase the amount of organic fertilizers.

The housing system strongly influences the maternal behavior of sows. Freedom of movement contributes to the manifestation of farrowing behavior, for example, nest building. It is also well known that environmental conditions determine the behavior of sows and piglets in the period before weaning and that an undesirable environment can increase the frequency of nervous behavior [8, 9, 10, 11].

Alternative technologies have proven themselves well in the rearing and fattening of pigs, while not yielding to the traditional use of specialized premises and artificial maintenance of the basic parameters of the microclimate.

There is no consensus among experts on the expediency of obtaining farrowing and keeping suckling sows on a deep permanent litter. The maternal behavior of pigs is determined by the housing system in combination with a suitable breed. Free-range sows always check the litter for piglets before laying and move away from piglets that are too close [12]. This behavior prevents piglets from being crushed, which is one of the main causes of mortality in litters [13, 14, 15, 16, 17]. These issues remain under discussion for the time being.

2 Materials and Methods

The following main methods were used for research: zootechnical - determination of the dynamics of live weight and feed payment by increments, reproductive and fattening qualities, varietal composition of carcasses; statistical - determination of the probability of differences between groups of animals.

The selection of animals was carried out using the method of analog groups (age, body weight, development, origin). For the first experiment, four groups of animals were formed. Purebred animals of large white breed (UKB-2) were selected in the first (control) and third (experimental) groups. The second (control) and fourth (experimental) groups include crossbreeds obtained from a combination of queens of a large white breed and boars of the synthetic Maxtor line (M - French breeding). Animals of groups I and II were raised using three-phase technology, and animals of groups III and IV were raised using single-phase production technology.

After weaning, pigs of groups I and II were transferred to the rearing workshop, where they were kept in groups of 20 heads in machines on a concrete floor using a removable litter with a floor area of 0.5 m2/head. Upon completion of rearing at 120 days, the animals were

regrouped and transferred to a fattening enclosure, where they were kept 15 heads each in a machine on a solid concrete floor with an area of 1.2 m2/head. until fattening was completed without using litter. The room is equipped with supply and exhaust ventilation.

Animals of groups III and IV were kept from birth to slaughter without rearrangements on a deep permanent litter with a floor area of 1.4 m2 per head until the completion of fattening.

3 Results

According to the methodology, in all experimental groups, the weight of piglets at birth was taken into account, on the first day after farrowing, at this time the piglets were tattooed (nest and individual numbers). For the first three days of their life, piglets fed mainly on sow's milk and therefore the conditions of keeping sows influenced their milk production, which was defined as the mass of the nest at 21 days. We conducted an individual weighing of piglets on the 21st day of life. On the 35th day after farrowing, the piglets were weighed again and numbered with tags of different colors depending on their belonging to the group. The next individual weighing was performed at the age of 60 days.

According to the data in Tables 1 and 2, according to the duration of pregnancy, the largest indicators, according to two experiments, were sows of a large white breed covered with boars of the same breed, both with traditional and alternative maintenance technology (116.78 and 116.14 days in the first experiment and 116.33 and 116.42 days in the second experiment). Sows covered with boars of the synthetic Maxtor line were noted to have lower gestation duration (115.20 and 114.0 days in the first experiment and 115.61 and 114.84 days in the second experiment).

Table 1. Reproductive qualities of sows in various ways of keeping, (first experience, M ± m, n=15)

Indicator	Group			
	three-phase technology		one-phase technology	
	I-control	II-control	III-experimental	IV-experimental
Duration of pregnancy, days	116.78±0.46	115.20±0.37	116.14 ± 0.29	114.0 ± 0.45
Number of piglets during farrowing, heads:	12.22 ± 0.57	12.79 ± 0.37	12.43 ± 0.45	12.81 ± 0.86
Total	11.56 ± 0.41	11.20 ± 0.37	11.57 ± 0.43	11.60 ± 0.60
Including live ones	1.48±0.034	1.64±0.036**	1.38±0.022**	1.31±0.024***
Large offspring, kg	17.11 ± 0.83	18.37 ± 0.80	16.00 ± 0.80	15.20 ± 0.84*
Nest weight at birth, kg	5.61 ± 0.070	5.97±0.078***	5.84±0.0210	5.97±0.043***
The average weight of the 1st head at 21 days, kg	62.31 ± 2.07	62.07 ± 2.60	67.20 ± 2.99	67.76 ± 3.82
Milk production of sows, kg	10.69 ± 0.39	9.8 ± 0.42	10.68 ± 0.52	10.9 ± 0.72
Number of piglets at weaning (in 35 days), heads	7.9 ± 0.10	8.4 ± 0.11	8.4 ± 0.06	8.6 ± 0.15
The average weight of 1 head at weaning in 35 days, kg	84.53 ± 2.90	82.32 ± 1.99	89.88± 4.18**	93.74±5.35***

Nest weight at weaning in 35 days, kg	92.47 ± 2.14	87.52 ± 1.87	92.24 ± 2.24	94.82 ± 2.13

*-P≥0.99; **-P≥0.99; ***-P≥0.999 compared with the I (control) group.

In the first experiment, the number of piglets born ranged from 12.22 to 12.79 heads, and there was a tendency for them to increase in sows when crossing. There were no significant differences between the groups in terms of the number of live piglets, both with three-phase technology and with single-phase technology of maintenance.

The weight of the nest at birth depends on both the number of piglets and their weight. In the first experiment, a tendency was established to increase the weight of piglets at birth using three-phase technology, where it was higher in control groups I and II by 1.11 and 3.17 kg compared with peers kept using single-phase technology.

Significant differences between groups of sows in both three-phase and single-phase technology have been established on large-scale fertility. With the three-phase method of keeping, crossbred piglets were heavier by 0.16 kg compared with purebred ones with a probability of P≥0.99. With a single-phase technology of keeping, crossbred piglets had a slightly lower weight, compared with purebred ones, this difference was 0.07 kg. In general, the large-fruited piglets obtained with the three-phase technology were 0.22 kg higher than with the single-phase one.

On the 21st day after birth, the weight of piglets depended more on the genotype than on the method of maintenance. Thus, the individual weight of crossbred piglets of the II control and IV experimental groups was significantly higher compared to the I control group. Purebred piglets kept on deep bedding, due to group suckling and more favorable microclimate conditions, also outperformed their purebred peers by 0.23 kg.

According to the indicator of milk production, there was a tendency to increase it in sows, which were kept during the suckling period on a deep litter using single-phase technology. The milk content of the sows of the experimental groups was higher by 5.21 kg compared to the control ones. There was no difference between the groups with different breeding methods.

At the time of weaning, the sows of the experimental groups had from 9.8 to 10.9 piglets left in the nest. A clear dependence on the technology of maintenance and the method of breeding has not been established. Thus, 10.69 piglets remained in the nests of purebred animals of the I control group, and 10.68 piglets remained in the III experimental group, while 9.8 piglets remained in crossbred nests maintained using three-phase technology, and 10.9 piglets remained in single-phase nests. The individual live weight of piglets at weaning ranged from 7.9 to 8.6 kg and was 0.35 kg higher in piglets kept using single-phase technology. With both single-phase and three-phase technology, crossbred piglets tended to have a higher weaning weight. Since the weight of the nest at weaning consists of the number of piglets for this period and their individual weight, which were higher in the experimental groups compared with the control groups, there was a tendency to increase the live weight of piglets in the control groups.

A similar tendency to increase the mass of the nest during weaning was observed in the experimental groups. Both with three-phase technology and with single-phase technology, the weight of crossbred nests during weaning was higher compared to their purebred peers by 1.97-5.15 kg.

The safety of piglets depended more on the method of breeding than on the technology of keeping. In the I control and III experimental groups, where purebred livestock were used, the safety to weaning was 86.92-92.02%. While under similar conditions, 83.30-95.92% of piglets remained in crossbred nests. The difference between the experimental and control groups was significant (P≥0.999).

In the second repetition of the experiments, results similar to the first experiment were obtained. According to the number of piglets at birth, there was a tendency to increase this indicator in sows, which were kept during farrowing and during the suckling period using a single-phase technology using a deep layer of permanent litter. The same trend was observed for multiple births. At the same time, there was also a tendency to increase the multiplicity of sows during crossing compared with purebred breeding, but the difference between the indicators was unreliable. According to large-scale fertility, there was a significant difference between piglets that were born with single-phase technology compared to their peers, who were previously kept in individual machines with three-phase technology.

Table 2. Reproductive qualities of sows in various ways of keeping, (second experiment, M ± m, n=15)

Indicator	Group			
	three-phase technology		one-phase technology	
	I-control	II-control	III-experimental	IV-experimental
Duration of pregnancy, days	116.33 ± 0.27	115.61 ± 0.47	116.42 ± 0.32	114.84 ± 0.40
Number of piglets during farrowing, heads:	11.96 ± 0.36	12.18 ± 0.49	12.34 ± 0.52	12.51 ± 0.74
Total	11.18 ± 0.46	11.38 ± 0.52	11.68 ± 0.49	11.84 ± 0.57
Including live ones	1.39 ± 0.020	1.30 ± 0.023	1.28±0.018**	1.25 ± 0.026**
Large offspring, kg	15.54 ± 0.78	14.80 ± 0.82	14.95 ± 0.80	14.80 ± 0.88
Nest weight at birth, kg	5.52 ± 0.038	5.89 ± 0.045	5.98 ± 0.054	6.14 ± 0.062
The average weight of the 1st head at 21 days, kg	58.72 ± 2.12	61.24 ± 2.85	66.48±3.23**	67.45±3.61***
Milk production of sows, kg	10.6 ± 0.41	9.8 ± 0.56	10.7 ± 0.60	10.9 ± 0.78
Number of piglets at weaning (in 35 days), heads	8.2 ± 0.13	8.5 ± 0.18	8.6 ± 0.15	8.8 ± 0.21
The average weight of 1 head at weaning in 35 days, kg	86.92 ± 2.72	83.30 ± 2.96	92.02±3.24***	95.92±4.83***
Safety of piglets before weaning, %	91.33 ± 1.92	89.18 ± 2.06	92.05 ± 2.36	90.74 ± 2.51

-P≥0.99; *-P≥0.999 compared with the I (control) group.

The individual birth weight of piglets born in an arched room with a single-phase technology was 0.05-0.11 kg lower than their peers (with a probability of P≥0.99) born in a capital room with a three-phase maintenance technology.

The effect of the breeding method on large-scale fertility in both single-phase and three-phase technology has not been established. A similar trend was observed in terms of nest weight at birth, which in sows of all experimental groups was in the range of 14.80-15.54 kg. According to the milk content, sows were isolated, which were kept using a single-phase technology. In our opinion, this is due to the group suckling of piglets. Thus, in the experimental groups of sows, which were kept in groups on a deep litter, the milk content

was higher (with a high probability of P≥0.999) and amounted to 66.48-67.45 kg. While their peers from the control groups had it at 58.72-61.24 kg. Both among the animals of the control groups and among the experimental ones, sows differed in higher milk content when they were crossed with boars of the specialized meat synthetic line "Maxtor", compared with their peers covered with boars of a large white breed.

According to the individual weight of piglets at the age of 21 days, the same trend was observed. Piglets that were raised using single-phase technology using deep litter had a weight of 5.98-6.14 kg during this period, which is 0.25-0.46 kg higher than piglets that were raised in individual machines using three-phase technology. With single-phase and three-phase technology, there was a tendency to increase the live weight of crossbred piglets compared with purebred piglets at 21 days of age. Before weaning, 9.8-10.9 piglets remained in the nests of the sows of the experimental groups. According to this indicator, there was a tendency to increase their number in crossbred nests compared with purebred ones. Comparing the nests of the I control and III experimental groups, it was found that in piglets of similar origin, kept with different technologies, the advantage was insignificant and amounted to only 0.1 heads in favor of animals of the III experimental group, which were kept using single-phase technology with group suction, using deep bedding. At the same time, this difference was more significant between the animals of the control group II and the experimental group IV and amounted to 1.1 heads in favor of a single-phase maintenance technology.

By weaning, both purebred and crossbred piglets of the experimental groups were gaining a higher weight, which were kept using single-phase technology in an arched-type room on a deep litter.

Among the piglets of the control groups, there was practically no difference in individual weight during weaning, while among the experimental ones there was a tendency to a slight increase in the weight of crossbred piglets. The same trend was observed in terms of nest weight during weaning. It was higher in sows of the experimental groups by 5.1-12.62 kg compared with their peers from the control groups (with a fairly high probability of P≥0.999). The safety of piglets before weaning was in the range of 89.18-92.05%. At the same time, in individual machines, it was lower by 0.72-1.56% compared with the group content of sows in hangars on deep bedding. With both single-phase and three-phase technology, there was a tendency to slightly improve the safety of piglets in crossbred nests compared with purebred ones.

To determine the complex indicators of reproductive qualities, the following indices were calculated, presented in Table 3.

Table 3. Index assessment of reproductive qualities of sows of experimental groups (M±m), n=15

Experiment	Group	Indicator		
		KPVC	VG	P, points
The first experiment	I - control	99.34 ± 3.21	6.29 ± 0.77	90.74±1.33
	II - control	103.89 ± 2.56	7.73 ± 1.34	93.66±0.51*
	III - experimental	104.35±4.21*	6.43 ± 0.31	91.66±1.71
	IV - experimental	107.05±5.94**	7.84±0.95*	94.05±2.94**
The second experiment	I - control	101.39 ± 2.48	6.38 ± 0.83	91.18±1.21
	II - control	102.73 ± 3.96	7.32 ± 1.06	92.48±1.44
	III - experimental	106.21 ± 5.03*	6.52 ± 0.72	91.63±1.26
	IV - experimental	108.44±5.85**	7.56±1.22*	93.54±1.98*

*-P≥0.99; **-P≥0.99 compared with the I (control) group.

The reproductive qualities of queens are best characterized by the KPVC indicator (a comprehensive indicator of reproductive qualities). According to the KPVC indicator, it was found that this indicator was highest in sows of the IV experimental group (large white breed uterus covered with boars of the synthetic line “Maxtor”), which were kept with single-phase

technology using permanent bedding (107.05 and 108.44, respectively). This indicator was slightly lower in purebred animals kept with the same technology (104.35 and 106.21, respectively) in sows of groups I and II, it was lower and ranged from 99.34-103.89.

According to the nest alignment index, it was found that sows with purebred piglets had more aligned nests, regardless of the pork production technology. In terms of the number of points, the advantage in two experiments belonged to the sows of the II control and IV experimental groups ($P \geq 0.99$).

4 Discussion

Most researchers note that there is no discrepancy in the average daily gains and the speed of achieving the realizable mass when comparing traditional and alternative technologies. There is no consensus on the receipt of farrowing and the maintenance of suckling piglets on a deep, unchangeable litter

The above material indicates that in terms of the number of piglets at birth, sows with local offspring with single-phase maintenance technology were characterized by the best indicators. On average, in two experiments, they outperformed their counterparts with purebred offspring by 0.34 heads. There was also a slight advantage in the number of live piglets at birth in these groups.

According to the indicator of large-fruited sows of the control groups significantly exceeded their counterparts from the experimental groups. With single-phase production technology, large-scale fertility was significantly lower compared to the control groups.

Since the mass of the nest at birth consists of the number of piglets and their individual weight at the moment, a similar trend was observed on this basis. The highest nest weight was in sows with local offspring with traditional technology, and the lowest in animals with local offspring with single-phase technology.

In terms of milk production, the best indicators were observed in sows with local offspring using single-phase technology. The indicator of sows with purebred offspring, which were also kept using single-phase technology, was close to this. The milk yield of sows kept in individual machines with three-phase technology was 6.34 kg lower. With both single-phase and three-phase technologies, no dependence on the genotype was established, sows that were kept using single-phase technology using unchanged litter had a higher milk content of analogues with traditional technology.

The safety of piglets did not significantly depend on either the method of keeping or the method of breeding.

The weight of one piglet at weaning depended on both the genotype of the animals and the method of maintenance.

5 Conclusion

It was found that the technology of cultivation and breeding methods do not affect the multiplicity of sows, but have an effect on the individual weight of piglets at 21 and 35 days, as well as the weight of the nest at weaning. According to the complex indicator of reproductive qualities (KPVC), the best indicators are characterized by sows that are kept with a single-phase technology using non-replaceable litter.

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