JUSTIFICATION OF CHOICE OF STRESS-FREE PIG HOUSING METHOD ON SMALL-SCALE FARMS AT DESIGNING STAGE

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Abstract. It is known that the animal body's resistance to stress is accompanied by the drop in the growth rate of the live weight of young animals and the increased culling rate of the productive livestock. Therefore, the stress-free methods of pig housing are recommended, which eliminate or limit the effect of stress on piglets. The aim of the study was to substantiate the choice of a stress-free method of pig housing designing a small-scale family farm for 500 pigs per year. With this aim in view, an engineering simulation was performed using the data from relevant regulatory documents for two-, three-, four- and five-phase pig housing methods. According to the calculation results, the technological space-planning solutions were developed. To choose the most suited ones, two indicators were taken as the criteria: use of the main-purpose area in the isolated sections for lactating sows, suckling piglets, weaned piglets and fattening pigs ($m^2 \cdot days$) and meat production per unit area per fattening cycle ($kg \cdot (m^2 \cdot days)^{-1}$). In terms of the main-purpose area use per year, the five-phase stress-free method of pig housing was found 34.7 % more efficient than the two-phase method, 7.2 % more efficient than the three-phase method and 13.8 % more efficient than the four-phase method. The second indicator for the five-phase housing method was 7.94 $kg \cdot (m^2 \cdot days)^{-1}$ that was 38.1 % higher than for the two-phase method, 5.4 % higher than for the three-phase method and 9.1 % higher than for the four-phase method. Comparative assessment of the methods under consideration showed the two-phase method to be much worse in all respects. The four-phase method had comparable indicators with the three- and five-phase methods, but in contrast to them had no time reserve for the use of premises for additional housing of pigs depending on the feeding quality and animal genetic potential. The most rational choice was between the three- and five-phase stress-free pig housing methods, with the latter being the most feasible based on the calculation results.

Key words: pig rearing, technology, stress-free method, area, calculation.

Introduction

It is common knowledge that the animal body's resistance to stress is accompanied by the drop in the growth rate of the live weight of young animals and the increased culling rate of productive livestock for various reasons [1;2].

Two-, three-, four- and five-phase stress-free methods of pig housing in single litters or combining two to three litters in one batch (pen) are known from the previous research and operating history of pig farms in Russia and abroad. The effect of stress on animals is avoided as they move freely on their own using special access holes between the sections throughout all stages of the technological process from the birth to completion of fattening [3].

A two-phase housing method means that at the age of 28 days suckling piglets from adjacent farrowing pens are grouped and housed in the same pens up to 3 months of age. Then they move on their own into an isolated section for fattening pigs. The three-phase housing method means that the suckling piglets move from the farrowing pens to the isolated section for complete growing of weaners and later they move to the isolated section for fattening pigs. In the four-phase housing method after the complete growing of weaners there are distinguished two periods of pig fattening with the relevant isolated sections provided. The five-phase housing method includes two periods of complete growing of piglets and two periods of pig fattening with the relevant isolated sections provided.

These methods observe more accurately the adopted technology and production rhythm and safeguard the favorable sanitary and veterinary environment for all age groups of pigs. They also provide for efficient use of the main-purpose floor are a through installation of pigpens, which correspond as closely as possible to the size of animals at each growing and fattening stage.

The aims and objectives of the study were set basing on the scientific principles of national and foreign researchers involved in the improvement of the existing and development of new technologies of pig production.

The aim of the study was to select a stress-free method of pig housing at the stage of conceptual designing, which would provide the most efficient use of the main-purpose area ($m^2 \cdot$day) and a high meat production rate per unit area ($kg \cdot (m^2 \cdot days)^{-1}$).

The following objectives of the study were set:to substantiate the assessment criteria; develop the assessment methodology; calculate the pig stock and the number of places in pens; develop the technological space-planning solutions for the pig farm under consideration; assess these solutions by the developed criteria and methodology and to choose the most effective one.

Materials and methods

Two-, three-, four- and five-phase stress-free pig housing methods were estimated in relation to a small-scale family pig farm with the full production cycle for 500 pigs per year. Since all housing methods have the same isolated sections for the adult breeding stock and boars, only the sections for lactating sows, suckling piglets, weaned piglets and fattening pigs were considered.

The main-purpose floor area, the area of passages and the area cleaned and disinfected after the completion of the production cycle were considered.

The initial data for technological calculations were as follows: production rhythm of 21 days; 2.34farrowings per year; 11 piglets per 1 annual average farrowing of one foundation sow; 88 % survival rate of pig stock; 3lactating sows in a group; productive life of sows – 2.5 years, boars – 1.5 years.

To choose the technological space-planning solution at the initial stage of conceptual designing of the farm, two indicators were used as the criteria: F_{MPA} – indicator of the main-purpose area use in isolated sections for lactating sows, suckling piglets, weaned piglets and fattening pigs ($m^2 \cdot$days) and K_M – meat production per unit area ($kg \cdot m^{-2} \cdot$days).

The indicator of meat production per unit of the main-purpose area was determined by the formula (1):

$$K_M = \frac{M_W}{F_{MPA}}, \tag{1}$$

where M_W – market (live) weight of fattening pigs per year, kg.

F_{MPA} during the whole production cycle (farrowing, piglets and weaners growing, pig fattening and disinfection of premises) under the workflow by the principle “all-in all-out”was defined by the formula (2):

$$F_{MPA} = F_{PEN} + F_{PASS} + F_{DIS}, \tag{2}$$

where F_{PEN} – indicator of pigpen areause, $m^2 \cdot$days;
F_{PASS} – indicator of passage areause, $m^2 \cdot$days;
F_{DIS} – indicator of additional use of the area to be cleaned and disinfected (as well as the pen equipment) after the production cycle is completed, $m^2 \cdot$days.

The indicator of pigpen area useon *i*-th phase of pig housing ($F_{PENiphase}$)was determined by the formula (3):

$$F_{PENiphase} = \sum N_{Sj} \times \left(n_{pj} \times \left(l_{pj} \times b_{pj}\right)\right) \times n_{dj}, \tag{3}$$

where N_{Sj} – number of isolated sections for housing the*j*-thgroup of pigs;
n_{pj} – number of pens in each isolated section for housing the *j*-thgroup of pigs;
l_{pj} – length of the pen in the isolated section for housing the *j*-thgroup of pigsin terms of feed space, m;
b_{pj} – width of the pen in the isolated section for housing the *j*-thgroup of pigs, m;
n_{dj} – number of housingdays of the *j*-thgroup of pigs.

The coefficient δ_{iphase} characterising the ratio of the passage area to the total area of the technological space-planning solution for each pig housing method was defined by the formula (4):

$$\delta_{iphase} = \frac{\sum f_{Pip}}{\sum f_{Sip}}, \quad (4)$$

where $\sum f_{Pip}$– total area of passages under the two-, three-, four-and five-phase stress-free methods of pighousing, m^2;

$\sum f_{Sip}$–total area of sections for housing all age groups of pigs under the two-, three-, four- and five-phase stress-free methods, m^2.

The indicator of the passage area use $F_{PASSiphase}$ on *i*-th phase for the space-planning solutions of small pig farms with stress-free pig housing methods was defined by the formula (5):

$$F_{PASSiphase} = \delta_{iphase} \times F_{PENiphas}, \quad (5)$$

The indicator of the area useto be cleaned and disinfected after all age groups of pigs F_{DIS} was defined by the formula (6):

$$F_{DIS} = \frac{F_{PEN} + F_{PASS}}{T} \times T_{DIS} \times P, \quad (6)$$

where T – pig housing time from the birth to completion of fattening, days;
T_{DIS} – time for cleaning and disinfection of sections, days;
P – number of phases in the housing method.

Results and discussion

Technological calculation of the pig farm with the full production cycle for 500 pigs per year was made in accordance with the Management Directive for Agro-Industrial Complex "Recommended Practice for Engineering Designing of Pig Farms and Complexes". Each group pen for weaners and fattening pigs is designed for one-time housing of 30 heads on fully slatted floors. The specific pen area requirement per head is 0.3 m^2 for weaners and 0.65 m^2 for fattening pigs[4].According to the calculation results the technological space-planning solutions for the above housing methods were developed [5;6].

The indicators of the main-purpose area use F_{MPA} determined at the stage of conceptual designing of a small pig farm with the full production cycle of 500 pigs per year with stress-free methods of pig housing on fully slatted floors are presented in Fig. 1.

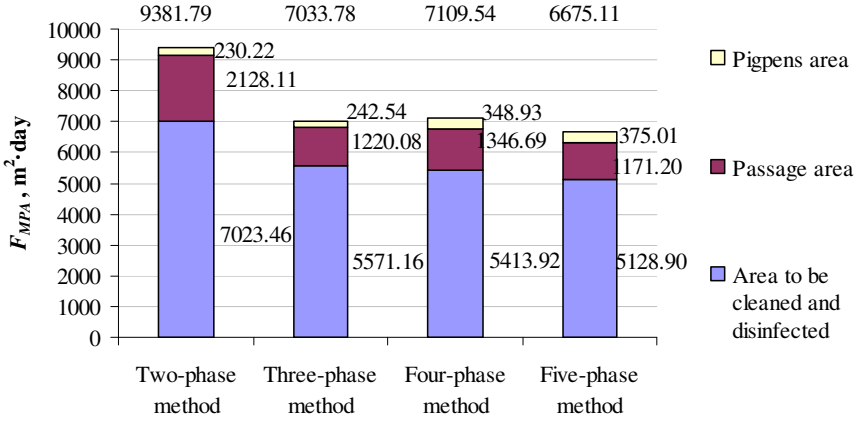

Fig. 1. **Indicators of main-purpose area use for small pig farm per production cycle**

When comparing the pig housing methods, it should be borne in mind that the lower are the values of the indicators under consideration, the more efficiently the production area is used per unit of time.

From Fig. 1, the most preferable in terms of the use open area and the passage area is the five-phase stress-free pig housing method. In terms of the use of the area to be cleaned and disinfected it is

worse than the two-, three- and four- phase methods, but this is due to the five sanitary treatments against the two, three and four sanitary treatments, respectively. In general, the indicator of the main-purpose area use per production cycle in the five-phase stress-free method is 6.1 %higher than that in the four-phase method.

Table 1 shows the dynamics of the pig weight growth to reach the market weight, the time of pig growing and occupancy of isolated sections under different stress-free housing methods. The following average daily weight increments were used in calculations: piglets – 230 g·day^{-1}; weaners – 450 g·day^{-1}; fattening pigs – 950 g·day^{-1}. Birth weight of piglets was taken 1.5 kg [7-9]. The method of statistical inquiry was applied for analysis. This allowed obtaining the reliable data on the growth dynamics of pigs.

Table1

Dynamics of pig weight up to the market weight, growing timeof pigs and occupancy of isolated sections

Pig categories	Stress-free methods of pig housing			
	Two-phase	Three-phase	Four-phase	Five-phase
Piglets, kg	29.99	7.94	9.55	7.94
Weaners 1st period, kg		31.5	18	15.75
Weaners 2nd period, kg				15.75
Fattening pigs 1st period, kg	77.9	66.5	38	33.25
Fattening pigs 2nd period, kg			38	33.25
Market weight of pigs, kg	107.89	105.94	103.55	105.94
Growing time, days	159	168	155	168
Occupancy of sections, days	168	179	168	183
Time reserve in the use of premises adjusted for the quality of the genetic potential of animals and the feeding level, days	-	31	-	27

After the simplified calculation, the indicator of market weight achievement under the two-phase and four-phase stress-free pig housing methods was found higher than that under the three-phase and five-phase ones, with the growing periods being shorter. However, the calculation of this indicator is conditional because the increase in the animal weight is described by a polynomial function and is not linear [1]. In this case, it is important to note that to reach the market weight of pigs within the growing period of 159 and 155 days, respectively, is possible only if the animals have high genetic potential, and this is almost impossible on the small-scale farms in Russia.

On small-scale farms, it is important to have a certain time reserve for housing of all groups of pigs. In case of poor feeding and low genetic potential of the animals, it might be needed to increase the housing time of animals in order to reach the market weight and at the same time not to break the process flow. The three-phase and five-phase stress-free methods provide for the use of premises for 31 and 27 days more, respectively.

In addition, stress-free methods of pighousing should be assessed in terms of meat production per unit area. The assessment results are presented in Table 2.

Table2

Indicators of meat production per unit area for different stress-free methods of pighousing

Stress-free methods of pig housing	F_{MPA} (per year), m^2·days	Market weight of pigs per year, M_W, kg	K_M, kg·(m^2·days)$^{-1}$
Two-phase	20383.07	117201.9	5.75
Three-phase	14342.62	108011.5	7.53
Four-phase	15446.32	112487.12	7.28
Five-phase	13313.74	105650.54	7.94

Table 2shows that in terms of meat production per unit area, the three-phase and five-phase stress-free methods of pighousing are preferable to the two-phase and four-phasemethods.

Conclusions

In terms of the main-purpose area use per year, the five-phase stress-free method of pig housing was found 34.7 % more efficient than the two-phase method, 7.2 % more efficient than the three-phase method and 13.8 % more efficient than the four-phase method.

The indicator of meat production per unit area for the five-phase housing method was found to be 7.94 kg·(m^2·days)$^{-1}$; it was 38.1 % higher than that for the two-phase method, 5.4 % higher than that for the three-phase method and 9.1 % higher than that for the four-phase housing method.

At the conceptual designing stage, the comparative assessment of technological space-planning solutions for a small-scale pig farm with the full production cycle for 500 pigs per year with the stress-free housing methods by the criteria of the main-purpose area use (m^2·days) and meat production per unit area (kg·(m^2·days)$^{-1}$) showed that the two-phase method of pig housing was much worse than the other considered methods.

The four-phase method had comparable rates with the three-and five-phase methods, but unlike them, had no time reserve for the use of premises adjusted for the feeding level and the quality of the genetic potential of animals.

The most rational choice was between the three- and five-phase stress-free pig housing methods, with the latter being the most feasible based on the presented calculation results and in terms of ensuring the favourable veterinary environment on the pig farm.

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