Organic pig farming as part of green economy

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Abstract. Organic agriculture is an important area of high-quality food production and one of the stages of transition of agricultural production to green economy rails. At the moment, assortment on the Russian market of organic products is limited and there are no meat products in general. The aim of this study is to analyze the state of domestic pig breeding and the possibilities of conversion a certain segment of the industry to organic production. The methodological basis was the researches by domestic, foreign scientists, as well as our own studies. In the course of the work, general methods of scientific knowledge were used, which ensured reliability of the obtained results. Taking into account global trends towards healthy nutrition, Russian pig breeding has all prerequisites for conversion to organic production. Due to the high marginality of organic pig breeding, there are all the prerequisites for organic pork to enter the world agrifood market. The implementation of this direction will require small business development, creation of a certification system for meat and meat products, training of qualified organic zootechnicians, as well as development and improvement of technologies.

1. Introduction

Organic agriculture is an important area of high-quality food production and one of the stages of conversion of agricultural production to green economy rails. In Russia, policy towards development of production and provision of the population with safe food products was proclaimed by the Food Security Doctrine of 2020, which develops provisions of the National Security Strategy [1].

The global organic market is currently valued at 80 billion dollars. In 84 countries, the production of such products is regulated by relevant laws. It should be noted that in Russia a similar law Federal Law No. 280 "On Organic Products" came into force on January 1, 2020, and even earlier similar laws were adopted in a number of regions of the country, including Krasnodar territory [2, 3].

The concept of organic agriculture, which is declared by the International Federation of Organic Agriculture Movement (IFOAM), is based on four basic principles, which can be formulated as follows:

• the principle of health, based on the position that human health is inseparable from well-being of the ecosystem, therefore, any activity should be focused on maintaining and improving the health of both humans and animals;
• the principle of ecology means production of food products within the scope of a natural ecological system and natural life cycles using organic substances and natural components;
• the principle of justice is focused on social part of economy and assumes food security for all countries and access to quality products for all people, while animals should also have decent living conditions, taking into account their physiological needs and instincts;
• the principle of care based on the position that increasing efficiency and productivity of agricultural production should not occur at the expense of health and well-being of both people and nature.

The purpose of the work is analysis of the current state of domestic pig breeding and possibilities of conversion a certain segment of the industry into organic production.

2. Materials and methods
The methodological basis was the results of research by domestic and foreign scientists in the field of organic animal husbandry, as well as our own studies.

The analysis of the status of the industry and prospects for ecologization was carried out using official data from state authorities and analytical materials from industry unions.

In the research work, general methods of statistical, scientific knowledge and methods of conducting zootechnical experiments were used. The cumulative use of generally accepted methods ensured reliability of the obtained results.

3. Results and discussion
Organic animal husbandry is a production that minimizes the use of synthetic feed, additives and growth stimulators. At the same time, the main requirement is to obtain products with biologically valuable and functional qualities, taking into account physiological and behavioral needs of animals (provision of high-quality organic feed, compliance with optimal number of animals per unit area, etc.) [4, 5].

The need to maintain a healthy lifestyle contributes to development of organic animal husbandry, because animal food constantly affects human health [6]. Therefore, high requirements are imposed on the production of organic meat products at all stages of the technological process. Disorders at any stage of the production process can negatively affect quality and safety of products. So, stress in pig breeding contributes to the accumulation of hormones unnecessary for humans in pork. It should be noted that narrowly targeted selection for high meat content led to the appearance of meat defects - pale, soft, exudative meat with reduced technological qualities and increased processing losses. According to the conclusion of Danish scientists, this defect is a consequence of "poor adaptation syndrome of pigs", which is also called stress syndrome. It should be noted that Denmark is the European leader in pig breeding. Danish pig producers in 1998 voluntarily adopted a ban on the use of antibiotics-growth stimulants on fattening farms. They introduced the mandatory use of toys in meat processing plants for pigs before slaughter, and much more. This is probably why the main buyer of pork in this country is Japan, whose residents are very responsible for their health. This branch of animal breeding significantly contributes to welfare of the country, where on average about two pigs per resident, and pig production account for 10% of exports. In Germany, a program called the Animal Welfare Initiative has been running since 2015, aimed at obtaining the highest quality meat by creating the most comfortable living conditions for animals.

In Russia, organic meat is still consumed mainly by prosperous residents of big cities: Moscow, St. Petersburg, Sochi. High prices and competition from uncertified fresh products are holding back organic production. Such products in our country are 3-7 times more expensive than ordinary ones, while in the USA and EU countries this value is only 30-50%. More than 70% of the Russian organic meat market is imported, with actually no pork. Meanwhile, according to forecasts, by 2030 organic meat products market may reach 5 billion euros [7].

Analysis of prospects for development of organic pig breeding showed that Russians traditionally prefer pork meat (more than 40%). This is due to both gastronomic preferences of compatriots, high taste and nutritional value of meat. Pig meat has a high calorie content (in 1 kg of pork 3160 kcal,
respectively - 13230 kJ), and in terms of vitamin B1 content it surpasses even black and gray bread (0.2-0.3 mg%). Also, this meat contains other vitamins and a large amount of minerals. Consumer properties of meat are determined content of biologically complete proteins, which are a source of essential amino acids. The digestibility of pork nutrients is 90-95%, the fat is more easily digestible than any other animal fat, and is necessary in production of sausages.

2018 was the turning point for the industry, when from an importer of pork in 2012, Russian pig breeding in 6 years reached full self-sufficiency in pork meat (Table 1).

| Table 1. Pork production in the Russian Federation, thousand tons. |
|---------------------------------------------------------------|
| **Year** | 2005 | 2010 | 2015 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|
| Pork production, thousand tons | 1520 | 2337 | 3083 | 3744 | 3937 | 4319 |
| Self-sufficiency, % | 60 | 66 | 91 | 100 | 100 | 100 |

It should be noted that according to preliminary results of 2020, pork is practically the only driver of growth in production of all types of meat. Other sources of animal protein show little or no gain. Saturation of the domestic meat market with pork is one of prerequisites for finding ways to improve quality. The conversion of certain sector into organic production is obvious and understandable. It should be noted that pork is a relatively inexpensive product; it consistently ranks third in retail and wholesale prices after mutton and beef. With an indicator of meat consumption of 77 kg per person per year, part of pork is more than 28 kg and this value continues to grow. According to statistics, over the past 5 years, annual consumption of pork has increased by more than 0.5 million tons due to decrease in its price, while the upward trend is predicted to continue.

As the experience of foreign countries shows, organic products, as a rule, are obtained on family-type farms. In Russia, at the same time, a large share of pork is produced by large holdings and more than 80% of pigs are kept in large agricultural enterprises (Table 2).

| Table 2. Pork producers in the Russian Federation, thousand tons. |
|---------------------------------------------------------------|
| **Form of organization** | **Year** | 2019 | 2020 |
|---|---|---|---|
| Agricultural organizations | 3420.8 | 3823.6 |
| Farm | 40.4 | 38.0 |
| Households | 475.6 | 455.5 |
| Total | 3936.8 | 4319.1 |

Since organic pig breeding is a fairly new direction in animal husbandry, this niche has not yet been filled in the world meat market, and there has been no competition among producers. Taking into account achieved complete self-sufficiency in pork, the issue of expanding export of this type of animal protein is relevant, which requires improving quality indicators to level of importing countries. Taking into account the global trends of growth in demand for organic food, production of organic pork may become one of the export items. Natural-climatic and production potentials allows to significantly increase volume of production and export of organic pig products.

Another important consumer of organic pork is baby food enterprises, where are severe regulatory requirements for quality of raw materials, especially for the presence of a number of growth-stimulating drugs. Therefore, production of pork for baby food is a separate segment of organic, eco-friendly, specializing in production of high-quality, and inexpensive products. This can be explained, in our opinion, both by complexity of the organization of the production process itself, and by the requirements for keeping, feeding and treating livestock. At least 50% of the feed must be of its own production or produced by other farms conducting organic production.
Organic pig breeding, taking into account the environmental factor, is a paradigm of sustainable development with low feed consumption and low emissions with high efficiency, which corresponds to the basic tenets of green economy [8; 9]. It should be noted that, both in the world and in Russia, organic animal husbandry is less developed than organic crop production. At least 50% of animal feeds must be of its own production or produced by other farms conducting organic production.

By cultivating quality feed, an optimal livestock density rate and a pig breeding system that ensures animal welfare and minimizes stressful situations, an optimal production model can be developed. Formation of harmonious relationships between soil, vegetation and animals, compliance of physiological and behavioral animal needs is the basis of organic pig breeding, because manure is an excellent fertilizer for obtaining high yields of cereals and soybeans. To maintain ecological balance in the European Union, the following standards for keeping pigs using organic technology have been adopted (Table 3) [10].

| Animal species    | Heads per hectare/year* |
|-------------------|-------------------------|
| Piglets           | 74.0                    |
| Sows              | 6.5                     |
| Fattening pigs    | 14.0                    |
| Other pigs        | 14.0                    |

*Calculated from the equivalent amount of generated manure and dung not exceeding 170 kg nitrogen/ha.

The total density of animals should ensure compliance with nitrogen intake limit of no more than 170 kg per 1 hectare of agricultural area per year. No more than 250 sows should be kept on territory of one household; at a final feeding point of herd - at the same time there should be no more than 1000 heads. A prototype of such a production works at the Kuban Agrarian University: training and production plant «Pyatachok» for 220 sows, where the production technology agree with the organic production system.

The requirements of the standard for organic agriculture regulate the use of certified natural feed, and only allow the use of veterinary drugs in emergency cases. Such requirements are quite feasible already at the present time in connection with the introduction of chips for animals, scanners that read not only the origin, but also the quality of rations when raising pigs.

The production of organic pork without the use of stimulants, the company imposes increased requirements for compliance with technological regulations. It is possible to obtain high performance in raising livestock at lower costs only with properly organized feeding and keeping of animals [11, 12, 13, 14, 15, 16]. In pig breeding, the sucking period is very important, when there is an intensive growth and development of digestive organs and tissues, as the basis for further assimilation of feed [17]. At this stage, it is necessary to provide young animals with optimal conditions, prepare piglets for future life, and adapt them to new living conditions. The problem of the period of weaning piglets from sows lies in the change of diets and their saturation with the plant part. This is especially true at early weaning (21-30 days), as well as for low-weight piglets in multiple litters (more than 12 heads) [18].

During this period, the condition and development of the intestines are critical to future health and productivity. As a rule, after weaning, piglets have a poor appetite, as a result of which they do not gain weight and do not reveal their productive potential. Low feed intake immediately after weaning results in villous atrophy and reduced nutrient absorption and available feed energy.

By the time of weaning, piglets, as a rule, have a poorly developed gastrointestinal tract, as a result of which an insufficient amount of hydrochloric acid is released for the digestion of feed. Due to physiological characteristics, the ability to produce hydrochloric acid in the required volume appears in piglets only by 12 weeks. It should also be noted that after weaning, a favorable environment is created for the development of pathogenic microflora, and the substances produced by it damage the intestinal epithelium, reducing its absorption capacity. At the same time, the pH of the stomach
contents rises, a large number of E. coli bacteria accumulate, which is the cause of severe and prolonged diarrhea, as a result of which the loss of piglets can reach 12-15%.

Until recently, one of the methods used in animal husbandry to combat disease-causing microflora was the use of antibiotics. However, now all over the world their use is sharply limited. With regard to organic pig breeding, there is a strict ban. Therefore, to limit the growth of pathogenic and opportunistic microorganisms, it is advisable to use organic acids and their salts as an additive to feed [19; 20]. Due to the anatomical structure of the gastrointestinal tract and the physiological characteristics of digestion, the greatest efficiency is observed when using acids in feeding weaned pigs. With the introduction of organic acids, an acidic environment is created (pH = 5-5.5), in which pathogenic microorganisms die, and beneficial microflora and lactic acid bacteria develop normally, suppressing pathogens. At the same time, the acidic environment increases the activity of digestive enzymes by 2-2.5 times, which improves the digestibility of feed [21, 22]. The introduction of acids accelerates the process of protein breakdown, increasing the digestive activity and growth rate of young pigs. Thus, organic acids from the feed are an alternative to antibiotics. Preparations based on organic acids are safe to use, mix well with feed and practically do not interact with them.

In pig breeding, monocarboxylic acids are often used, containing one carboxyl group: formic and propionic acids in an amount of 0.5% by weight of feed. Compared to organic ones, they are in a partially dissociated state, and their dissociation is allowed to use formic acid - a fairly harmless substance registered in the register of food additives (E236). Compared to other organic acids, formic acid has a high acidic value - 17.3 meq/kg (for citric and lactic acid, this indicator is 9.5-9.4 meq/kg). When formic acid enters the stomach, the pH of the medium decreases to 4.0-4.5, and a barrier is created for the reproduction of pathogenic microflora. At the same time, reaching the optimum pH value increases the digestibility of the feed.

To confirm the feasibility of using formic acid for acidifying feed for weaned pigs, a research and production experiment was carried out. Piglets from 28 days of age, after weaning from sows and transferring to clean and warm pens of the nursery section, where they were kept for 7 weeks, were given acidified feed. Feeding was carried out from group feeders of a round type, one for two pens. For the experiment, two groups of piglets, 30 heads each, were formed according to the principle of analogues in terms of age, sex, origin and state of health. The experimental groups were fed with feed according to the diet (SK-5 OR), the pigs were housed in two adjacent pens. Piglets of the experimental group, in addition to the basic diet (OR), together with the feed (SK-5), were given formic acid in an amount of 0.5% by weight of the feed. The results of such studies are presented in Table 4, from which it can be seen that, with the same amount of food eaten, the experimental animals by the age of 84 days had a live weight of 32.8, versus 29.6 kg in the control, which is 10.1% higher.

### Table 4. Efficiency of pig feeding.

| Indicator                                      | The control group | Experimental group (+ 0.5% formic acid to OR) |
|------------------------------------------------|-------------------|---------------------------------------------|
| Number of pigs in group: at the beginning of the experiment, heads | 30                | 30                                           |
| at the end of the experiment, heads            | 28                | 29                                           |
| Live weight at the beginning of the experiment, kg | 8.42 ± 0.21       | 8.39 ± 0.18                                  |
| Live weight at the end of the experiment, kg   | 29.60 ± 0.32      | 32.80 ± 0.24                                 |
| Amount of feed consumed per 1 head per day, kg | 0.69              | 0.70                                         |
| Average daily gain, g                          | 380.2 ± 25.4      | 436.4 ± 21.3                                 |
| Survival, %                                    | 94                | 97                                           |
| Number of piglets suffering from digestive tract disorders, % | 3                 | 1                                            |
In the course of a scientific experiment, it was found that the introduction of an acidifier - formic acid in the diet of piglets - weaners in an amount of 0.5% by weight of feed increases the growth rate. There was an increase in average daily gains by 14.7%; the safety in the experimental group was 3% higher compared to the control group of piglets. The number of gastrointestinal diseases among the animals of the experimental group decreased by 2%. It should also be noted that in the experimental group there were fewer fights and clashes between animals, which indicates a more comfortable ethological environment. Thus, the use of organic acid contributes to the improvement of health status, increases the intensity of growth and, as a result, the financial condition of the industry.

Due to the fact that the use of synthesized vitamins and stimulants is not allowed in organic animal husbandry, it is promising to include an organic feed concentrate "Furor" on the basis of natural humic acids in the diet [23]. On the basis of the UPK "Pyatachok" of the Kuban Agrarian University, a research and production experiment was carried out to study the effect of the feed concentrate "Furor". Piglets of the experimental group on rearing during the period of growth from the 30th to the 40th day, once a day, "Furor" was added to the feed in the amount of 5 g/head, and from the 41st to the 60th day of growth - 10 g/head. Piglets on the feed from the 63rd to the 120th day, the concentrate was introduced into the feed in an amount of 15 g/head, and from 121 to 153 days, 20 g/head. The additive was introduced in the following scheme: 4 days of application, 4 days off. The results of the experiment indicate that the use of an environmentally friendly feed additive for piglets for growing and fattening in doses selected depending on age has a positive effect on the growth rate and safety of animals (Table 5).

| Group      | Average daily growth rate for growing, g | Average daily gain in fattening, g | Survival, % |
|------------|-----------------------------------------|-----------------------------------|-------------|
| Control    | 366                                     | 874                               | 98          |
| Experimental | 414                                     | 964                               | 100         |

It was found that the average daily gain for growing up in the experimental group was higher than in the control group, and 13.1%, and for fattening - by 10.3%. Safety in the experimental group was 100%, and in the control - 98%. The data obtained make it possible to recommend the use of fodder organic concentrate of natural origin "Furor" in feeding pigs and rearing and fattening.

Fulfillment of the requirement for the use of own-made feed in feeding cannot completely prevent the ingress of mycotoxins into the feed - the products of the vital activity of fungi developing on grain at high humidity and temperature. The consumption of feed with mycotoxins negatively affects the development of piglets, and in some cases can even lead to their death. For the purpose of contamination of feed, natural adsorbents based on bentonite clays can be used. It was found that the introduction of bentonite into the diet in an amount of 1% completely adsorbs mycotoxins. In addition, with bentonite, animals receive a whole range of trace elements necessary for the full growth and development of pigs [24].

The organic livestock management system includes measures to prevent environmental pollution and minimize the risk of harmful effects. Meanwhile, the intensification of production is inextricably linked with the growth of waste generation. At the same time, it should be noted that pig breeding is a potentially hazardous industry for the environment due to the large amount of organic matter and the emission of greenhouse gases. The main pollutants are nitrogen (N) and phosphorus (P) compounds. Long-term disposal of industrial pig waste leads to the accumulation of mobile phosphates in the soil to abnormally high values. Therefore, an important problem in pig breeding is the processing of pig waste. One of the ways of utilization is the processing of manure in biogas plants [25]. However, at the current level of technology development, biogas production is a rather expensive enterprise, and in the conditions of our country, with cheap electricity, it is inexpedient.
One of the ways to reduce the pressure on the agroecosystem is the production of pork in family farms for 5-6 thousand pigs. With such production, an ecological balance is achieved, when the manure transported to the fields, being included in the cycle, contributes to an increase in the amount of humus in the soil and an increase in yield by 8-11%. It should not be forgotten that, when running a family business, interest in the results of one's work increases, the socio-economic situation is stabilized due to the employment of the population. At present, in the domestic scientific literature, there are practically no works on scientific and methodological substantiation and increasing the efficiency of the functioning of pig-breeding enterprises of small forms of management. Meanwhile, in the leading countries of the world, it is this form of production that is dominant in pig breeding.

Improvement of the ecological situation can be ensured both by organizational and economic measures, and by monitoring compliance with the technology of raising animals. The main requirement of environmental legislation is the constant reduction of environmental impact through the introduction of the best environmentally friendly available technologies [26]. Recommendations for their use are set out in the information and technical reference book 41-2017 "Intensive breeding of pigs" [27, 28].

4. Conclusion
Growth in consumption of organic products is a global trend, while in Russia this segment of the meat market has significant growth potential. The country has labor resources, as well as a sufficient amount of land suitable for organic farming without long conversation period. The transformation of pig farming into organic production reduces the burden on the environment, while increasing the profitability of the business and the quality of the products produced. The state of the industry with 100% self-sufficiency of the population in pork creates the preconditions for the entry of organic meat products into the world agri-food market and profit from its export. The natural, climatic and production potential makes it possible to significantly increase the volume of production and export of organic pig products with government support from producers and the promotion of Russian products on the international meat market. The implementation of this direction will require the development of family pig breeding, the creation of a product certification system, the training of qualified specialists and the improvement of technology that meets the requirements of organic production. One of the ways to improve the safety of weaned pigs is to use acidifiers to replace antibiotics. To prevent mycotoxicosis in pigs, it is advisable to use natural bentonite clays as adsorbents in feeding.

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