Economic assessment of the development potential of mushroom production in the Russian Federation

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Abstract. The article assesses the issue of further development of the industrial mushroom production in the Russian Federation in order to fulfill the objectives of the State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials, and Food Markets for 2013-2020. It was developed in accordance with the principles of ensuring food independence of Russia, sustainable development of rural territories of the Russian Federation, and financial sustainability of agricultural producers. Conducting an analysis of the state of the world mushroom industry, general trends in the organization of industrial enterprises, and the choice of modern technological solutions, which are the basis for the intensification of production and its economic efficiency. The article assesses a level of self-sufficiency of the Russian Federation in mushroom products on the basis of a comparison of the consumption levels of cultivated mushrooms in the developed European countries, the USA, as well as East and Southeast Asia.

1. Introduction

There are economically justified prerequisites for the rapid and effective development of industrial mushroom production in the Russian Federation. In 2016-2017, the demand for fresh mushrooms amounted to about 115,000 tons. Out of them, 100,000 tons of them are imports, which consumes more than $400 million. In addition, more than 20,000 tons of compost for growing mushrooms are imported annually. At the same time, Russia has gained practical experience in growing mushrooms in previous years, when large industrial mushroom complexes were built in the Moscow, Leningrad Region, Chuvash, Tatarstan Republics, Voronezh [1]. There is a powerful resource base in various regions of the country. The main components for preparing the substrate are available in sufficient quantities, namely cereal straw and chicken manure, which is the basis for the production of compost for the cultivation of mushrooms. The decisions taken on the food embargo also favor the development of the Russian mushroom industry, which significantly reduces imports.

The course on import substitution is declared in the Russian Federation since 2014. According to statistics, the level of self-sufficiency in mushroom products is only 6.4%. In recent years, positive dynamics of the construction of contemporary greenhouse and mushroom production complexes have been noted. Projects implemented in the field of vegetable and mushroom greening have a high investment attractiveness due to the use of intensive technologies provided by contemporary technological equipment and high economic indicators. The Program for the Development of Vegetable
Growing and Mushroom Production until 2020 has been adopted at the state level. Its goal is to implement significant government support for the industry. High boundaries are indicated in this program, the implementation of which must be done in the near future [2]. According to the data of the Food and Agriculture Organization of the United Nations, Russia occupies about 22 place in the structure of world production of mushroom products, and only 46 in terms of per capita consumption only. The per capita consumption of cultivated mushrooms in developed countries ranges from 2 to 4.5 kg. In Russia, this figure is about 1 kg per person. Thus, the main target of the program is to achieve an annual volume of mushroom production of about 143,000 tons [3]. The domestic market capacity of mushroom products in financial terms is about 25 billion rubles. Thus, a unique situation is created, allowing to increase the production of fresh mushroom products, rich in protein and environmentally safe, produced in specialized cultivation facilities, and almost completely replace imported products of domestic.

2. Materials and Method
In conducting an economic analysis of the potential for the development of domestic mushroom production and modern technological systems for the production of edible mushrooms, the most widely used in the global production of mushrooms and recommended for introduction, the following methods are used: economic and statistical, methods of systems and comparative analysis, mathematical modeling and planning [4], [5]. The study is based on the collection and analysis of information and statistical data of the Rosstat, an international organization FAO (Food and Agriculture Organization of the United Nations), both of which have a reliable information in the field of global production of various types of food. We also used data from the Republican Production and Scientific Association “Greenhouses of Russia,” the assessment of trends in the development of world industrial mushroom production and the state of the domestic sector of mushroom producers. Our research was conducted in the following three stages: (1) Analyzing the level of world edible mushrooms production and the rate of its development over the past 20-25 years; (2) Assessment of the state of the domestic mushroom industry; (3) A business-innovative model of the perspective development of the domestic mushroom industry based on the use of the latest organizational and technological system is justified and proposed.

3. Results
The study was conducted in three stages. At the first stage, our analysis of the world champignon production was carried out. The production of champignons as a type of economic activity in the developed countries is allocated to an independent branch of agricultural production. In the world, in 2015-2017, the production area of cultivated mushrooms was about 27.5 thousand hectares. This is a huge area, allowing to achieve production volumes at the level of about 11 million tons of mushroom products. According to the FAO, only China produced about 7.8 million tons of various types of mushrooms in 2017. Over the past 35 years, the mushroom production increased in 10 times (about 1.5 million tons in 1980, about 11 million tons in 2017). In this structure, champignons hold the championship (more than 80%), but other types of mushrooms such as shiitake and oyster mushroom are becoming increasingly popular due to their nutritional and medicinal properties. About 15 other species of various cultivated mushrooms are produced in the world. The largest regions of mushroom production are also Europe. In the European countries, 1,300,000 tons of champignons are grown annually. About 70% of them are sold fresh, and 30% are canned or frozen. Poland was distinguished in terms of active growth in the production of fresh mushrooms, reaching a level of 260 thousand tons, almost equaling the Netherlands.

The USA is the largest producer of mushrooms in North America. The annual volume of champignon production is relatively constant and amounts to 420,000 tons per year. Most champignons are sold fresh in the domestic market.

Canada is the second largest producer of champignons in North America. The annual volume is about 100,000 tons. All fresh mushrooms enter the domestic market and the US market in small quantities.
One of the fastest growing mushroom industries in the world works in Australia. Over the past 10 years, production in this country has grown by 20% and reached 75,000 tons.

**Table 1.** World ranking of countries in terms of production of cultivated mushrooms.

| No | Country          | Production volume, t | No | Country              | Production volume, t |
|----|------------------|----------------------|----|----------------------|----------------------|
| 1  | China            | 7,800,000            | 16 | Hungary              | 32,000               |
| 2  | USA              | 420,000              | 17 | India                | 30,000               |
| 3  | Italy            | 683,000              | 18 | Belgium              | 29,450               |
| 4  | Netherlands      | 300,000              | 19 | The Republic of Korea| 26,200               |
| 5  | Poland           | 260,140              | 20 | Vietnam              | 24,000               |
| 6  | Spain            | 197,000              | 21 | South Africa         | 18,800               |
| 7  | France           | 120,000              |     |                      |                      |
| 8  | United Kingdom   | 100,000              | 22  | Russian Federation  | 18,000               |
| 9  | Canada           | 100,000              | 23  | Lithuania            | 15,800               |
| 10 | Australia        | 75,000               | 24  | Ukraine              | 15,000               |
| 11 | Germany          | 72,000               | 25  | Romania              | 14,500               |
| 12 | Ireland          | 70,000               | 26  | Portugal             | 12,000               |
| 13 | Japan            | 65,600               | 27  | Taiwan               | 10,530               |
| 14 | Indonesia        | 40,900               | 28  | Cyprus               | 11,500               |

The production of champignons in Europe is fairly stable, although a tendency to a decrease in consumption is expected. On average, consumption in Europe is 2.0 kg per person per year.

In China, the production structure of cultivated mushrooms is changing rapidly. Large modern facilities with a full set of technological equipment are replacing small primitive farms. At the same time, the growth in production remains unchanged, but in the near future, its decline is possible due to the reorientation of the Chinese mushroom industry to the large-scale cultivation of traditional for the local market mushrooms (shiitake, enoki, eringi, black tree fungus, etc.). In China, the domestic consumption of champignons is small and amounts to only 0.2 kg per person per year, with a total consumption of other types of mushrooms up to 14 kg per person per year.

The North American mushroom industries are stable and not prone to drastic changes. In the US, champignon consumption is small and amounts to only 1.5 kg per person per year. In Canada, it is much more – about 3 kg per person per year. In recent years, the Australian mushroom industry has experienced a slow growth, as the market is close to saturation. Today, Australia has the highest per capita consumption of 3.2 kg per person per year.

At the second stage, assessment of the state of the domestic mushroom industry is carried out. In Russia, industrial mushroom production is an integral part of the greenhouse vegetable growing industry. In Russia, mushroom enterprises were built on imported and domestic equipment based on the use of targeted public investment in the period from 1976 to 1995. The enterprises used the Dutch technology of cultivation of champignon of the full technological cycle. They included the following: workshops for preparing the substrate and coating material, when the cultivation of the main product, namely the champignon fruit bodies, was carried out. The payback rate for agricultural enterprises of this type was 7-8 years. In 1980, as part of the mushroom complex with a useful area of 0.25 hectares, a plant for the production of planting material of edible mushrooms was purchased to import, the project was implemented in “Zarechye” CJSC of the Moscow Region (51 km of the Moscow Ring Road). It provided the existing of 9 complexes in the country with of mushroom mycelium, as well as private entrepreneurs, focused on the production of oyster mushroom, which was grown mainly in adapted premises. The production capacity of a plant made it possible to produce up to 300 tons of mycelium annually, which ensured the cultivation of at least 12-15 thousand tons of mushrooms of various kinds. At present, the Moscow mycelium plant has ceased to exist. Therefore, in the near future, new construction of an industrial plant for the production of quality planting material would be appropriate to implement. The plant can exist as an independent production, as well as as part of the mushroom production complex, which would allow production control of the products to be carried out.
In Russia, the growth rate of the production of edible mushrooms is extremely slow. First of all, this is due to the high capital intensity of industrial mushroom production complexes. Previously built mushroom enterprises completely ceased their production activities for a number of objective reasons. The first reason is the full or partial depreciation of cultivation structures and outdated technologies (for example, “Moskovsky” Agrokombinat CJSC). A number of built champignon greenhouses work on imported compost, which is supplied from Lithuania or Poland, and this does not guarantee the operation stability of these enterprises. A centralized compost production is absent in Russia.

Analysis of the state of the domestic branch of mushroom production showed that the enterprises built earlier almost fully developed their resources, being in operation for more than 25 years. However, the experience of new construction of mushroom complexes in a market economy is absent.

In the international practice of the agribusiness, mushroom production is one of the most economically efficient industries. To date, sanctions imposed on foodstuffs from the EU countries did not affect the Russian mushroom market and the Phase 3 compost market. Polish mushrooms are supplied to Russia under the guise of products from third countries. Imported compost is not a sanctioned product.

The main influence on the market for fresh mushrooms and compost is rendered by the ruble exchange rate against the dollar and the euro, as it directly determines the cost of imported products on the Russian market. Compared with the previous year, the cost of imported compost and mushrooms in rubles increased by 20%.

The ruble devaluation also affects the budgets of new projects. Due to the absence in Russia of the production of a complex of machines for the production of compost and mushroom cultivation, they must be purchased via import. Their ruble value also increases in proportion to the depreciation of the ruble. Evaluating the prospects of import substitution equipment and the purchase of planting material of mushrooms for the production of compost for imports before 2020, we can conclude that it is not yet technically possible.

In the third stage, a model of organization of the industrial mushroom industry was developed. This model justified the following two types of production organization: expansion of mushroom production through the organization of enterprises for the centralized preparation of compost and the construction of new complexes with a full technological cycle and significant production volumes from 3000 tons per year and more.

According to the Agroinvestor Publishing House (July 2017), the Ministry of Agriculture of the Russian Federation proposed to support the development of mushroom production, including it in the State Program of Agricultural Development for 2013-2020. The corresponding draft government decree posted on the portal <regulation.gov.ru>. This confirms the interest of the state in accelerating the development of mushroom production in the Russian Federation. Real actions in this direction are also carried out by the regional authorities of Kaluga, Belgorod, and Tula regions. Regional support for new construction projects in Moscow, Samara, and Penza regions was announced.

4. Conclusion
The proposed business innovation model for the development of domestic mushroom production was the basis for the development of the Concept for the Development of Domestic Mushroom Production for the Period 2013-2020 and the development of agricultural policy measures laid down in the State Program for the Development of the Industry.

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