Formation of an organisational and technological mechanism for the development of the fertiliser market in the Russian Federation

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Abstract. Ensuring the technological sovereignty of the country, achieving a food independence is associated with the development of the fertiliser market. The conducted research points to the formed market of mineral fertilisers with stable supply and demand, with a focus on export operations. There is no organised market for organic fertilisers in Russia. Production on an industrial scale has not been established, although all the prerequisites are present, in particular, a sufficiently powerful resource and raw material base. During the period from 2009 to 2021, the volume of solid manure decreased from 105.95 million tons to 86.64 million tons, semi-liquid from 117.02 million tons to 109.13 million tons, liquid manure increased from 38.68 million tons to 87.62 million tons. There is an urgent need for the production and application of organic fertilisers, as indicated by the negative balance of humus in the soil from 3.14 to 6.26 million tons d.v. It is proposed to develop an organisational and technological mechanism for the development of the organic fertiliser market. The conceptual apparatus of the mechanism is presented, organisational and technological components are defined. In order to justify the placement of organic fertiliser production, it is proposed to use the optimal localisation of processing enterprises based on the theories of production placement. The technologies of applying organic fertilisers are substantiated, a modern set of technical means developed using high-tech technologies and tested at agar enterprises in the south of Russia is proposed. Full-fledged application of high-quality organic fertilisers contributes to the restoration of soil fertility, increasing the yield of agricultural crops.

1 Introduction

Ensuring the technological sovereignty of the country has been declared by the President a priority task for the coming decades. Thus, the country’s leadership creates prerequisites for the development of technologies, technical solutions, and the formation of the technological
potential of the state. Technologies and technical solutions in the agricultural complex of the economy are knowledge-intensive and strategically significant, as they are directly related to the formation of the country’s food independence, ensuring the food and economic security of the state. The development and modernisation of technological aspects in the agro-industrial complex is implemented in all sectors, the basis is the branches of plant and animal husbandry [1-3]. Their main task is to meet the needs of the population in food products through the development of their own production based on domestic technologies and technical means. The reduction of soil fertility in the long term threatens the food independence and economic security of the state [4-7]. The record harvests of recent years have mostly been provided by an increase in the use of mineral fertilisers. During a speech in the State Duma on December 14, 2022, Minister of Agriculture Dmitry Patrushev said that since the beginning of the year, more than 159 million tons of grain in bunker weight have been harvested in the country. In terms of net weight after cleaning and drying, this can give about 150 million tons. The Minister noted that a high indicator was achieved, in particular, due to the increase in yield, which over the past five years has increased from 25 to 34 quintals per hectare. The yield has been increased, including through the introduction of mineral fertilisers: in 2018, 39 kg/ha was introduced, in 2022, already 60 kg/ha [8].

As it is known, the direction of action of mineral and organic fertilisers is different. Mineral fertilisers have a stimulating effect on agricultural crops, provide high yields, while negatively affecting the quality of the soil. Organic fertilisers contribute to the restoration and formation of a fertile soil layer, providing a slow, but at the same time prolonged accumulation of nutrients in the soil.

Thus, with sufficient application of organic fertilisers to the soil, they are able to partially displace mineral fertilisers, contributing to the production of high yields, the cultivation of environmentally safer crops, restoration and preservation of soil fertility. The best result is achieved with the combined use of mineral and organic fertilisers in an optimal ratio.

The purpose of the study is to develop the main elements of the organisational and technological mechanism for the development of the fertiliser market with the justification of the links between its elements from the position of ensuring the technological sovereignty of the agro-industrial complex of the country.

2 Research methodology

The study and generalisation of the works of leading domestic and foreign scientists devoted to food and economic security, technological sovereignty, production of mineral and organic fertilisers, technologies, and technical means used in the agro-industrial complex was carried out. The methodological apparatus of the research is based on monographic, statistical-economic, and abstract-logical methods, as well as on resource and structural-functional approaches.

In the course of the study, it was found out that the mineral fertilisers market in Russia has been formed, the main participants have been identified, and continues to develop dynamically. The production of mineral fertilisers is one of the few branches of industry that has become competitive on the world market during the years of reforms as part of the transition to the market. The key companies producing mineral fertilisers are export-oriented, receiving most of the profits from export operations. For example, PJSC “PhosAgro”, being one of the leaders in the production of phosphorus-containing fertilisers, receives about 65-70% of revenue from the export of fertilisers. The “MHK Eurochem” Group, a producer of fertilisers with all three main active ingredients, receives about 80% of its revenue from export operations. PJSC “Uralkaliy”, which produces potassium
fertilisers, receives about 80% of revenue from the export of products. PJSC “Akron”, a producer of nitrogen and complex fertilisers, receives about 80% of its revenue from fertiliser exports. JSC “Uralchem”, which produces nitrogen fertilisers, receives 70-80% of revenue due to exports [7-8].

The considered participants of the mineral fertilisers market are suppliers to the domestic market. The development of the domestic market is hindered, on the one hand, by the low effective demand of most rural producers, and on the other hand, by the lack of commercial interest among producers to produce fertilisers at lower prices than for export. In the last few years, prices for mineral fertilisers have increased significantly and the state had to fix them for the domestic market, making them available to domestic agricultural producers. Artificial containment of domestic prices for mineral fertilisers contributes to their slower growth in relation to world prices. However, there is an increase in prices and it is very significant for domestic farmers. According to Rosstat, since 2020, nitrogen fertilisers in Russia have risen in price by almost 2 times, while export prices have increased by 4.5 times. The cost of phosphorus and potassium fertilisers has also increased significantly. The growth is likely to last until the end of 2023, and in general, prices may increase by 70% over the year.

Thus, there is a fully developed market for mineral fertilisers, with leading enterprises and outsider enterprises, which has an export orientation, in excess of the profit from the sale of mineral fertilisers in the export mode, which meets the needs within the country.

Unlike the developed market of mineral fertilisers, there is no market for organic fertilisers today. Such an important commodity for the potential development of the agro-industrial complex as organic fertilisers is produced artistically, there is no organised sale of it. We believe that there is a need to develop the production of organic fertilisers on an industrial scale, with the sale organised through sales centres, exchanges. Figure 1 shows the dynamics of organic fertiliser application in agricultural organisations. We see that in recent years the volume of organic fertilisers has increased slightly. Since 2009, the application of fertilisers has increased slightly from 1.0 t/ha to 1.6 t/ha in 2021, with the recommendation of application of concentrated organic fertilisers of about 4 t/ha. The specific weight of the fertilised area increased from 7.0% to 9.6% during the period under analysis [9].

The development potential of the organic fertilisers market is significant not only in terms of the domestic market, but also with the sale of organic fertilisers on the world market.

The organic fertilisers market has economically determinants of development. Firstly, it is the prices of mineral fertilisers, which are constantly growing both on the domestic and global markets, which means it is advisable to replace mineral fertilisers with organic ones. Secondly, the growing market of organic production, for which organic fertilisers are preferred for application. The state, for its part, creates a favourable regulatory climate for the use of these factors, reducing barriers that have hindered development.

Prerequisites for the formation of an organised civilised market exist. These include, first of all, the need for full-fledged application of organic fertilisers due to the reduction of humus in the soil [10].

The fact that there is a resource base for the production of organic fertilisers speaks in favour of the development of the organic fertiliser market. Figure 2 shows the dynamics of obtaining solid manure (TN SM), semi-liquid (PN SL), and liquid manure (WN LN). During the analysed period, we observe a decrease in the production of semi-liquid manure from 117.02 million tons in 2009 to 109.13 million tons in 2021, a significant decline in the production of solid manure from 105.95 million tons to 66.64 million tons. The decrease in these types of manure is associated with a reduction in the number of heads of animals that are suppliers of solid and semi-liquid manure. The number of cattle decreased by 16.50%,
sheep and goats, by 33.40%, horses, by 42.09% during the study period. A positive aspect in the production of solid and liquid manure is the increase in the number of poultry by 37.58% over the analysed 12 years.

Fig. 1. Dynamics of organic fertilisers application in agricultural enterprises of the Russian Federation [9].

Fig. 2. Manure production by type in agricultural organisations of the Russian Federation. Source: calculated by the authors based on [9].

Positive dynamics is observed in the production of liquid manure: from 38.68 million tons in 2009 to 87.62 million tons in 2021, which is justified by the increase in the number of pigs: from 10597.78 thousand heads in 2009 to 24005.19 thousand heads in 2021, that is, by 126.51%.
Despite the reduction in the number of some agricultural animals, as well as the growth in the number of pigs and poultry, the production of manure and manure remains significant and is increasing in aggregate terms: from 240.54 thousand tons of manure in 2009 to 254.35 thousand tons in 2021, from 211.09 thousand tons of manure and droppings in 2009 to 290.41 thousand tons in 2021. These volumes of manure require organised processing on an industrial scale to obtain high-quality organic fertilisers.

3 Results of the Research

As part of the formation of an organised organic fertiliser market, it is necessary to develop the infrastructure of the market with the allocation of the main participants: producers and consumers of organic fertilisers, as well as the mechanism of distribution of fertilisers produced. An economically important aspect in the formation of the infrastructure that requires thorough study is the justification of the distribution of organic fertiliser production. To determine the location of production, the optimal localisation of processing enterprises based on the theories of production placement (standard theories) is used. Having analysed the models of activity placement and organisation of the space of the well-known scientists-economists of Tunen, the successor of his teachings of Launhardt, the Weber model, Hotelling, the Kristaller model, and the Lesh model, we came to the conclusion that the location of the processing industry is determined by minimising costs within the framework of the standard theory, and after the saturation of the territory with products, the economic landscape is formed. The sequence of formation and placement of an enterprise for the processing of organic waste should include the elaboration of the following issues [7, 11-12].

1. Technology of production of organic fertilisers and technical means of its realisation. The introduced industrial technology should ensure the stability of production from the point of view of the resource and raw material base used, be subject to automation, be able to diversify, increase flexibility. The technical means implementing the technology interact in a single system of technological operations and provide performance optimisation.

2. Organisation of production. It is necessary to provide for the structure of the organisation, the business processes used, to justify the depth of production.

3. Availability of labor resources to ensure production. It is necessary to consider working structures with a high degree of integration of tasks and continuous professional development, management and ordinary employees are motivated to achieve decent results by the current remuneration system [13].

4. The finished product is in the form of high-quality organic fertilisers. The product requires standardisation, adaptation to different markets (domestic, global), it should provide for the possibility of expanding the product range, the introduction of new products, as well as modularisation, that is, modular production and the use of the platform concept [14-15].

5. Development of a network structure, manifested in association with other production sites; cooperation with suppliers, marketing and sales, equipment maintenance, R&D; training and retraining of cadres; development of a production site outside of its own enterprise [16].

These aspects should be taken into account when calculating the cost of produced organic fertilisers, justifying economic efficiency and profitability, prospects for the development of export operations for the sale of organic fertilisers.

We believe that there is a need to form an organisational and technological mechanism for the development of the organic fertilisers market. Under the organisational and technological mechanism we understand a system of technological processes and
organisational measures united by the economic feasibility of the production and sale of organic fertilisers on the domestic and world markets.

The structure of the organisational and technological mechanism for the development of the organic fertilisers market from the position of the organisational component will include state authorities, producers of organic fertilisers, consumer enterprises, marketing organisations, exporters, and importers of fertilisers. The enumerated participants are considered as subjects of management in the structure of the mechanism.

As an economic component of the organisational and technological mechanism for the development of the organic fertilisers market, the followings are distinguished:

- finished products (varieties of organic fertilisers with fixed prices);
- a set of economic indicators of the efficiency of production and implementation of organic fertilisers (cost, selling price, revenue, profit from sales, net profit);
- the system of customs regulation (tariff and non-tariff methods of regulation, import and export duties, quotas for the import and export of organic fertilisers).

As a result of the formation and implementation of the organisational and technological mechanism for the development of the organic fertilisers market, the followings are distinguished:

- organised satisfaction of consumer demand for high-quality organic fertilisers;
- formation of competitiveness of domestic producers of organic fertilisers;
- price availability of organic fertilisers for domestic agricultural producers;
- implementation of the fiscal function through the replenishment of the budget through the operations of the sale of fertilisers on the domestic market, as well as sales in export mode;
- restoration of soil fertility, improvement of soil quality with increased availability of organic fertilisers in the domestic market;
- reduction of the cost of production of crop and livestock products by reducing the use of mineral fertilisers, when using organic fertilisers;
- increasing crop yields.

The development of the organic fertilisers market should be accompanied by the availability of appropriate technologies and technical means for their implementation. Taking into account the situation on the market, organic products of new types (humates, concentrated organic fertilizers, biohumus, and others), it is necessary to improve the technical means, the working bodies of which must be adapted to the physical and mechanical properties of fertilisers [10]. In the south of Russia, the most common are concentrated organic fertilisers, the distinctive feature of which is low humidity (40-50%), dust-like shape, increased content of humic substances, which allows them to be applied with a dose of up to 4 t/ha. At the same time, the intensity of their influence on the state of the soil and the efficiency of cultivation of agricultural crops are equated to traditional forms of solid organic fertilisers, which are applied with doses of 40-60 t/ha.

4 Discussion and Conclusion

Technology of growing grain and row crops requires the introduction of concentrated organic fertilisers in three variants: surface, intra-soil, and in the feeding between rows.

For the surface application of concentrated organic fertilisers by the scientists of the FGBOU in the Don State Agrarian University, a machine has been developed on the basis of serially produced RUM (MVU) with a pneumocentric working body for the distribution of fertilisers over the field surface. A distinctive feature is the presence of two high-pressure fans connected by pneumatic conduits that ensure the unloading of fertilisers to the left and right along the movement of the unit. Unloading of fertilisers from the hopper of the machine is carried out by a bottom conveyor, at the exit of which it is divided into three
Two streams enter the pneumatic ducts. In the central part, the fertiliser flow enters the centrifugal spreading disc, which ensures the unloading of fertilisers in the central part of the passage of machines.

For the intra-soil application of concentrated organic fertilisers, cultivators-plant feeders are used, which allow the introduction of concentrated organic fertilisers by means of fertilising boxes through a system of fertilising wires to a depth below the seed embedding. Fertilising boxes are equipped with special agitators that exclude the formation of arches. These aggregates also ensure the row-to-row application of concentrated organic fertilisers by feeding them into the zone of operation of cultivator paws with simultaneous embedding in the soil.

This technical equipment compares favourably with existing developments, has been well tested at agricultural enterprises in the south of Russia and is the basis of the technological component of the proposed mechanism for the development of the organic fertilisers market.

The formation and development of the organic fertilisers market will allow consumers to get access to fertilisers in an organised manner if they have full information about prices, volumes, and delivery conditions. Consumers will have the opportunity to purchase high-quality organic fertilisers and apply them to agricultural crops in full, necessary to restore soil fertility and to obtain maximum yields. With the full-scale introduction of organic fertilisers using promising technologies and technical means for their implementation, domestic farmers will have the opportunity to partially replace mineral fertilisers, which will affect the reduction of the cost of production, its quality from the standpoint of improving environmental safety and the environmental situation as a whole. The formation of an organisational and technological mechanism for the development of the organic fertilisers market as a system of organisational measures, promising technologies, and technical means for the production and application of organic fertilisers, contributes to the development of technological sovereignty of the country. Restoration of soil fertility, increasing crop yields are direct prerequisites for ensuring food independence and economic security of the state.

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