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CONTROL OF TECHNOLOGICAL PROCESSES OF ORGANIC FERTILIZERS APPLICATION AS A TOOL TO ENSURE FOOD SAFETY

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Abstract: *Food security of the state is based on the progressive development of the agrarian sector by improving the profitability of its branches. The growth of profitability of the crop sector is possible while building soil fertility by using organic fertilizers. The purpose of the study is to form the aspects of implementation and approaches to the control of the process of organic fertilizers application and to identify their economic substance as a theoretical base in the current conditions of organizational and economic development and management in the agricultural sector. In order to improve the production process management and use of organic fertilizers in the agrarian sector a hierarchical system of resource and product models to optimize production and transportation of organic fertilizers has been developed. The system of resource and product models gives an opportunity to create a strategy of accommodation the technological platforms for the processing organic waste, to optimize transport costs at different levels of the hierarchy of the system implementation, to form a set of measures to increase the level of providing agricultural areas with organics. All this tends to increase the profitability of the crop production branch. To substantiate the effectiveness of the proposed measures to improve the process control of organic fertilizers application divergent forecast scenarios, such as regulatory and extrapolatory (which is subdivided into extrapolatory-inertial and extrapolatory-integrational) have been developed, the consistency of the extrapolatory-integrational forecast scenario has been proved. The designed forecast scenarios are recommended for implementation at various levels of control of technological processes in the agricultural sector, from an economic entity to the state level, using a closed loop process control of the technological processes of production and use of organic fertilizers based on resource and product models.*

Key words: *technological processes, fertilizers, organizational and economic mechanism of control, profitability.*

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1. Introduction

At present, the agrarian reforms in Russia are characterized by not quite correct attitude toward the principal means of production in rural areas, the land. In any country of the world agriculture cannot be developed without significant state support [7]. Without getting the full support, Russian agricultural production in the last 20 years survived by exhaustion of the production and soil capacity accumulated during the Soviet period.

The country has actually abandoned more than 20 million ha of the cultivated area. Of the remaining 76.3 million hectares almost 40 million have not received a single gram of fertilizers for over 20 years, that is in fact they can also move into the category of abandoned lands at any time. Disposal from the turnover of every third hectare of the agricultural land and decline in fertility of the remained land in use are the result of insufficiently thought-out agricultural policy.

With a powerful production and resource potential of 8.9% of the global productive arable land, 53% of the world humus, 20% of fresh water, 8% of the production of mineral fertilizers and 2.2% of the population in the world, the country cannot provide their population with food products and it is forced to import tens of billions of dollars of agricultural products, raw materials and food. It can threaten the Russian Federation with the loss of food security, and eventually national security [5].

In conditions of anti-Russian sanctions and the retaliatory embargo to food security is a complex, large-scale task, but the first priority is to supply the population and industry with agricultural products and raw materials in the required amounts, as well as to reduce the import dependence.

The purpose of the study is to form the aspects of implementation and approaches to the control of the technological processes of organic fertilizers application and to identify their economic substance as a theoretical base in the current conditions of organizational and economic development and management in the agricultural sector.

Food security of the Russian Federation is the state of the economy of the country which provides food independence of the Russian Federation, guarantees the physical and economic access of food to every citizen according to the Russian legislation concerning the technical regulations of the amount of food not less than the rational norms of food consumption required for active and healthy lifestyle.

The Doctrine of the Russian food safety defines a quantitative or qualitative characterization of the state of food security which allows to assess the extent of its achievements on the basis of the criteria adopted.

To assess the food security status the share of the domestic agricultural and food products is determined as a criterion in the total volume of commodity resources (including carryover) of the internal market of relevant products, having thresholds in respect of: grain – not less than 95%, sugar – not less than 80 % vegetable oil – not less than 80%, meat and meat products (based on meat) – not less than 85%, milk and dairy products (based on milk) – at least 90%, potatoes – not less than 95%.

On the basis of these data the main directions of the state economic policy in the sphere of food security of the Russian Federation have been developed. In particular, in the field of agricultural production, raw materials and food the efforts should focus on the following areas:

– improving soil fertility and productivity, the expansion of

agricultural crops at the expense of unused arable land;
- accelerated development of animal husbandry [6].

In achieving the above-mentioned crop production volumes the most important role is given to improving the effectiveness of soil fertility. Humus is the basis of soil fertility and it contributes to the improvement of air, water and heat regimes of the plow layer.

The use of large doses of mineral fertilizers, pesticides, highly-intensive tillage of soil effects negatively the soil microflora and eventually the humus formation processes. Excessive use of agrochemicals, the imperfection of technologies of crops cultivation and technical means for their implementation lead to increased mineralization of humus and as a result to the destruction of the soil [1].

The main source of increasing soil fertility is organic fertilizers. Here livestock production plays an important role, where a liquid, semi-liquid manure and litter are produced. To maintain soil fertility it is necessary to make 15 tons of organic fertilizer per 1 conditional hectare of soil. By 1990, this figure had reached the indicator of 10 tons of organic fertilizer per 1 conditional hectare. At present organics is made from 0.8 to 1.1 t/ha [2].

2. Materials and Methods

2.1. Some Theoretical Aspects of Control of Technological Processes

In modern conditions of organizational and economic development and management in the agricultural sector it is required to form the aspects of implementation and approaches to the management of technological processes and identify their economic substance as a theoretical basis.

No doubt, technological processes in agriculture have particular, distinctive features and the most important of them is the use of land as a means of production. The state of land resources and soil fertility determine the composition of the technological process and its effectiveness [4].

By the technological process in agriculture we mean a set of technological operations in crop and livestock production, organized and managed by the subject of production within the framework of the application of technology and technical means of its realization, effecting the production.

Taking into consideration the specificity of the agricultural sector and the allocation of its two most important sectors: crop and livestock production, the approaches of the scientists who are experts in this field of knowledge in the examination of processes of a particular industry have been analyzed.

The authors believe that a technological process in crop production is a set of elementary operations and actions aimed at the cultivation of crops. It is based on the principles of resource conservation, in order to obtain the maximum gain of productivity and maintaining or restoring soil fertility.

The economic efficiency of the sector of crop production is determined by the effectiveness of key technological processes [8].

Thus, under the technological processes of production of organic fertilizers we understand a series of technological operations for processing organic waste as an alternative source of resource-saving to obtain a qualitatively new product – organic fertilizers, implemented under a unified technology through technical means, labor and other resources.

Ready organic fertilizers are used depending on the specialization of agricultural organizations or for their own needs, or for the realization with the purpose of getting income. Under the technological processes of organic fertilizers application, we mean an ordered set of operations to prepare, transport and apply organic fertilizers to the soil to improve its fertility and increase crop yields, as well as the actions for the implementation of organic fertilizers for getting an additional income for the agricultural organization.

The technological processes in animal husbandry are considered by the authors as a set of manufacturing operations to ensure the vital activity of animals (mainly cattle, pigs, poultry) in the implementation of resource-saving technologies, equipping them with technical facilities and other objects of labor.

Provision of farm animal life must be accompanied by full volume of nutrition, which in its turn depends on the yield of fodder crops, and hence on soil fertility.

Under the control/management of technological processes the authors mean a goal-oriented action to implement, stabilize and/or improve the system of technological processes to achieve the planned results.

On the basis of the proposed treatment as a part of the process control we should identify the main elements:

- storage, processing, storage and transmission of information about the system of technological processes;
- making managerial decisions to implement, stabilize and/or improve the technological processes;
- formation of the administrative impact for the implementation of the control object;
- analysis, evaluation and monitoring of the results of the implementation of administrative decisions concerning the realization of technological processes.

The algorithm for management of technological processes in the agricultural sector sets the interconnection and interdependence between the processes and the technologies for their implementation, taking into account the above-mentioned elements of controls [10].

As a technological process is an integral part and an element of the production process, we can state with confidence that technology is a required condition, a factor of implementation of the production process and production activity of the agricultural enterprises in the whole.

Considering crops and livestock farming as branches of agriculture, it is necessary to distinguish between two separate systems – controlling and under control, which interact with each other through management technologies. Within this interaction some management solutions are developed [11].

The control process should be viewed as a mechanism, which is a set of interrelated and interdependent objects and control subjects, principles in use as well as objectives and management practices.

An organizational and economic resource control mechanism (OERCM) is a set of interrelated organizational, economic and administrative procedures aimed at improving the efficiency of application and revitalization of economy of material and technical resources, the introduction of resource-saving technologies, as well as agricultural production with minimum costs of all resources in money and kind.

The most suitable activities to be economic incentives, and possible elements of the economic mechanism are introduced on the basis of calculation of economic efficiency for agricultural, processing and service companies of the country and the size of the annual economic benefit or loss for the latter.

On the basis of these studies it can be noted that the technological process is oriented on the economic essence of management.

The economic essence of management is reflected in two aspects: on the one hand, it means reduction of the cost of agricultural production, on the other hand, increasing the yield of the product realization [3].

2.2. The System of Models of Integration of Technological Processes of Organic Fertilizers Production and Distribution

To improve the management of the production and use of organic fertilizer technological processes in agrarian sector a certain toolkit of the organizational and economic mechanism has been developed. On its bases the system of models of integration of technological processes of production and distribution of organic fertilizers with the vertical organization of the cluster structure formed by taking into account the organizational and new economic aspects of managing the placement point for the recycling raw materials, is founded. The means for its implementation include: the system of integration model of technological processes of production and transportation of organic fertilizers to control the placement point for the recycling of raw materials; the information and analytical system of support of decision-making of inter-farm transportation of organic fertilizers in the resource and product range with the placement point for the recycling of raw materials.

In general, the system of models of integration of technological processes of organic fertilizers production and distribution with the vertical organization of the cluster structure and the placement of points of raw material processing comprises the following elements (Fig. 1):

- levels of hierarchy of the organic fertilizers production control;
- three modification approaches to the development of the system of the first level models – the level of agricultural organizations in order to select the optimal center of location of organic waste processing points (OWPP);
- a closed loop process of control under the production of organic fertilizers based on a hierarchy of levels and having a bilateral dimension in taking management decisions.

The closed-loop control when moving "down – up" allows us to determine the territorial occupancy of OERCM (1st management level) and calculate the inter-farm, inter-cluster, inter-district and inter-zone transport costs (1, 2, 3, and 4th management levels), as well as the cost of production of organic fertilizers at each of the above-mentioned levels.

The system of models of the integration of technological processes of production and distribution of organic fertilizers allows to form a placement strategy for technological sites for the processing of manure, to optimize transportation costs for different levels of the hierarchy of the system implementation, to form a set of measures to increase the level of provision of agricultural land with organics (PALO), which contribute to the boom of profitability of crop branch.

3. Results and Discussion

Based on the system of model of integration of technology of production and distribution processes of organic fertilizers with the vertical organization of the cluster structure and control of the placement of points of processing raw materials using IASPPR of inter-farm transportation and location of the points of recycling organics (PRO), the costs of production of the solid concentrated

organic fertilizer (SCOF), the gross output and the lost gross of winter wheat yield in bulk and in money terms have been determined, as well as the profit from the use of organic fertilizers (Fig. 1). These economic criteria have been designed within the frame of regulatory and extrapolatory forecast scenarios. The extrapolatory scenario is subdivided into the extrapolatory-inertia and extrapolatory-integrational.

The regulatory forecast scenario has been formed on the basis of the Concept of development of agro-industrial complex of the Rostov region until 2020 (approved by the Government of the Rostov region of 23.05.2012, № 424), the Resolution of the Legislative Assembly of the Rostov region "Strategy of socio-economic development of the Rostov region for the period up to 2020" (of 24.11.2011, № 1752), as well as the federal Government of the Russian Federation "The strategy of socio-economic development of the Southern Federal District until 2020" (of 5.09 .2011, №1538-p).

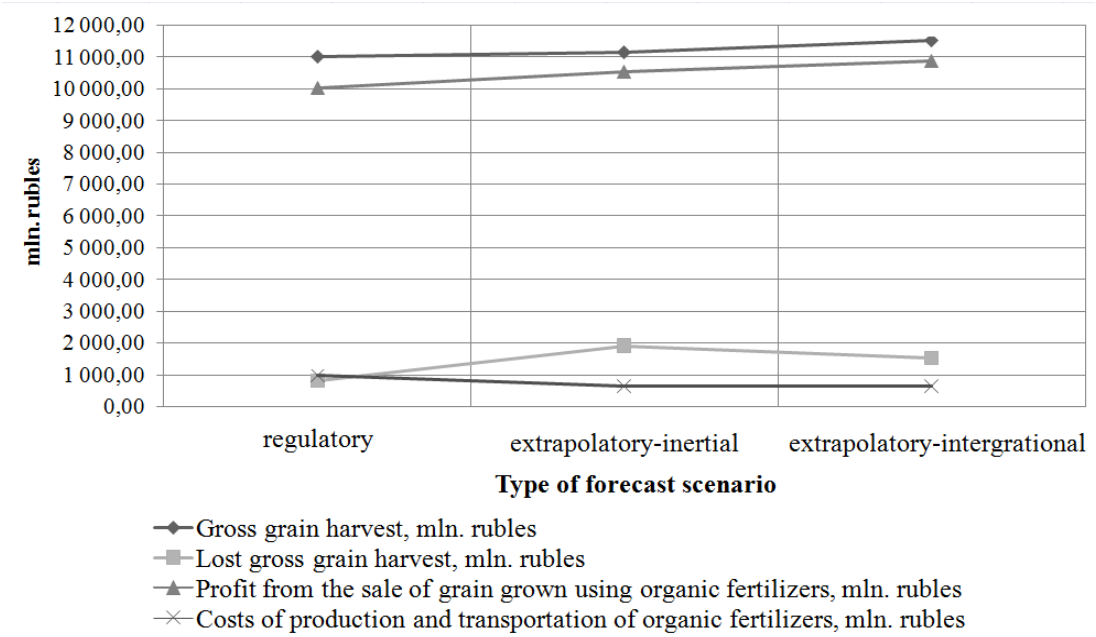

Fig. 1. *The indicators of the effectiveness of solid concentrated organic fertilizers in forecast scenarios for the period of 2017-2020 per year on average (in the Rostov region)*

When developing *extrapolatory forecast scenarios* for a medium term, an extrapolation method of trend lines, obtained by analytical smoothing changes of the number of animals and birds in the region in 2009-2016 has been used. The extrapolatory-inertial forecast scenario calls for the accumulation, processing of manure (litter) into organic fertilizers, with the implementation of technological processes of the traditional areas and resource-saving technologies in the areas of its obtaining and the introduction of agricultural areas.

Extrapolatory-integrational forecast scenario includes collecting, processing manure (litter) into organic fertilizer in the agricultural organizations – organics recycling points (ORP) in the implementation of technological processes of production and use of organic fertilizers based on resource and product models. The

main objective of organization of ORP is complete processing of produced manure (litter) and the even provision of either raw materials for processing or of ready-made organic fertilizer of the company which cultivates crops.

The most effective for implementation is an extrapolatory-integrational forecast scenario. For this scenario, the profit from the use of organic fertilizers while winter wheat cultivation was 11542.70 million rubles with applying solid concentrated organic fertilizer. The lost gross grain harvest amounted to 1 533,99 million rubles, the profit from the sale of grain which were grown using fertilizers was 10 884.00 million rubles. At the same time the costs of production and use of organic fertilizers amounted to 1 539,03 million rubles, which is comparable to the foregone revenue from the sale of crops during their cultivation with full provision with organic fertilizers.

The second efficient is the extrapolatory-inertial forecast scenario. The regulatory forecast scenario is recognized as irrational.

4. Conclusion

The developed system of models of integration of technological processes of production and distribution of organic fertilizers with the vertical organization of the cluster structure and control under the placement of raw materials processing sites allows us to select agricultural enterprises on the basis of which it is advisable to carry out the implementation of technological processes of production of organic fertilizers. The proposed modification of the integration models let us calculate the cost of fertilizers production and transportation.

The implemented in the system of integration models closed loop process of control of the production of organic fertilizers gives the opportunity to optimize the inter-farm, inter-cluster, inter-district and inter-zone transport expenses of organic waste and fertilizers.

The designed divergent forecast scenarios show different efficiency and are recommended for implementation at the level of an economic entity, district, region, up to the level of the state by using a closed loop process control under the technological processes of production and use of organic fertilizers based on the system of models of integration processes of production and distribution of organic fertilizers with the cluster structure of vertical organization.

Improving the technological process control of the agricultural sector, including those spheres, related to the production and use of organic fertilizers, aimed at levelling and improving soil fertility, can significantly boom the profitability of the crop industry by increasing crop yields and, therefore, can ensure food security of the country.

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