Management of Regional Bioresource Sustainability Based on Modern Modeling Methods

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Abstract*: *The article's aim is the development of proposals related to the management of bioresource sustainability based on modern modeling methods. The analysis of the approaches used in theory and practice of modeling regional bioresource sustainability has shown that the most reasonable solution is to form comprehensive methods of its assessment that will include comparative, normative, balance and modeling methods. The normative method has helped the authors to determine a sum of bioresource potentials by elements, which are designed for technological processes in all of the region's economic sectors. It has been established that the peculiarity of a system of support and decision-making on the modeling of regional bioresource sustainability is the system's ability to forecast the state of food security and to determine the possibility of the effect on it through fluctuation of factors. It has been proved that the modeling of regional bioresource sustainability by means of fuzzy logic makes it possible to determine its condition in the future. This, in turn, is the basis for the creation of the relevant management strategy. It has been determined that a system designed for the making and support of managerial decisions allowing to adequately assess the initial state of a problem and to define the best ways of its resolution can be used while managing regional bioresource sustainability.

Index Terms*: *bioresource sustainability, modeling, management, goals of sustainable development, concept, indicator, region, strategy.

I. INTRODUCTION

The pace of modern life causes new problems, activates methodological research and forms new paradigms for the study of economic processes. The problem of determining regional bioresource sustainability stands out in the long list. The necessity and relevance of bioresource sustainability studies are stipulated by the fact that lately there has been an underestimation of economic re-regulation and, as a consequence, of the use of economic management mechanisms on the part of the state which does not comply with the potential possibility. Substantial challenges for the state are threats arising from the asymmetry of the Russian Federation's obligations. This can deprive Russian manufacturers of a considerable share of the domestic market. The monoculture of the country's output has increased uncontrollably. This can spark imports of a considerable number of food items, which are essential for consumers.

All this proves the relevance of this problem and creates the need for the elaboration of a theoretical-methodological and terminological concept of bioresource sustainability management in modern conditions. Bioresource sustainability aims to create conditions for social, physical and economic access of each individual to food both at present and in the long term. Special attention should be paid to the study of measures aimed to provide bioresource sustainability at the local level, which is the basis for the formation of national food security.

II. LIYERATURE REVIEW

The study of issues related to regional bioresource sustainability was reflected in the papers written by O.Yu. Vaver [1], A.P. Zhuk [2], M.F. Kazantsev [3], V.I. Kiryushin [4], G.A. Motkin [5], M.S. Sokolov [6], etc. The analysis of literature related to the study's topic makes it possible to identify controversies, which prove the necessity of managing regional bioresource sustainability based on modern modeling methods.

Scientists [7-9] pointed out that modeling is a universal and efficient tool of the learning of internal and external patterns which are typical for economic phenomena and processes. Modeling provides a possibility to study quantitative interrelations and the interdependence of the modeling system, as well as to improve its further development and operation through a mathematical model.

The global experience of bioresource sustainability modeling is based on the use of diverse multi-factor comprehensive models. One of them is the dynamic model GLOBE, a global computer system of general equilibrium. This model covers a wide range of agricultural products, takes into account changes in population and climate parameters, exports and imports of goods in various food and non-food groups.

III. METHODS

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A. General description.

The analysis of the approaches used in theory and practice of regional bioresource sustainability modeling shows that it is reasonable to form a comprehensive methodology of its assessment that includes comparative (analogy), normative, balance and modeling methods. With the use of the normative method, we determine a sum of bioresource potentials per elements, which are designed for technological processes in all of the region's economic sectors.

The comparative method is based on the determination of regional bioresource sustainability by its designation in the base region and the ratio between food consumption in the base region and the initial region. In the balance method, bioresource sustainability is assessed based on the value and the structure of the regional food balance and research data. The article's information base consists of statistical data from public authorities, laws and statutory acts regulating bioresource sustainability modeling at the regional level and results of research conducted [10-12].

B. Algorithm.

In the course of the study, we plan to improve the approach to bioresource sustainability modeling at the regional level, to develop measures aimed to coordinate activities carried out by main participants in the food market that ensure the formation of bioresource sustainability, to substantiate a viewpoint about the rational design of food consumption in the conditions of economic reforms at the regional level.

C. Technological scheme.

We plan to conduct the study using the following chart in which bioresource sustainability modeling is viewed as a dynamic process arising from a set of bioenvironment factors (Figure 1).

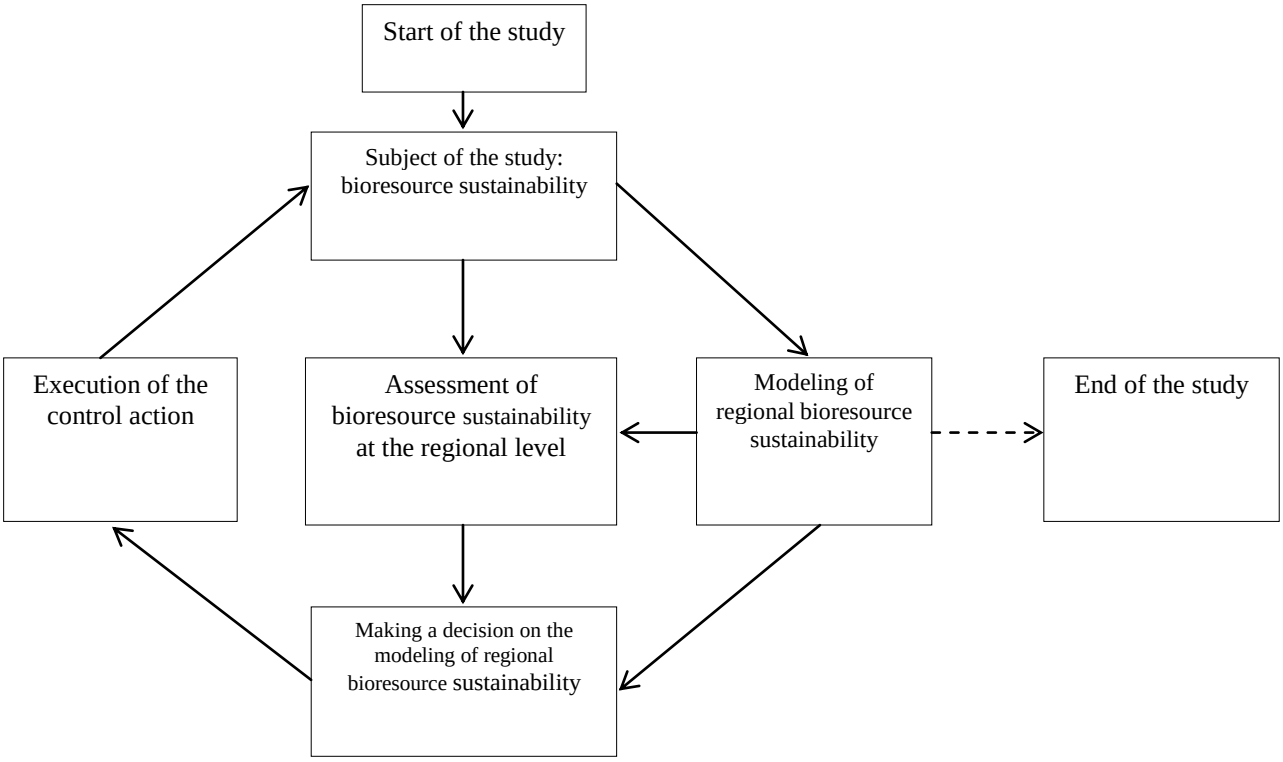

Fig. 1. Technological scheme of regional bioresource sustainability modeling.

IV. RESULTS

Sustainable Development Goals (SDGs) contain topics that can be grouped into three clusters (social, environmental and economic), students specializing in various disciplines participated in the study for the most comprehensive approach to the modeling of regions' development plans from the viewpoint of Russian regions. The work on all three clusters within SDG 2 and SDG 15 was performed on the basis of the comprehensive approach: the inspection of problems faced by the region under review, the identification of causes and consequences of problems, the determination of possible and desirable directions of the region's development, the creation of the Road Map for the fastest achievement of sustainable bioresource use in the regions.

As regards the youth model of bioresource sustainability modeling, we invited 15 experts from three economic sectors: public administration (the Ministry of Agriculture), scientists (sectorial research institutes and institutions of the Russian Academy of Sciences), and the business community represented by agricultural and woodworking enterprises. Experts were polled prior to the execution of the bioresource sustainability model. The results showed that bioresource sustainability modeling processes are highly detailed.

Bioresource sustainability modeling makes it possible to forecast food consumption and access to food. Consumption takes account of such agricultural products as cereals, edible roots and a group comprising all other food items. These three food groups account for 100% of the calories consumed. The population of each country must be divided into five equal groups depending on income. The number of people who are unable to get 2,100 kcal a day, required for consumption, can be determined based on food consumption in each

group and the total population by means of modeling.

Social risks can be considered when modeling bioresource sustainability at the regional level. Modeling must cover two directions. On the one hand, it must cover economic dependencies that reflect interrelation between the condition of bioresource sustainability (food consumption expressed in kcal) and the number of household characteristics and, on the other hand, it explains how modern characteristics, risks and possibilities of their management influence the likelihood of the favorable (or unfavorable) condition of bioresource sustainability in the future.

It is also possible to use economic-mathematical models reflecting the influence of various factors on bioresource sustainability. Main factors are the amount of imports and domestic food production per capita, intensiveness of agricultural output, the economic activity of the population, the specific weight of population with income below the subsistence minimum. Trend models can be developed for each of factor variables. With the help of the extrapolation method, trend models are used in calculating forecast values, determining parameters of consumption adequacy and economic accessibility.

Problems and prospects of using modeling in the bioresource sustainability management system can also consider the formation of a balanced food ration for the population of the region, the maximization of food volumes considering the breakdown of agricultural lands by yield. However, more accurate results can be shown by the fuzzy set theory, which is also used in forecasting the system's behavior. The feasibility of applying fuzzy logic in bioresource sustainability modeling can be shown with the help of Table 1.

Table 1. Advantages from the use of the fuzzy set theory when modeling regional bioresource sustainability.

Features typical for the regional bioresource sustainability system	Advantages of the fuzzy logic theory
Dynamic economic development, global changes, the substantial impact of the global economy on bioresource sustainability.	Possibility to adapt to changing economic conditions
The incompleteness of data because the essence of bioresource sustainability is currently not limited to the levels of agricultural production and food consumption. It is necessary to consider the state of the environment and food quality that cannot be described by exact indicators.	Possibility to work in the conditions of incomplete information and uncertainty
The level of regional bioresource sustainability is closely connected with the political and economic stability of a state and a region so it is required to consider the opinions of experts from these fields.	Considering experts' opinions
The level of bioresource sustainability substantially depends on natural conditions, possible disasters, force majeure events and revolutionary development of science and technologies that can be unpredictable and cardinally change the modern condition of the economy.	Considering changes in the directions and vectors of the movement

The fuzzy logic theory makes it possible to determine main factors influencing regional bioresource sustainability, to formalize interrelations among them, to define and formalize the assessment of factors, to build fuzzy relations among them, to find fuzzy equations based on estimates and the fuzzy knowledge base, to optimize parameters of the fuzzy model. However, in this case, the selection of factors influencing regional bioresource sustainability is an important stage. For this purpose, we studied indicators proposed in Russian and international statutory and legal acts, methodologies. In this respect, three main groups of bioresource sustainability indicators were suggested (Figure 2).

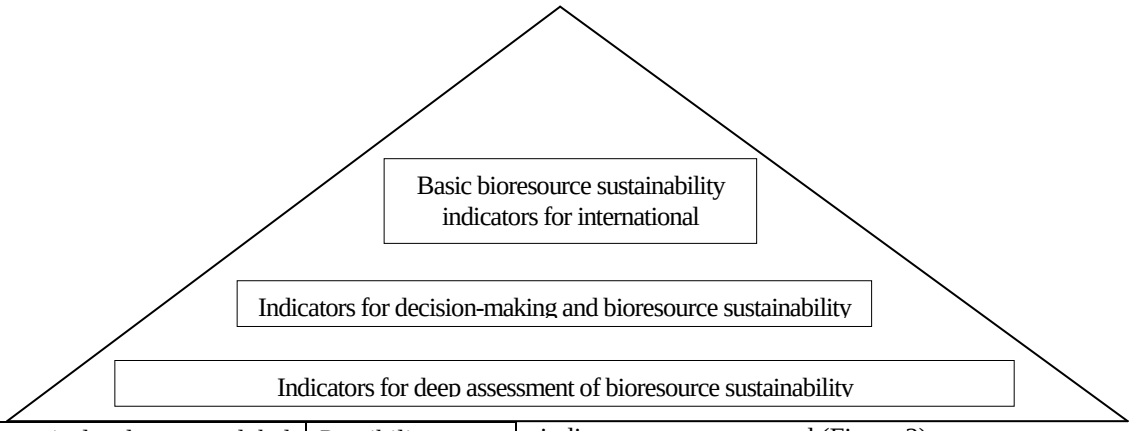

Fig. 2. Conceptual levels and the structure of indicators for the analysis of regional bioresource sustainability.

The main goal of high-level indicators, which are at the top of the pyramid, is to ensure general and objective assessment of bioresource sustainability that would be easy in the application. At this level, we propose the minimum possible number of indicators to avoid confusion and long calculations. For the attainment of this goal, indicators must consider

effective indicators of bioresource sustainability rather than the process of achievement itself. This makes these indicators appropriate for space/time comparison. The achievement of goals separately in every country can be studied in this manner.

The pyramid's second and third levels are the main structural elements of the formation of bioresource sustainability. The second analytical level (indicators for modeling and decision-making) aims to determine direct factors connected with the main list's effective indicators. This category comprises such indicators as productivity in animal husbandry and plant growing, market prices, socioeconomic and other conditions defining bioresource sustainability but are not its effective factors.

The third level (indicators for the deep assessment of bioresource sustainability) gives a detailed characteristic of the country's peculiarities. These indicators can be used to determine structural ratios in the system designed to ensure the country's bioresource sustainability. To this group, we refer the availability and accessibility of means of production, market factors, cultural and socioeconomic conditions, climate factors. Specific conditions of the countries will be determined in the list of indicators for each of them.

To the assessment of bioresource sustainability, one can refer the following to main indicators: the daily energy value of a person's ration, the minimum criteria in kcal per day (2,500 kcal); the provision of a person's ration with main types of food; the adequacy of grain reserves in state resources; economic accessibility of food that is determined as a share of aggregate food expenses in total aggregate household expenses; the volume of the domestic market in terms of separate food products; food stability in terms of separate food products.

The reliability of the presented approaches is confirmed by the fact that they help public authorities make decisions on the formation of the adequate level of regional bioresource sustainability. Food sales and distribution subsystems are referred to functional-target subsystems. Other subsystems – public administration, environmental measures – pursue the goal of bioresource sustainability and its efficient development, i.e. are support subsystems.

The quality of food market operation and, as a result, the provision of population with food directly depends on the development level of market infrastructure used to deliver products from manufacturers to consumers and contributes to forming a single market. It is also necessary to include the food industry as a system of industries, which satisfy the food needs of the population in the subsystem. In this respect, the successful operation of the food industry must be promoted by the development of market infrastructure, territorial specialization of various industries that minimize aggregate costs of food production, processing and sales, and by the improvement in the food sales mechanism.

The formation of food reserves can ensure bioresource sustainability because the grain and food fund is regulated by the market through purchases of the surplus and the relevant sales of the surplus in times of shortage. Minimum grain and food reserves are formed to prevent unpredictable situations such as natural calamities and the shortage of seeds. Environmentally clean natural resources (land and water) hold a special place in the bioresource sustainability system because they are the main means of production in the agricultural sector.

Damage inflicted by agriculture comes from the use of pesticides in agricultural land, the outwashing of mineral food components and the mechanical influence of machinery in the course of agricultural operations. In this case, the application of the required amount of mineral and organic fertilizers is one of the conditions of soil fertility restoration.

The quality of land is, therefore, closely connected with sums invested in agriculture through the purchase of machinery and the application of advanced technologies. A major goal of bioresource sustainability at the regional level is to protect the environment against the adverse impact of human activities and to restore damaged resources. These measures must provide for the optimal organization of output in the agrarian sector considering environmental factors.

In the formal mathematical form, the influence of green food production can be shown as direct costing with the description of main factors characterizing the level of bioresource sustainability provision. One of the most important requirements for bioresource sustainability is the adequacy of food consumption that can be determined by means of general and partial adequacy factors.

V.CONCLUSION

To sum up, it can be noted that the peculiarity of a system of support and decision-making on regional bioresource sustainability modeling is the system's ability to forecast the condition of food security and to determine the possibility of affecting it through fluctuation of factors. It should be noted that these models ensure the execution of such important properties as interactivity, integrity, power, accessibility, flexibility, reliability, operability and manageability when building information systems.

The modeling of regional bioresource sustainability by using the fuzzy logic theory allows us to determine its condition in the future. This, in turn, is the basis for the creation of a relevant management strategy. A system designed for making and supporting managerial decisions, which makes it possible to assess adequately the initial state of a problem and to define the best ways of its resolution, can be used when managing regional bioresource sustainability.

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