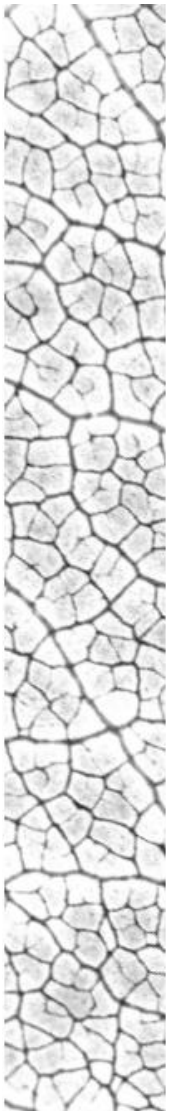

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Forecasting of the risks in the agro-industrial complex system

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Abstract
The agro-industrial complex system refers to complex heterogeneous systems often exposed to external and internal risks of various nature: environmental, economic, technical, technological, social and financial. The forecasting of riskogenic events and risk management in the agro-industrial complex system is characterized by imperfection of methodological and tool support. The methods of expert assessment and cognitive modeling are not used enough in the process of risk forecasting. There is a significant number of studies on risk forecasting in the agro-industrial complex, but in general, the level of coverage of risks in the system is insufficient. The algorithms for research and forecasting of risks and risk management in the agro-industrial complex system are presented in our work. Theoretical and practical aspects of the use of expert assessment methods, cognitive modeling, generation of scenarios for riskogenic situations based on a systemic analysis of potential situations are considered in risk forecasting. The algorithms we propose can be successfully applied in the context of digitalization of the agro-industrial complex for planning, monitoring and development of innovations in the technical, socio-economic and eco-economic subsystems of the agro-industrial complex.

Keywords: risk forecasting, systemic analysis, expert assessment method, cognitive modeling, development of scenarios, examination of risk situations, agro-industrial complex system

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INTRODUCTION

One of the main tasks of system analysis is to learn how to combine mathematical and informal methods of analysis, rigorous methods of studying the formalized models with experiment, heuristic devices, and expert judgments, as one of the leading Russian experts in system analysis, N.N. Moiseev (Lotov, 1989) stated.

The agro-industrial system refers to complex heterogeneous systems and includes three subsystems of different nature and functioning on the basis of different laws: economical, technical, ecological and social. Forecasting is an important means of strategy and tactics of sustainable system development.

The problem of effective forecasting of the agricultural sector is associated with the imperfection of methodological and tool support (Samygin, Baryshnikov, & Mizyurkina, 2019).

The ability to recognize timely the probable onset of a qualitative change in the system (abrupt or bifurcation) is important in making the forecast. In this case, forecast based on the experience and intuition of an expert can play the decisive role. Thus, it can be assumed that high-quality or informal forecasting is advance of the stage of formalized system-analytical forecasting.

The ability to forecast the risks in the system refers to the highest forms of heuristic activity performed by experts.

Since forecasting is a process of generating information about possible future states of the system, it is advisable to carry out it by generation of the scenarios based on business and pretend plays, followed by reflection in cognitive models that allow to assess more adequately the contradictions and perform a qualitative analysis of the system.

The essence of cognitive modeling is to reflect the most complex problems and trends in the development of the system in a simplified form within the model, to explore possible scenarios for the emergence of crisis situations, to find a way and conditions for their resolution in the model situation (Bolbakov, 2015).

To solve each problem, an exceptional, specially adapted algorithm for analysis and subsequent improving intervention may be required. It is possible

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that the algorithm for solving one problem can be successfully used to solve other problems.

Literature review

The forecast of the future is based not only on the analysis of objective laws, but also reflects the personality attitudes and value system of the researcher - I. Blauberg (Blauberg, 1997).noted. When there is a lack of certain data parameters, one has to rely on subjective assessments (Shannon, 1978, Lotov, 1989).

In the three groups of forecasting methods (extrapolation methods, methods of expert assessment and logical modeling), extrapolation methods dominate - this is the tradition established in science (Nalimov, & ulchenko, 1969, Lotov, 1989, Antonov, 2004).

Methods of expert assessment have a significant variety and are used relatively rarely in the theory and practice of forecasting. In combination with expert assessment methods, cognitive modeling technology combines well.

The technology of cognitive analysis and modeling makes it possible to study various problems with distinct and indistinct factors and relationships, taking into account the influence of the external environment, to forecast the development of occurring conditions, resulting in a controlled cognitive process used to support managerial decision-making (Sukhodolov, & Marenko, 2018; Sheikhshoaie et al., 2018). Cognitology as a science allows to transfer the information from the subject of study to the software based on its structuring (Medvedeva, 2016).

The method of alternative scenarios, which reflects the development trends of the system taking into account the influence of factors on the dynamics of the situation, plays such an important role in forecasting of the risks (Lotov, 1989, Medvedeva, 2016; Hameed et al., 2019).

There is a significant number of works on forecasting risks in the agro-industrial complex system based on the positions of systemic analysis and reflecting mainly production (technical and technological) and financial and economic risks.

Risk management (in the agro-industrial complex system) should be understood as the risk assessment based process of the development and implementation of decisions allowing to minimize the negative impact of various factors of the external and internal environment, leading the enterprise to various losses (Kuzmenko, 2014). (Khitrova., Vlasov, 2014), (Samarukha., Krasnova, Purdenko, 2006), (Samarukha, 2014), (Makarova, 2014). (Nechaev, & Rasputina, 2020), (Rasputina, Ziboreva, 2019), (Rasputina, et al. 2020).

In general, the level of risk study in the agro-industrial complex system is insufficient.

Peshin, Sadykov (Peshina, & Sadykov, 2012).”point out five types of risks, speaking of the necessity for active influence on the set of risksin the agro-industrial complex in order to ensure sustainable development:

Agroecological.
Technological.
Macroeconomic.
Foreign trade.
Social.

Medvedeva (Medvedeva, 2016, Medvedev, 2016), Samygin, Baryshnikov and Mizyurkina (Samygin, Baryshnikov, & Mizyurkina, 2019), Romanenko, Evdokimova (Romanenko, & Evdokimova, 2018). note the effectiveness of scenario forecasting of the agro-industrial complex development (taking into account possible risks).

The features of the environmental and economic risks manifestation in the agricultural system were noted by Ivanyo (Ivanyo, 2007, Ivanyo,, Asalkhanov,, Bendik, 2019), Krezhanovskaya (Krezhanovskaya, 2008).”, Kuzmenko (Kuzmenko, 2014). Tyrsin, Surina (Tyrsin, & Surina, 2017).” note the modeling risk in multidimensional stochastic systems with the goal of minimizing the risk.. Ovchinnikov, Arshba consider the problem of the need for insurance as an effective method of risk management in the agro-industrial complex system (Ovchinnikov, & Arshba,,2013; Ramazani et al., 2017).

There are a number of works on modeling and forecasting of risks in other sectors of the economy and production, the experience of which can be used in the agro-industrial complex system : Yakhneeva (Yakhneeva, 2013), Kononov, Kotelnikov, Chernysh (Kononov, Kotelnikov, & Chernysh, 2012), Ovanesyan (Ovanesyan, 2015), (Sukhodolov, et al. 2020, Sukhodolov, et al. 2019), Khitrova (Khitrova, Khitrova, 2019). and many others.

Research methodology

The methodology of the study performed is based on the selective application of systemic analysis methods aimed at studying of compound objects of the agro-industrial complex system, with the predominant use of expert assessment methods structured through business and pretend plays, generating scenarios and cognitive models that facilitate the adoption of scientifically based decisions for the purposes of optimal control of the system in various situations.

RESULTS

In the process of studying the problems of risk forecasting in the agro-industrial complex system from the point of systemic analysis, we managed to formulate two working algorithms corresponding to two stages of the problem study. In the first case (**Fig. 1**), we obtained an algorithm for research and forecasting risks in the agro-industrial complex system, which allows to present in the concentrated form the sequence and interaction of the main elements and operations to create the ideal model for neutralizing (or adapting) the forecasted risk.

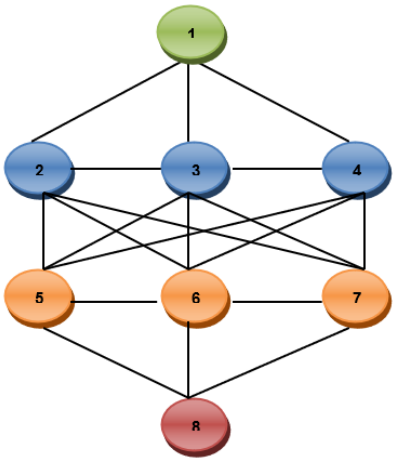

Fig. 1. Algorithm for research and forecasting of risks in the agro-industrial complex system
1 - Statement of the risk problem, 2 - Determination of goals, 3 - Determination of interests, 4 - Determination of resources, 5 - Optimistic scenario, 6 - Realistic scenario, 7 - Pessimistic scenario, 8 - The ideal model of risk neutralization

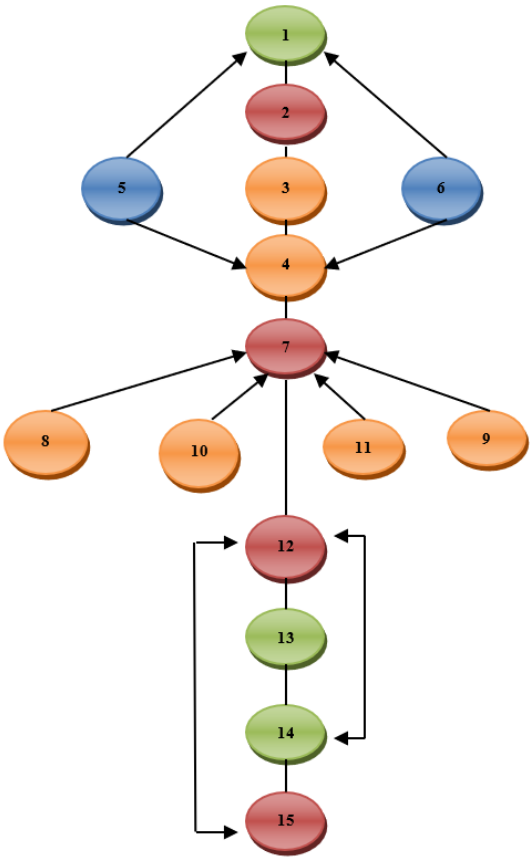

Fig. 2. Risk management algorithm in the agro-industrial complex system
1 - Management of the agro-industrial complex system (Ministry of Agriculture), 2 - Risk management subsystem, 3 - Targeted risk forecasting program, 4 - Database of potential risks, 5 - Monitoring of the external environment, 6 - Monitoring of the internal environment, 7 - Database of experts, 8 - Existing expert systems, 9 - Business and pretend plays for risk forecasting, 10 - Scenarios of risk situations, 11 - Bank of cognitive models and extrapolation models, 12 - Remote consultation service (system), 13 - Regional agro-industrial complex system, 14 - Municipal agro-industrial complex system, 15 - Agricultural producers and rural settlements

In the second case (**Fig. 2**), we obtained a risk management algorithm in the agro-industrial complex, suitable for practical application on different conditions of the hierarchy of the system (federal, regional and municipal).

3, reflecting the functional structure of the risk management algorithm in the agro-industrial complex system, the vertical relationship is observed clearly between the four functional components of risk management : 1) The subsystem of risk management (having a vertically horizontal hierarchical structure); 2) a community of experts represented in the database of experts and involved in the process of risk assessment and forecasting; 3) Remote Consulting Service (also having a vertical-horizontal hierarchical structure, which is currently poorly manifested in practice); 4) agricultural producers and rural settlements directly involved in the process of neutralizing (minimizing or adapting) all kinds of risks in the agro-industrial complex system.

Information resources, system-analytical and cognitive technologies conditionally distributed over various databases need further filling, structuring, optimization and expert assessment of the applicability and demand in modern processes taking place in the agro-industrial complex system.

The same kind of work should be done with the expert community - it is necessary to create the most comprehensive database of experts by district, region and the Federation as a whole, to structure the expert community into problems and directions, to determine the rating within the community and to develop optimal conditions for the participation of experts in the work of the risk-management subsystem.

Practical significance

The algorithm of research and forecasting of risks allows to place quickly emphasis in the search for significant qualitative information at the stage of researching the problem of risks in the agro-industrial complex and formulate clearly three generalizing lines (goal-setting, determining the interests of the interacting parties and the presence of aggregate resources used to solve the problem), leading to the development of three main scenarios (optimistic, pessimistic and realistic) aimed at solving the problem (forecasting and overcoming the risks). As a result of pretend plays, we get the final product of the study phase: an algorithm for an ideal model of risk neutralization, suitable for further practical application in forecasting and extrapolation of risks.

The risk management algorithm in the agribusiness system, presented in **Fig. 2** is a prototype of an applied risk management model, i.e. innovative technological product suitable for practical use (after appropriate refinement at the stage of experimental introduction at the regional and municipal levels.

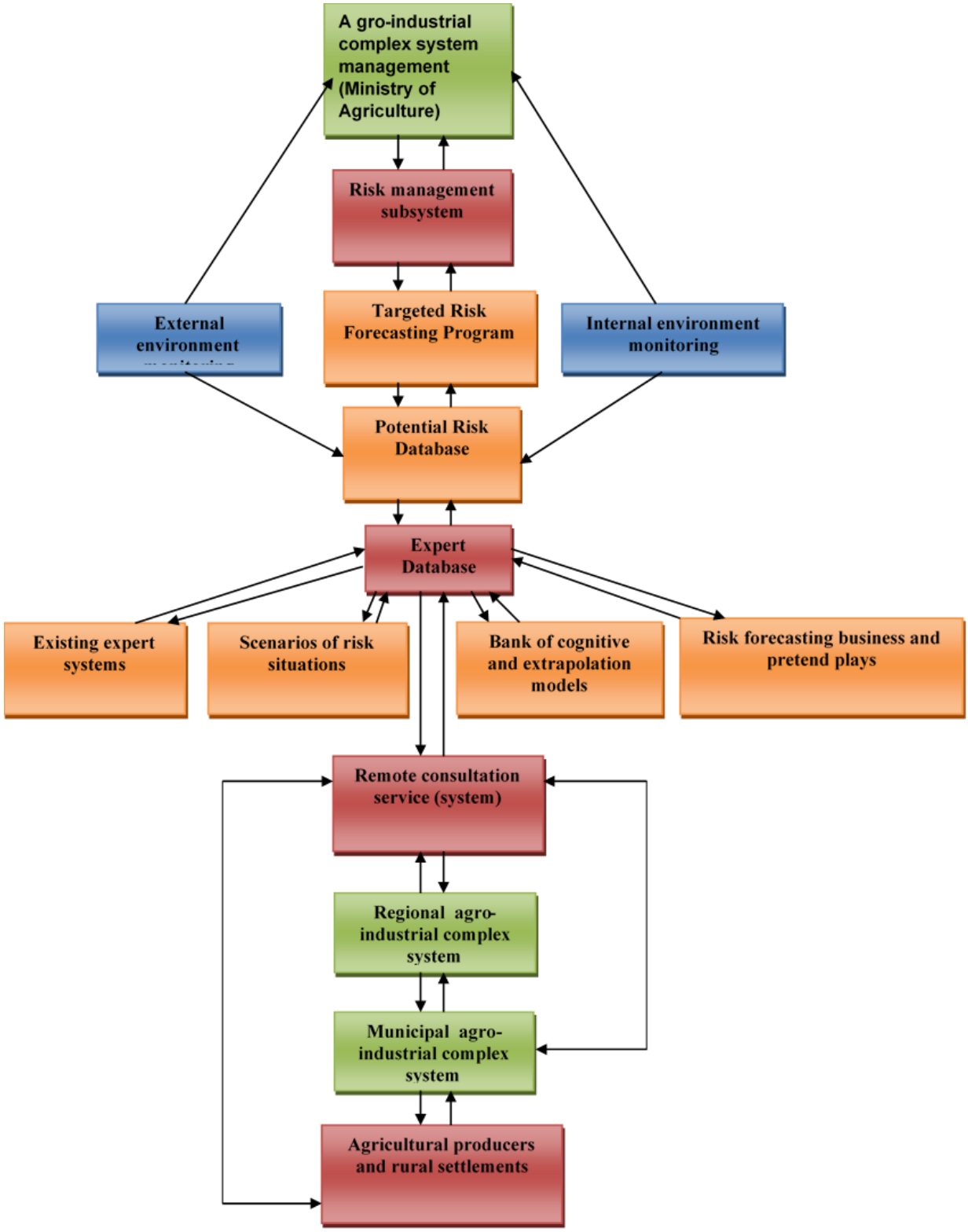

Fig. 3. Functional structure of the risk management algorithm in the agro-industrial complex system

The functional structure of the risk management algorithm, shown in **Fig. 3** can serve as the basis for cognitive modeling and organization of activities for experimental modeling and introduction of risk management in the direct process.

CONCLUSION

Thus, a systematic and analytical consideration of the forecasting risks problem in the agro-industrial complex system leads us to conclusion that the method

of expert assessment strengthened by cognitive technologies, expert systems and relevant information resources in the form of databases of model situations and scenarios can be considered the most promising forecasting method.

The practical use of the algorithms proposed is possible with the effective interaction of the risk management subsystem with the remote consulting service with the participation of highly qualified experts.

The discussion of the results

The problem of forecasting the risks occupies one of the important places in optimizing the management of the agro-industrial complex system and achieving of high and sustainable economic, social and ecological results.

The algorithms we propose can be successfully used in the context of the digitalization of the agro-industrial complex system for the planning, monitoring and development of innovations in the technical, socio-economic and eco-economic subsystems of the agricultural complex. Of course, all information and system-analytical components of the risk management algorithm need a more complete, detailed mapping, showing their functional structure and synergetic potential for interaction with the methods used for expert assessment, cognitive modeling, scenario development, pretend and business plays within the heuristic examination of risk situations.

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