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Management Aspects for the Integrated Agro-industrial Formations in Russia

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Abstract

Management of an integrated agro-industrial formation (IAF) is a process involving a complex cross-sectoral nature, associated with a complex multi-level system with modification variability consisting of interconnected organizations, operating in a complex, competitive and dynamic environment. This work proposes a concept for managing the development of integrated agro-industrial formations based on the use of an integrated, multi-aspect approach to solving strategic problems. Modeling a control object is based on the synthesis of fundamental and technical analysis methods. At the same time, based on indicators determined in a temporal coordinate system, it is recommended to identify events in the history of the IAF, and then identify and substantiate correlations between these events. The revealed dependencies are used to build a management model for an IAF. In this study, conceptual, theoretical, and methodological provisions for managing the development of integrated agro-industrial formations operating in territorial socio-economic systems were clarified and developed. This work discusses characteristics of the management object as part of the ecosystem, the IAF as a control object. This work also considers data, information, knowledge, and their relationships for successful management of the IAF.

Disciplinary: Agricultural Economics, Modern Management, Institutional Economics.

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1 Introduction

Systemic, purposeful modernization of agricultural production requires consolidated efforts of the state and society, which determines the need to form science-based approaches and new technologies for managing the socio-economic development of agricultural territories (Golubyatnikova et al., 2019), including integrated agro-industrial formations of the meso-economic level. One of the effective ways to achieve sustainable development of the regional agro-industrial complex, to realize the innovative and investment potential is the formation and development of integrated agro-industrial formations (IAF). This provision is actualized by the need to ensure food and environmental and economic security in the face of external and internal constraints. The formation and development of diversified integrated structures in territorial socio-economic systems will make it possible to realize the production and resource potential of agriculture, to carry out innovative modernization of the assets of economic entities of the agro-industrial complex, to solve a set of problems of a socio-economic nature.

The research concept is based on the principles, approaches and methods in the theoretical and methodological coordinate system of the management mechanism of integrated agro-industrial formations. The scientific literature presents a variety of general schemes of management influences that have received practical approbation in modeling strategies for sustainable development of the regional agro-industrial complex.

The main efforts of researchers in this area are aimed at solving the problems of regional economic development, creating corporate production structures focused on the effective use of the internal resource potential of agricultural territories.

Russian and foreign scientists-economists have comprehensively worked out:

- theoretical and methodological foundations of the organization and management of integrated agro-industrial formations, including the problems of their sustainable development;

- methodological provisions of a systematic approach to the development of agro-industrial formations.

Taking into account the theoretical and practical significance of the research, it should be noted that the issues of multivariate analysis, forecasting and development of strategies for managing the development of integrated agro-industrial formations in the transformation of goals and strategic objectives should be noted. Global trends in agroeconomics, an expanding range of innovative tasks determine the need for further study of the methodological aspects of IAF management.

In this regard, it seems expedient to study the instrumental apparatus of the control system and algorithms for the formation of the IAF, methods of modeling, evaluation and analysis, which allow solving practical problems within the framework of the selected strategies of production activities based on the optimization of management decisions.

The considered methodological aspects of the management of integrated agro-industrial formations are based on system analysis and an integrated approach to solving the issues of designing a strategic and operational management system based on the analysis of the formation and assessment of the added value of agricultural products.

The problematic area of research consists in solving the problem of theoretical and methodological support for managing the development of agro-industrial integrated formations, including:

- in substantiating the conceptual provisions of the IAF management, formulating goals, objectives, principles of their development, which allows us to update the subject-object base of interaction between the subjects of the integrated structure to ensure sustainable socio-economic development of agricultural territories;

- in determining strategic priorities and recommendations for the development of regional IAF, due to the need to solve problems specific to the regional agro-industrial complex, associated with the implementation of the production, financial, innovation, resource potential of the industry.

This research is based on the assumption that the application of a management methodology hinged on a multidimensional system analysis will make it possible to form an effective management system for integrated agro-industrial formations and obtain an organizational hierarchy for each level of management, taking into account the requirements of the external environment and the economic state of the research object.

2 Materials and Methods

The methodological basis of the research is the fundamental and conceptual provisions of Russian and foreign scientists in the field of systems theory and systems analysis.

The process of developing models and mechanisms for managing the effective development of the IAF is based on systemic, process, synergetic, economic-qualimetric, innovative and conceptual-methodological approaches using methods of analysis and synthesis, modeling, formalization, systemic and statistical analysis, expert assessments, tabular and graphical interpretation results.

The IAF management methodology is based on the use of multifaceted systems analysis, the application of which is aimed at:

- formation of subsystems and a general control system adapted to the requirements of the external and internal environment;

- development of strategic guidelines based on multivariate forecasting of indicators of the development of an integrated agro-industrial formation and its agro-industrial subsystems;

- determination of priority directions of income and expenditure policy, depending on the changing dynamics of the external environment.

The main prerequisites for the application of system analysis in the design and study of complex systems, the formation of management decisions in conditions of incomplete or fragmented information, lack of resources, including labor, are set out in the works of (Golubkov, 1982). The solution to the problems of the development of agri-food systems is based on the use of formalized models and informal knowledge and methods.

When problem situations arise, a system analysis algorithm is developed, including a description of an object or problem in the form of a system; the appropriate methodological toolkit is determined. The applied methods, methodological tools are determined by the sequence of developed and regulated stages and sub-stages of system analysis.

In a significant part of Antonov (2004), Anfilatov et al. (2009), Volkova & Denisov (2019),), the methods of system analysis of complex systems are used for:

- formulation and identification of a range of problems;
- determining the goals and objectives of the study;
- development of decision-making models and alternative options;
- evaluating alternatives and finding solutions;
- implementation of the decisions taken;
- determining the effectiveness of implemented solutions.

The points of view of the researchers agree that the definition of the goals and functions of the system is fundamental in the implementation of the system analysis methodology, while the choice of methods for obtaining and evaluating models directly depends on the problem situation for which the methodology is being developed.

Our point of view boils down to the fact that in order to improve the management of the development of the IAF, the methodology of systems analysis is applicable in the implementation of the following stages:

1. Identification of the IAF management problem: analysis of the internal and external environment; identification and formulation of the problem.

2. Goal-setting and specification of tasks: analysis of methodological approaches to solving the set tasks, with the definition of the apparatus and tools for the solution.

3. Modeling and development of an algorithm for managerial decisions for the assigned tasks: determination of methodological tools, development of models of managerial decisions and alternative solutions for each task.

4. Evaluation of alternatives and search for solutions: search and selection of evaluation methods, the study of the possibilities of their application.

5. Implementation of management decisions: a comparative analysis of assessment results, selection of the optimal solution to the problem.

The works of Aaker (2007); Russell (2002); Baranovskaya et al. (2011); Makarevich, 2015; Milner, 2002) substantiated general approaches in the field of methodology of strategic management and planning of activities of integrated structures. Makarevich (2015) studied in detail the methodology of system-cognitive analysis, a distinctive feature of which is the possibility of implementing classical approaches of strategic management in the presence of incompleteness and fragmentation of data for making management decisions.

3 Results and Discussion

In agroeconomics, the use of management methods is interconnected not only with the characteristics of the management object itself, but also with environmental factors in which the business entity develops. The architecture of the designated ecosystem has a complex structure and includes natural, macroeconomic, microeconomic, information and analytical components. At the same time, the information environment is distinguished by the imperfection of the initial databases, noisiness (distortions) and incomplete reporting information.

According to the author's refined definition, IAF management is a process that has a complex cross-sectoral nature, because the association is a complex multi-level system with modification variability; consisting of interconnected organizations; operating in a complex, competitive and dynamic environment.

Thus, the IAF ecosystem, being a complex nonlinear multi-parameter control object, has a high degree of uncertainty in its functioning and acceleration (Figure 1).

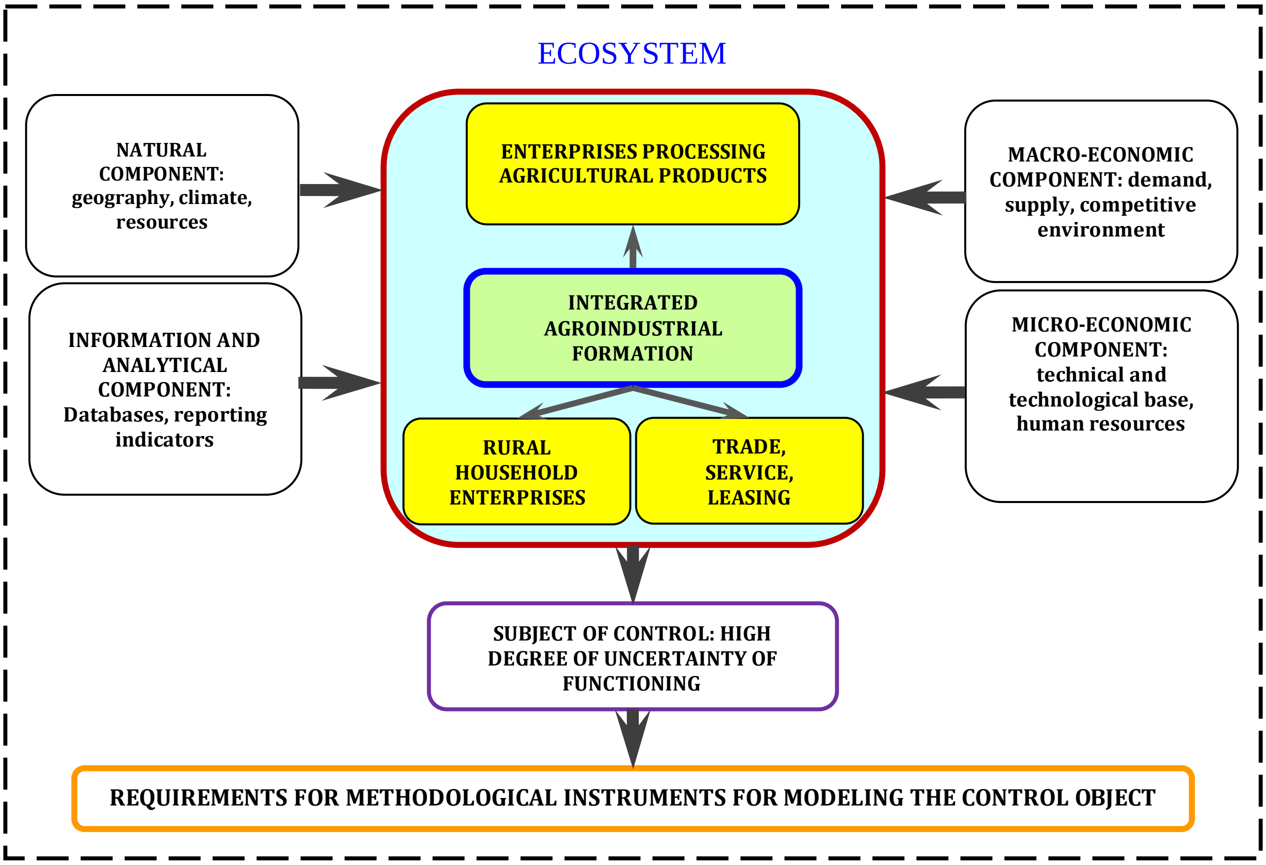

Figure 1: Characteristics of the management object as part of the ecosystem

Management of an integrated agro-industrial formation provides a proactive response to expected situations, threats and risks. In this regard, we consider it expedient to determine the range of classification features with the allocation of factors affecting the control object and the identification of threats caused by the properties of these factors.

The classification of problem areas associated with factors affecting the control object is shown in Figure 2.

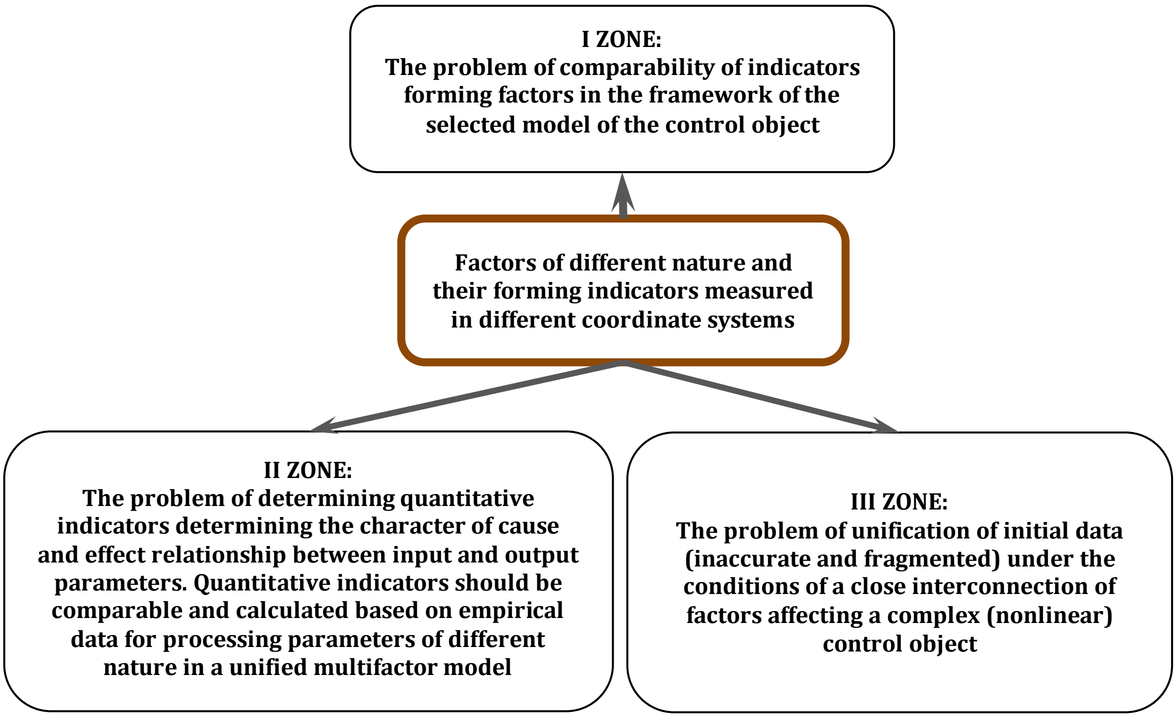

Figure 2: Classification of problem areas with the allocation of environmental factors affecting the control object

Justification of the requirements for the control method.

The IAF as a Control Object (CO) has several specific properties: complexity, multifactorial, weakly deterministic, nonlinearity. The highlighted qualities make it difficult to develop and implement an adequate IAF control system. The initial data on the formation are fragmented and inaccurate.

To generate the missing data on the object of modeling, in technical sciences, as a rule, several experimental, experimental operations are carried out, which in relation to the IAF, with a characteristic long (more than a year) control cycle, is excluded (Figure 3).

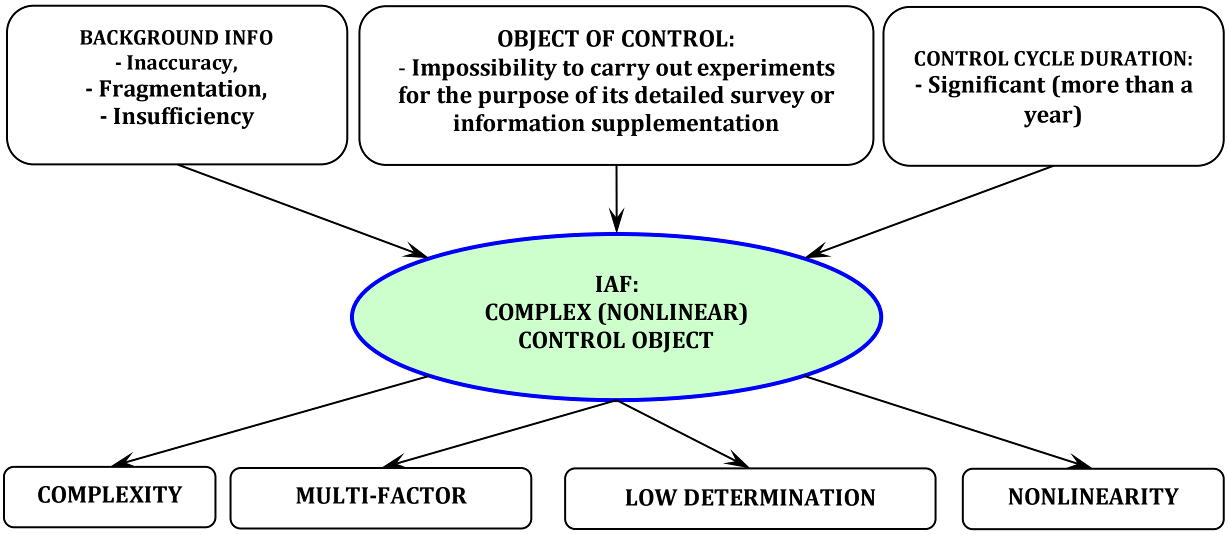

Figure 3: Characteristics of the IAF as a control object

Many tasks in the IAF control system can be solved only based on the control object model, which identifies the intensity and vector of the impact of the selected factors on the control object.

The properties of the IAF as a complex systemic control object require substantiation (regulation) of the requirements for methodological tools when building the IAF control model (Figure 4).

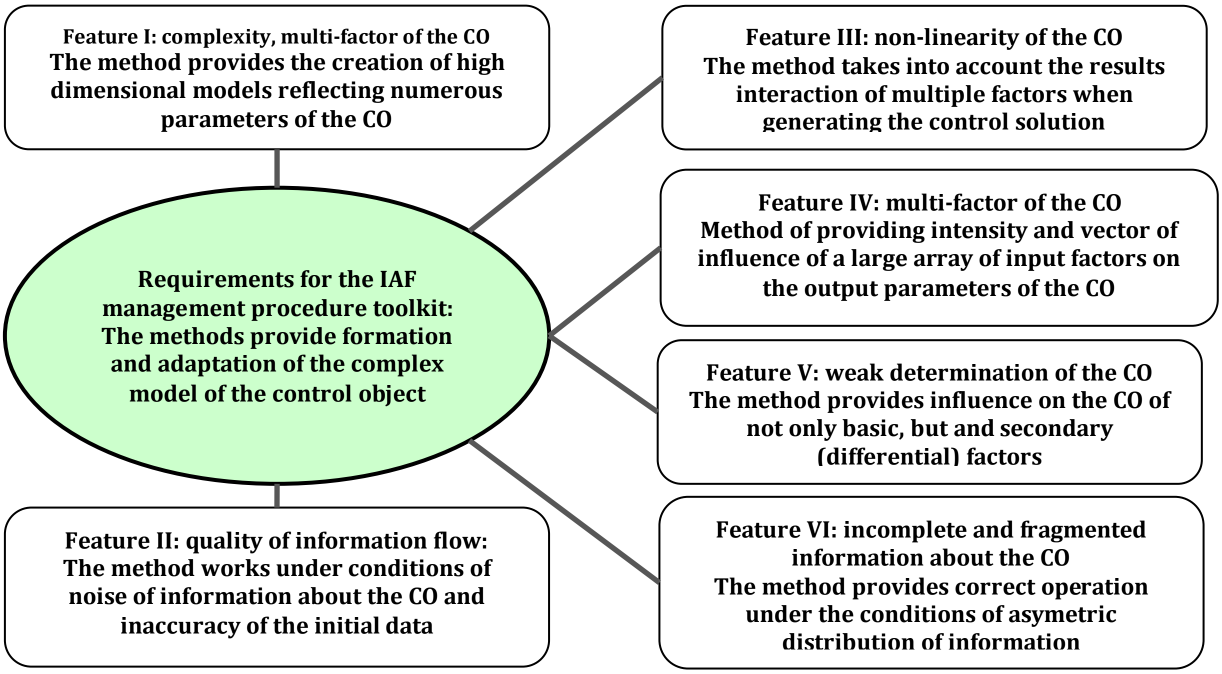

Figure 4: Regulation of methodological tools when building a management model of the IAF in accordance with the characteristics of the CO

Integrated agro-industrial formations of the meso-economic level in this study are considered as a control object using automated control systems (ACS).

The traditional approach uses classical methods of studying complex systems (genetic and simulation methods, calculation models), which, in our opinion, are not fully suitable for modeling the IAF control system as a complex self-developing business entity.

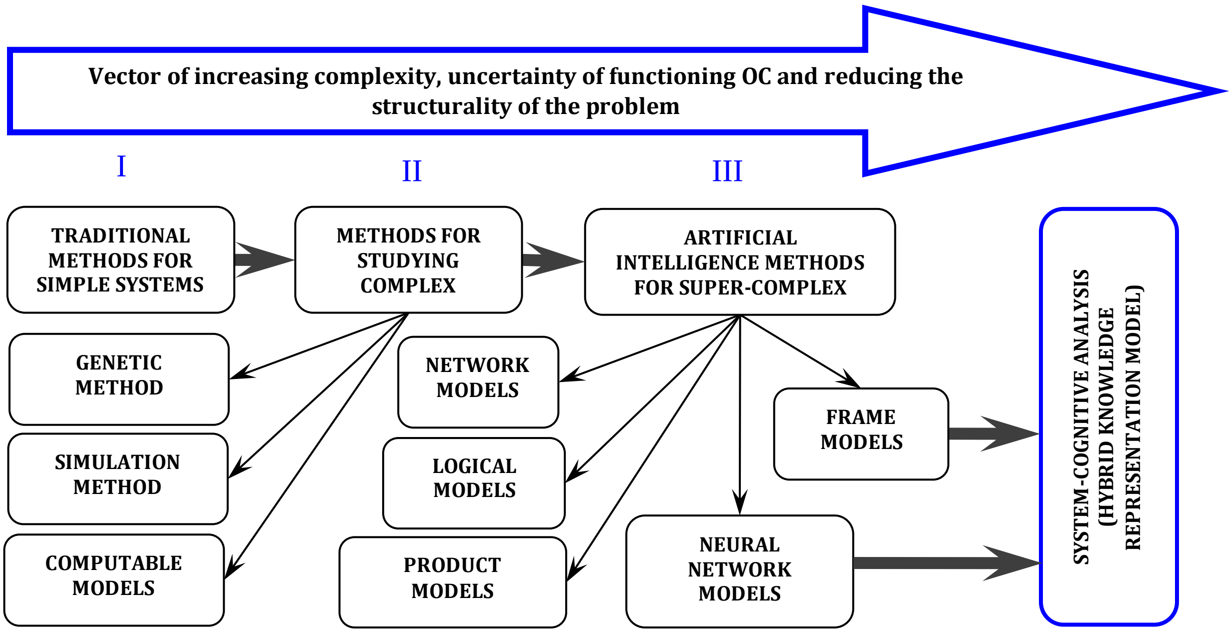

Figure 5: Methods for managing objects of varying complexity and uncertainty

In this regard, we consider it necessary to investigate the correspondence of classical methods to the requirements of IAF management. To solve management problems in the context of global trends in the development of agricultural territories in economic research, artificial intelligence methods are applicable, which provide a solution to a wide range of difficult, poorly formalized applied problems (Figure 5).

The author's approach is based on the synthesis of fundamental and technical methods of analysis. At the same time, based on indicators determined in the temporal coordinate system, it is necessary to identify events in the history of the IAF (technical method of analysis), and then identify and substantiate the correlations between these events (fundamental method of analysis). The revealed dependencies are used to build a management model for an integrated agro-industrial formation.

The source material about the control object, as a rule, contains data linked to time. In accordance with the methodology and technology of automated system-cognitive analysis (ASC-analysis) for management and decision-making, it is necessary to convert the initial data into information, then information into knowledge about how various decisions affect the IAF. The content of the categories «data», «information», «knowledge» and their interrelationships that affect transformation processes are shown in Figure 6.

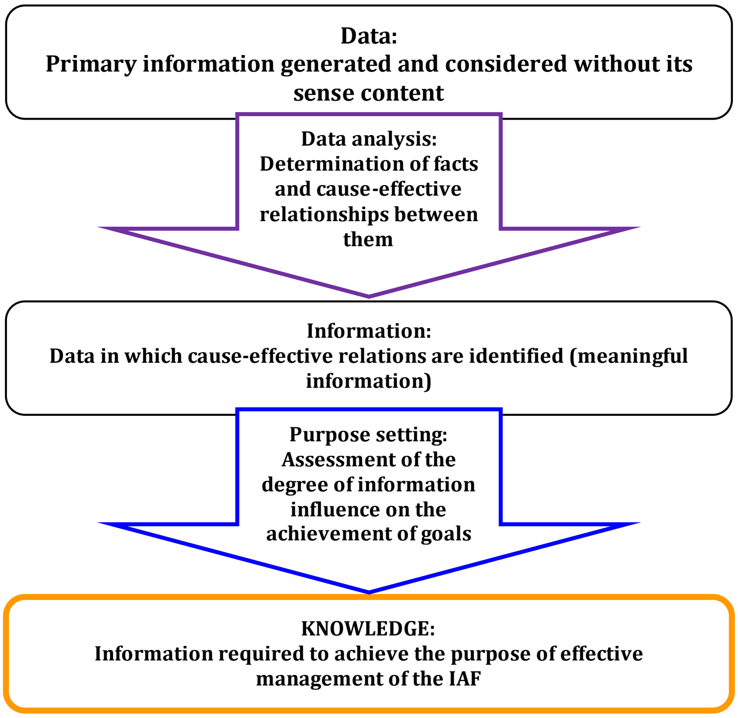

Figure 6: Data, information, knowledge and their relationships needed to manage the IAF

Thus, to solve the problems of modeling the control system of the IAF, it is necessary to consistently increase the level of formalization of the initial data to such an extent that will ensure their input into the intelligent system. The application of the cognitive approach is carried out to:

- converting initial data into information;

- converting information into knowledge;

- application of knowledge to solve various problems related to the management of the IAF and the implementation of managerial actions.

All models of knowledge representation are grouped according to the following classification criteria:

1) clear and fuzzy;

2) procedural and declarative.

To solve the problems of effective management of the IAF, fuzzy declarative models are applicable, which include the ASC-analysis model implemented in the intellectual system «Eidos» [12]. Intelligent methods and systems are subdivided into those using traditional logic with two variations of the truth of decisions:

1. *«Truth», «Lies»*. Production, network and logical models are based on the traditional Aristotelian logic (the doctrine of scientific proof), which is trans-discursive (Aristotle, 1978). These models and the software systems that implement them are practically not applicable to control such a highly complex and contradictory object as the IAF.

2. *The degree of truth that takes a series of discrete values or values that change smoothly, continuously.* Neural network and frame models, as well as fuzzy logic models (Zadeh, 1996) with a certain degree of truth.

In Zadeh's fuzzy logic (1996), the level of truth is not derived based on empirical databases, but is set artificially. A feature of the frame model, (super-difficult to implement), is the rapid increase in complexity with an increase in the number of frames. In the neural network model, there is a problem of interpreting the weight coefficients, which complicates the study of the modeled object.

The production models used in expert systems also have some disadvantages:

- there is a need to attract professional cognitive engineers to increase the degree of formalization of knowledge and input into the software system, which is unrealistic given the dimensions of the models that are important and necessary for modeling the IAF control system;

- difficulties arise when studying the object of modeling on the basis of its model of knowledge, based on recalculation and reforming during their application, as well as taking up significant computational resources and time.

The identified shortcomings of clear and production knowledge models can be eliminated when using the ASC-analysis in its software toolkit - the «Eidos» system (Figure 7).

The knowledge model of ASC-analysis is considered a hybrid model (similar to a frame model) with a non-local interpreted neural network and with simplified software without loss of functionality. Unlike traditional neural networks, the ASC-analysis model makes it possible to comparatively analyze not data or information, but knowledge in various types of measuring scales.

ASC-analysis is proposed to be classified according to some characteristics:

1) An analysis based on the theoretical substantiation of a meaningful interpretation of a hybrid knowledge model with a simple software implementation (a combination of the properties of a frame and neural network models);

2) Analysis with high accuracy and independence of the calculation results from the units of measurement of the original data (by analogy with statistical systems).

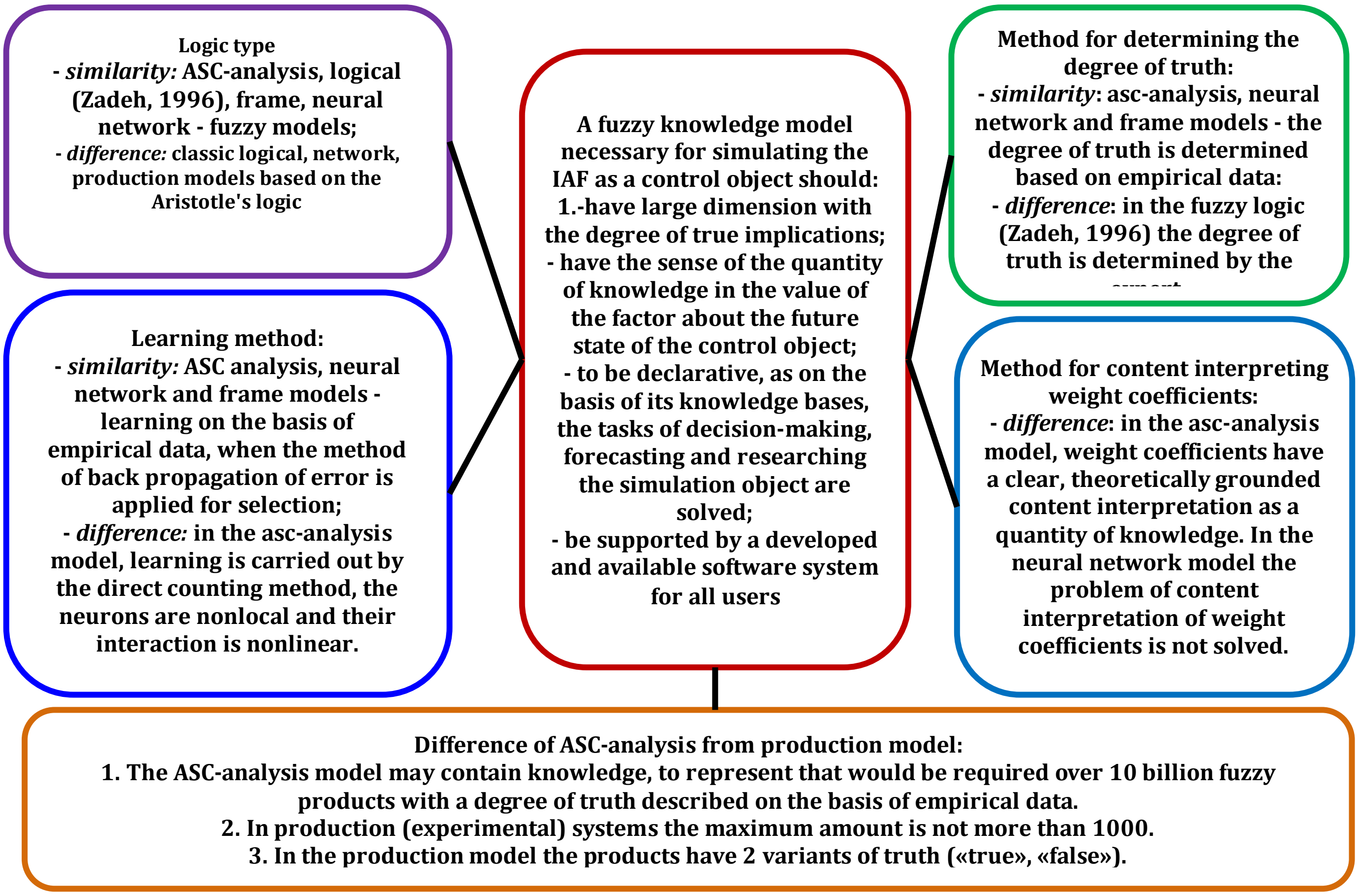

Figure 7: Distinctive features of the ASC-analysis for the selected classification features

Systematic ASC-analysis is considered by us as a way of cognition and can be structured according to basic cognitive (cognitive) operations. The minimum sufficient set of these operations (cognitive configurator) follows from the formalized cognitive concept, according to which the cognition process is considered as a multilevel hierarchical system of transformation: data – information – knowledge. In this system, the cognitive structures of each level are the result of the integration of the structures of the previous level.

The levels of the hierarchical transformation system are as follows (Kuhn, 2020):

- the first level - the presence of discrete components of sensory perception;
- the second level - embedding data into the image of a specific object;
- the third level - embedding data into generalized images of classes and factors;
- the fourth level - the formation of clusters based on data;
- the fifth level - the formation of constructs based on data.
- the sixth level - the formation of the current paradigm of reality based on the system of constructors;

- the seventh level - the formation of knowledge: the current paradigm is not the only possible one, and one paradigm of reality is periodically replaced by another in the course of transformation processes.

The main thing for the cognitive concept is the concept of precedent or fact - the ratio of discrete and integral components of knowledge. In ASC-analysis, a fact is considered as a quantum of knowledge, which is the basis for its formalization. The concept, formed by Baklazhenko (2013), contains a cognitive configurator in the form of a system of basic cognitive operations and a generalized scheme of ASC-analysis, structured to the level of basic cognitive operations. There is a relationship between the cognitive structures of different levels of the hierarchy «discrete – integral». This connection is the basis for the formalization of semantic meanings. The cognitive configurator is the smallest perfect system of basic cognitive operations of system analysis.

The mathematical model of ASC-analysis based on information theory includes:

- a systemic generalization of the Hartley formula (Hartley, 1959);
- systemic generalization of the Kharkevich formula (Kharkevich, 1960);
- method of forming a matrix of absolute frequencies;
- compilation of a matrix of relative and absolute frequencies;
- obtaining a matrix of information content;
- solving problems of identification (forecasting, management (decision-support) and research of the simulated subject area.

The ASC-analysis model solves the important problems of metrization of various measuring scales (nominal, ordinal, numerical) and comparable processing of descriptions of objects in them.

The intelligent system «Eidos» is a developing and constantly improving software toolkit for ASC-analysis. Eidos provides the construction of comparable large-dimensional models based on fragmented, noisy initial data of various nature (numerical, text). Eidos cognitive analytical system is adapted for use in agriculture, including in the development management system of integrated agro-industrial formations. Eidos is applicable for solving problems of identification, forecasting, decision-making (management) and studying IAF. It connects subsystems and modes that provide:

- input of initial data from external databases of various standards (tables, texts, images);
- creation and measurement of the reliability of statistical and knowledge models;
- solving problems of management, identification, forecasting and study of the subject area.

Thus, the ASC analysis seems to be an adequate tool for solving the problems of managing a multi-sectoral integrated agro-industrial formation on the basis of fragmented (incomplete) and noisy information about it and its enterprises.

4 Conclusion

Management of an integrated agro-industrial formation is a process that has a complex cross-sectoral nature, due to the fact that the association is a complex multi-level system with modification variability; consisting of interconnected organizations; operating in a complex, competitive and dynamic environment.

The proposed concept for managing the development of integrated agro-industrial formations is based on the use of an integrated, multi-aspect approach to solving strategic problems solved based on the system analysis methodology.

Modeling a control object is based on the synthesis of fundamental and technical analysis methods. At the same time, on the basis of indicators determined in a temporal coordinate system, it is recommended to identify events in the history of the IAF (technical method of analysis), and then identify and substantiate correlations between these events (fundamental method of analysis). The revealed dependencies are used to build a management model for an integrated agro-industrial formation.

In the course of the study, conceptual and theoretical and methodological provisions for managing the development of integrated agro-industrial formations operating in territorial socio-economic systems were clarified and developed, including:

- the state of the issue of management of the IAF as part of the regional agro-industrial complex was studied and the economic, organizational and managerial problems of their development were considered;

- the problematic aspects of the IAF development management were investigated and the methodology of system analysis was substantiated;

- From the analysis of the affected subject area, the substantive basis of the methodology of system analysis and the methodology of development management of the IAF is substantiated.

The considered set of methods of the economic and economic-mathematical apparatus is focused on the development of a variety of alternative options for the development of the research object, their assessment and the adoption of an optimal management decision.

The automated system-cognitive analysis seems to be an adequate tool for solving management problems of a multi-sectoral integrated agro-industrial formation based on fragmented (incomplete) and noisy information about it and its member enterprises.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

6 Acknowledgement

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