

Methodological approaches to digitalization of biotechnological processes in industrial viticulture

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Abstract. Factors affecting the stability and efficiency of reproduction processes in industrial viticulture have been identified. Destructive changes in the elements of grape agrocenosis in the conditions of changing climatic factors and chemical-technogenic intensification of production are determined. A generalizing characteristic of the biologization of intensification processes in industrial viticulture is given. It is established that the strategic appearance of promising technologies in viticulture is determined by modern methods of process biologization and their management based on digital technologies. The functional content of digitalization of management of biotechnological processes in grape agrocenoses is identified. An algorithm for the formation of digital technologies for managing biotechnological processes is proposed, including: the formation of multifunctional databases and data banks on technology elements, the formation of digital applications, the formation of an empirical database and geocoded collection of information on technological operations, cognitive modeling of system relationships and the formation of cognitive maps that determine the influence of external and internal environmental factors on functional areas of influence, the development of a system program prototype architectures, approbation and verification of the adequacy of digital technologies. An assessment of the effectiveness of the use of digital technologies in the management of biotechnological processes in viticulture is given.

1 Introduction

Grape production technologies based on the exploitation of perennial agrocenoses are quite conservative in terms of location and the main elements of the agrocenosis: rootstock, graft, planting scheme, method of formation, agrotechnological regulations for the cultivation of grape plantations, which are based on many years of research and proven optimal variations.

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At the present stage of development of grape production technologies (improvement of production and technological processes), energy conservation, biologization and rationality of nature management are of particular relevance.

These aspects constitute the main focus of the modification of existing technologies in order to reduce material and technical costs, human labor costs, increase the stability of agroecosystems, which should ensure a reduction in production costs and chemical and technogenic pressure on grape agrocenoses.

The industrial use of biological processes and agents based on the production of highly effective forms of microorganisms, cell cultures and plant tissues with specified properties is the subject of biologization.

The search for the most optimal technological solution is carried out by means of digital technologies for controlling the processes of biologization using long-term empirical databases in combination with mathematical methods of their processing.

2 Materials and methods

In ensuring the stability of grape agrocenoses, reducing the chemical and technogenic load on agroecosystems, leveling the negative manifestations caused by these impacts, a priority role is given to biologization – the fullest involvement of natural biological resources in reproduction processes and increasing the biological potential of plants themselves through modern methods, including breeding.

Digital technologies – operational development of optimal regulations for technological processes and operations based on the formation and processing of multifunctional databases, cognitive modeling using software and hardware.

The most important structural element of digital technologies are databases, which are integrated information systems that enable operational management decisions and optimize resource costs for the implementation of plant biopotential, agrocenosis.

3 Results and discussions

In the conditions of negative manifestations of climatic and macroeconomic factors, factors of intensification of production in the Krasnodar region, there is a decrease in the stability and efficiency of reproduction processes in industrial viticulture.

For the period 2015-2021, the average annual growth rate of the cost of grapes of technical varieties amounted to 8.8%, sales prices 7.0%, which led to a decrease in production efficiency by more than 11 points. The negative impact of macroeconomic factors (the inflation rate projected by the Ministry of Economic Development is 12% per year, the planned increase in prices for plant protection products by 10-15%, for fuel – by 5-8%, for fertilizers – by 9.1%) may cause an increase in the cost of grape production in 2022 by more than 12%, which will have an impact on reducing the real efficiency of the production of industrial products by more than 4.5 percentage points.

The main destructive changes in the elements of the grape agrocenosis in the conditions of changing climatic factors and chemical and technogenic intensification of reproduction processes in industrial viticulture are: reduction of soil fertility and biogenicity, violation of the immune status of plants and the inability of them to realize their productive potential, violation of the stability of microbio-, acaro- and entomcosystems. Leveling the negative consequences of chemical-technogenic intensification of production causes the attraction of additional financial resources [1-5].

The cumulative decrease in the production efficiency of industrial products as a result of the synergetic influence of climatic factors and factors of chemical and technogenic intensification averages more than 10 percentage points.

Taking into account the presence of direct causal relationships between the state of grape agroecosystem and chemical and technogenic load on various elements of agroecosystem, it should be emphasized that the intensification of technological processes (the part of the production process, a set of technogenic and biotechnological methods (technological operations) of transforming the object of labor that have a certain goal setting: changing properties or state, ensuring biological processes or optimal agroecosystemic state, etc.) should be carried out mainly biological methods (Figure 1).

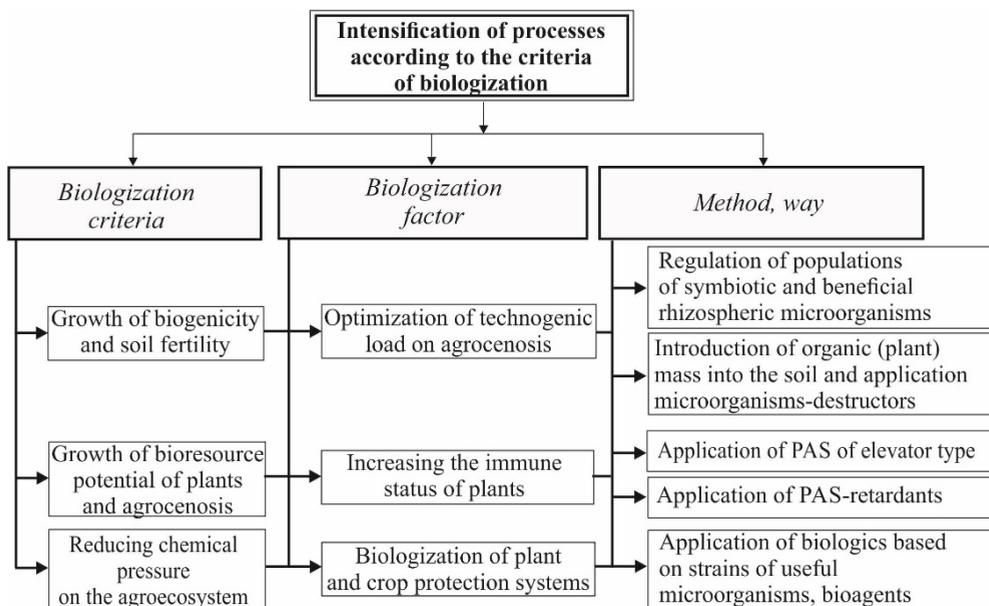


Fig. 1. Generalizing characteristics of the biologization of intensification processes in industrial viticulture.

The characteristic features of the strategic appearance of promising technologies in viticulture include the dominance of modern methods of biologizing technological processes and managing them through digital technologies using long-term empirical databases [6-7].

The development of digital technologies should be carried out according to the elements of technology and the viticulture management system as a whole (Figure 2).

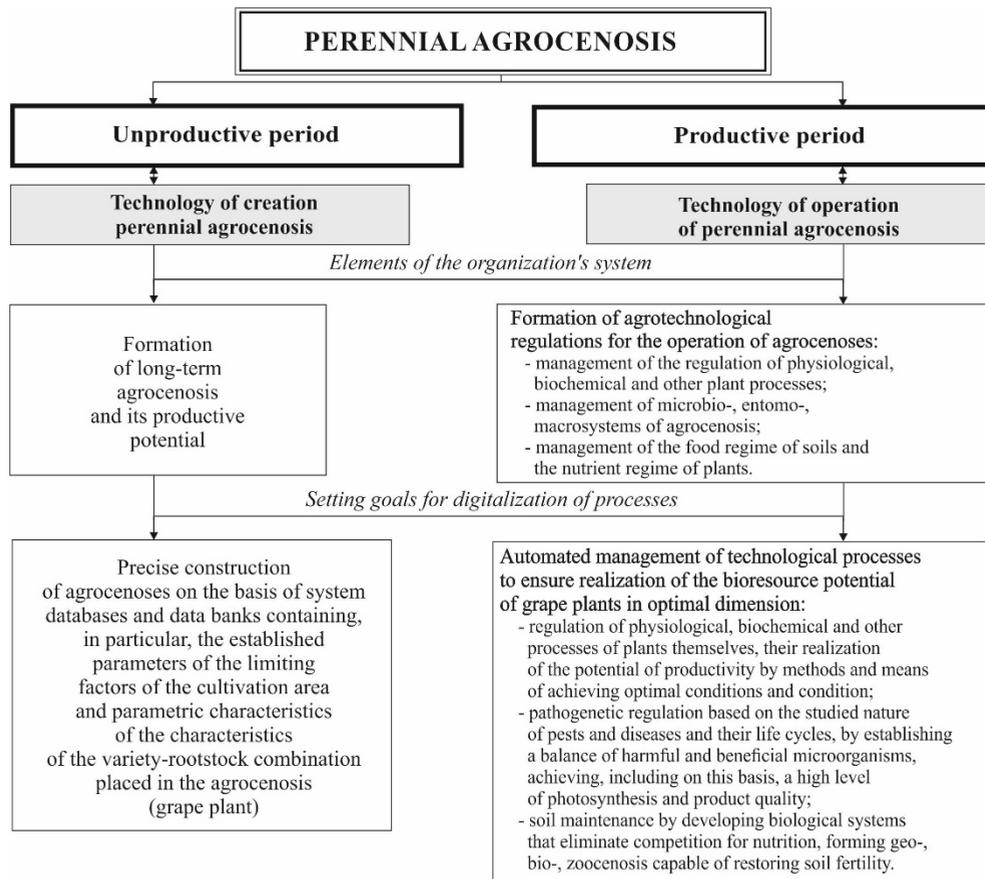


Fig. 2. Functional content of digitalization of management of biotechnological processes in grape agroecosystems.

In general, the algorithm for the formation of digital technologies for managing biotechnological processes includes the following stages: the formation of multifunctional databases and data banks on technological elements, the formation of digital applications, the formation of an empirical database on technological operations, cognitive modeling of system relationships and the formation of cognitive maps that determine the influence of factors of the external and internal environment on the functional areas of impact, the development of a system architecture the prototype of the program, approbation and verification of the adequacy of digital technologies (Figure 3).

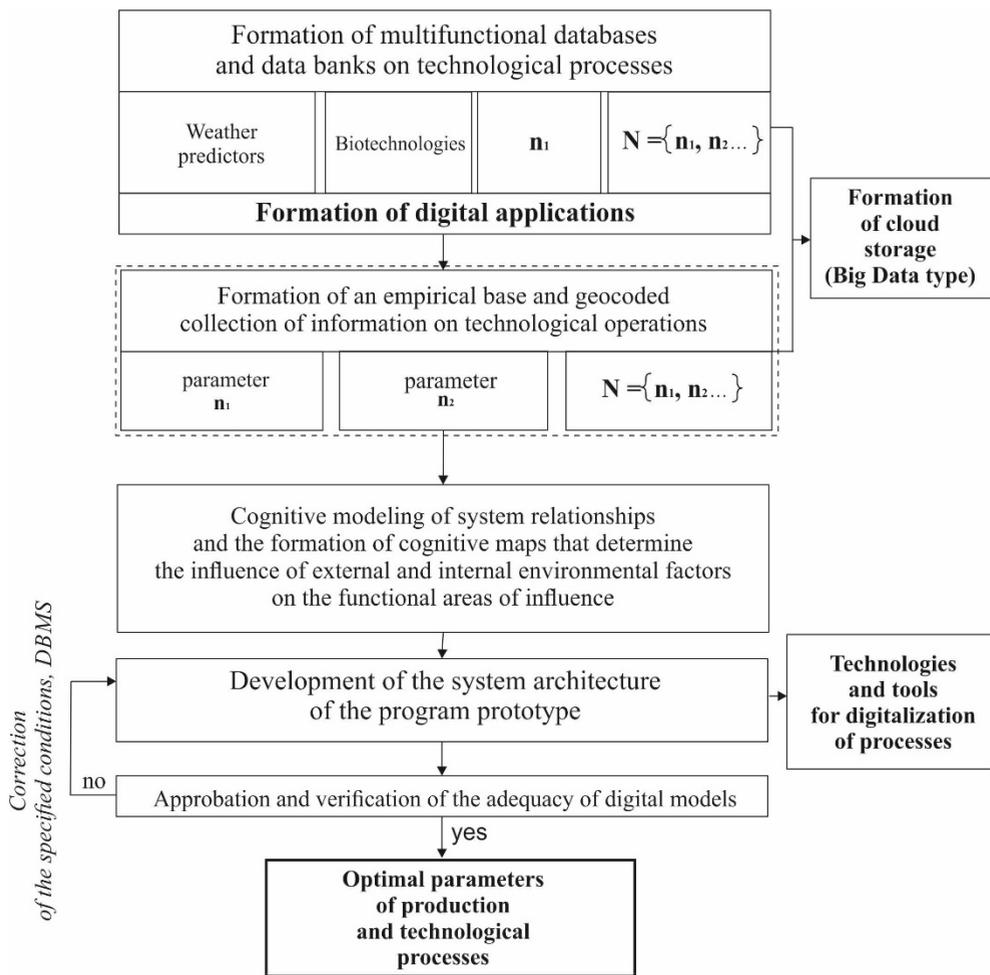


Fig. 3. Typical algorithm for the development of digital technologies

The formation of an empirical database on technological operations and multifunctional databases and data banks is carried out by encoding information based on IT solutions [8-10].

The creation of integrated digital technologies creates new opportunities for the use of qualitatively new technological solutions and approaches in the management of production and technological processes.

4 Conclusions

The use of digital technologies in the management of biotechnological processes in viticulture will increase technological and economic efficiency through the development and operational adoption of management decisions aimed at optimizing resource costs associated with the realization of the productive potential of the grape agrocenosis.

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