Agricultural crops programmed cultivation using intelligent system of irrigated agrocoenoses productivity analyzing

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Abstract. The article considers the possibilities of controlling the programmed cultivation of agricultural crops using an intelligent system for analyzing the productivity of irrigated agrocoenoses. The information support of the intelligent system is standard information about agrometeorological conditions, technical parameters of irrigation systems and irrigation machines, as well as information about the amount of water resources allocated for irrigation. The obtained results provide a strict theoretical basis for solving the issues of irrigation water distribution and operational management of the irrigation regime, clarify and simplify the procedure for choosing the optimal variant of the irrigation system design solution, and make it possible to make reasonable decisions related to the rational use of water resources in existing systems.

1. Introduction

The development of new forms of economic relations in the agricultural sector of our country, the need to protect domestic producers from the expansion of foreign firms, the increased interest of agricultural producers in the results of their activities led to the need for more effective management of the processes of cultivation of agricultural crops, including during reclamation works (construction of irrigation, drainage and anti-erosion systems, agroforestry, liming of acidic soils, gypsum solonets, etc.), development of specialized zones of guaranteed production of the most important types of agricultural products.

The problem of improving the management of crop cultivation processes in the world science is given great attention; there are significant practical achievements in this field of activity. The methodological basis for managing these processes in Russian science was formed on the basis of theoretical and practical results obtained in the field of programmed crop cultivation and complex regulation of plant life factors. At the same time, for a number of practical tasks, including the effective use of available resources to obtain high and sustainable yields, a rigorous scientific solution has not yet been obtained. The methodological approaches proposed by some researchers to managing the process of growing crops do not fully take into account the potential opportunities for increasing the productivity of reclaimed land, poorly stimulate the use of resource-saving technologies, and do not sufficiently contribute to the rational and efficient use of resources in agricultural production.

The main direction of scientific and technological progress in improving the management of the processes of cultivation of agricultural crops on reclaimed lands, as shown by the results of scientific
research and best practices in our country and abroad, is the creation of expert systems and information technologies for managing the processes of agricultural production. Computerized technologies and systems of this profile, implemented at the intersection of branches of knowledge based on the laws of biology, physics, chemistry and other fundamental sciences, allow synthesizing traditionally divided by spheres of activity decision-making processes into a single purposeful process of managing the cultivation of agricultural crops in each farm, in each specific field.

To solve the complex, both in terms of content and from a formal point of view, the problem of irrigation management, it is necessary to create appropriate automated systems. In countries with developed irrigated agriculture, a significant amount of research is being carried out to develop and implement automated irrigation planning and management systems in agricultural production. A significant number of experimental studies of practical and theoretical orientation have been devoted to the development of optimal irrigation regimes for individual agricultural crops, taking into account soil types and various irrigation technologies for individual regions, zones and agricultural areas of our country [1-10].

2. Materials and methods
In practice, when planning irrigation, a number of complex problems arise, the solution of which cannot be obtained by empirical methods. First of all, it is very difficult to take into account such factors as the variability of weather conditions, the state of technical means, the availability of water and labor resources, the placement of agricultural crops, environmental requirements and restrictions. Analysis of the results of production activities of farms with irrigated land shows that the multiplicity of irrigation, which usually characterizes the general crop of agriculture, correlates with the level of scientific and technical support of regional irrigation management services. All these factors significantly affect the formation of the irrigation plan. At the same time, the operational mode of irrigation planning and management becomes the basis for optimizing the process of crop formation.

Modeling an intelligent system for assessing the environmental safety of irrigated lands in the conditions of differentiated placement of crops implies the ability to accumulate knowledge of specialists in this subject area and manage this knowledge when making a decision. Among the main requirements of this control system is the possibility of its practical application by a specialist of any level of information training.

A distinctive feature of the programmed cultivation of agricultural crops is the consideration of the peculiarities of each specific field and the differentiation of agricultural techniques depending on the prevailing weather conditions. Practical implementation of control systems for the technology of programmed crop cultivation is possible with the use of specialized information and computing centers, the main tasks of which are:

- development of technological maps for the planned yield using data from agrochemical analyses of fields, the availability of mineral and organic fertilizers in the farm;
- operational adjustment of technological schemes in connection with changes in weather conditions, production situation and resource availability of farms, operational management of irrigation regimes;
- control over the implementation of the main technological schemes and adjustments in real time;
- coordination of actions of various organizations included in the agro-industrial complex.

Intelligent information systems for managing programmed crop cultivation were actively introduced into the practice of agricultural production [11-16] In various regions of the Russian Federation, Programmed technologies for growing vegetable, grain and fodder crops were used on an area of more than 70 thousand hectares. The software created by the authors is organized in such a way that when developing technological maps for growing crops, this work could be performed by an agronomist using computers, including mobile ones.
Figure 1. Block-diagram of an intelligent information system for programmed crop cultivation on irrigated land.

Figure 1 shows a block diagram of an intelligent information system for programmed crop cultivation on irrigated land. The system includes multi-user databases, a complex of simulation models of agricultural crops cultivation, and a simulation model of inter-farm irrigation systems. The implementation of the intelligent information system will provide the solution of the following key tasks:
- perform regular calculations to assess soil moisture and crop condition (development phase) for all fields of the irrigation system in real time;
- coordinate the timing and norms of irrigation for a given pre-irrigation humidity, using standard agrometeorological data;
- manage the water regime of plants in individual fields, solve problems of water allocation and completion of irrigation schedules, taking into account the characteristics of the irrigation network and the availability of water resources [17-19].
Figure 2. Structural model of the intelligent system of programmed cultivation of agricultural crops on irrigated lands

The task of optimal irrigation planning should be based on combining the irrigation regime of each crop with the distribution of water between fields, taking into account soil fertility, agrotechnical measures carried out and existing ecological restrictions, covering, first of all, the on-farm part of the irrigation system. However, in order to solve the problem of rational use of water in irrigation, it is also necessary to take into account a number of other factors.

When planning irrigation, as the analysis of the activities of pilot farms shows, the greatest difficulties arise when collecting current information about the current state of crops and soils and then predicting their water needs. Since meteorological conditions do not lend themselves to a reliable long-term forecast, the relevance and accuracy of the assigned operational irrigation regimes is related to the efficiency of their planning, which allows taking into account the current moisture supply of plants, the course of vegetation and the short-term weather forecast.

The existing regional management systems used centralized collection of current information (on the state of fields, weather conditions and irrigation), its transmission and subsequent processing on a computer to prepare optimal management decisions. At the same time, the required efficiency is lost. The remoteness of the decision-making center from the specialists of the farm, in addition, leads to a mismatch of the technological complex and the loss of some information about the features of crop growth, the state of the fields and the current economic situation. The resulting inconsistencies significantly reduce the value of information support and the effectiveness of managing technologies for growing crops on irrigated lands [21-31].
3. Conclusion
Technical aspects of yield programming in the framework of optimal operational management of crop cultivation on irrigated lands are a key task in the framework of the Development Strategy of the Russian Federation in the coming years. The development of models for the growth and development of agricultural crops that allow us to accurately get an idea of the state of crops, the creation of intelligent software systems for solving problems of optimal resource allocation and operational management of irrigation and crop nutrition regimes are the most important tasks in the development of the agro-industrial complex at the Federal level.

However, intelligent information systems for crop programming and operational irrigation management were not widely used, as a whole range of scientific, technical and organizational issues remained unresolved. Excessive centralization of technological process management at the regional level led to ignoring the local characteristics of agricultural production, the actual state of management facilities and resources, excluded high detail and efficiency of management decision making.

The problem of optimal irrigation planning should be based on combining the irrigation regime of each crop with the distribution of water between fields, taking into account fertility.

The information support of the model system is standard information about agrometeorological conditions, technical parameters of the OS and irrigation machines, as well as information about the amount of water resources allocated for irrigation. The obtained results provide a strict theoretical basis for solving the issues of irrigation water distribution and operational management of the irrigation regime, clarify and simplify the procedure for choosing the optimal variant of the OS design solution, and allow reasonable decisions related to the rational use of water resources in existing systems. The solution of practical problems in the development of computerized systems for optimal irrigation management is primarily associated with the need to develop adequate models of productivity of agrocenoses in irrigation conditions for reliable determination of the dependence of the yield of various crops on the availability of water.

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