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INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS)

Automation of the process of controlling irrigation regimes based on modern information technologies

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Abstract

The issues of automation of the process of control of irrigation regimes of agricultural crops based on the use of modern information technologies are considered. The main tasks solved during automation of the process of control of irrigation modes of agricultural crops for making management decisions on irrigation regimes are described. The purpose of the information technologies used in the automation and functioning of the system of control of irrigation regimes of agricultural crops is given.

Keywords: Automation of the process of control of irrigation regimes. Information technologies. Information security.

Introduction

In the world, it is important to automate the management process of various activities using modern information technologies. This article describes the tasks and ways to solve them when automating the process of managing irrigation regimes for agricultural crops.

Main Part

In modern conditions, the following basic requirements are imposed on irrigated agriculture: efficient use of land and water; obtaining planned agricultural products; careful attitude to the natural environment. For the growth and development of agricultural crops, to obtain planned yields and increase soil fertility, it is necessary to timely determine the irrigation regimes of agricultural crops, that is, determine the timing, norms and amount of irrigation, taking into account the type of crops and their development phases, irrigation methods, weather conditions and water-physical properties of soils. Automation of the process of managing irrigation regimes of agricultural crops is an urgent problem.

The irrigation norm is the volume of water in cubic meters supplied to 1 ha per irrigation. The irrigation regime should: take into account the water needs of crops in their development phases; regulate the water and nutrient regimes of soils; promote soil fertility.

To establish an irrigation regime for agricultural crops, it is necessary to take into account:

– water-physical properties of the soil, the depth of the root layer; soil moisture before irrigation;

– irrigation rate, taking into account the biological characteristics of the crop and its development phases;

– the total amount of water consumed, that is, the total water consumption.

To provide plant with water in the required quantity in all phases of their development, it is necessary to maintain soil moisture in the root zone at the level of maximum field moisture capacity (the lowest) by irrigation. Maximum field moisture capacity depends on the crop being grown, soil composition and weather conditions.

Water reserves in the soil are replenished by precipitation, irrigation, groundwater inflow, surface water inflow and intrasoil moisture condensation. Water reserves in the soil are spent on plant transpiration, evaporation from the soil surface, groundwater outflow, surface runoff and the formation of organic matter by plants. The ratio between water consumption for transpiration and the flow of water into the plant from the soil is called the water balance of plants. When the soil moisture reaches the maximum field moisture, as a result of irrigation and precipitation, the growth of the root system improves and its mass increases.

The irrigation rate is determined by the equation of the water balance of the root zone. The total water consumption of plants is satisfied by irrigation and precipitation. To achieve efficiency from irrigation, it is necessary to carry out irrigation at certain times corresponding to:

– external conditions of plant growth and development (soil moisture, water reserves in the root zone of the soil and meteorological data);

– biological characteristics of crops and their development phases.

For each irrigation it is necessary to determine: the irrigation rate, i.e. the amount of water required per 1 ha of field per irrigation, and the irrigation method. Based on the data obtained, an irrigation regime is compiled, i.e. an irrigation regime containing the timing of irrigation, the irrigation rate, the irrigation method, the amount of irrigation and the total water consumption of each crop in all fields. As the soil moisture decreases from the maximum field moisture to the critical (minimum permissible) moisture, and especially to the moisture of stable wilting, the availability of soil moisture for plants and their productivity in using it decrease. Irrigation is prescribed until the moment of the permissible limit of drying out of the active soil layer, in % of the maximum field (lowest) moisture, i.e. until the onset of critical (minimum permissible) soil moisture, according to the type of crop, the type and salinity of the soil, as well as the depth of the active soil layer, according to the phases of crop development.

Total water consumption (total evaporation) is defined as the sum of the total water consumption for transpiration and the total water consumption for evaporation from the soil surface. Total water consumption is expressed in m3/ha or mm, and it depends on the soil water regime, the growing season of crop development and meteorological conditions. Total water consumption is used to calculate the timing and amount of irrigation.

To calculate crop irrigation rates, the following are calculated daily for each crop according to their development phases: total water consumption (total evaporation) based on actual meteorological data; water reserves in the root zone of the soil based on water reserves for the previous day and total water consumption for the current day; irrigation dates; gross irrigation amounts (rates); gross irrigation rates per day; amount of irrigation. Then, for each crop, forecasting is performed up to the tenth day: water reserves, soil moisture, irrigation dates, gross irrigation amounts (rates), gross irrigation rates per day and amount of irrigation [3-8].

For the effective organization of automation of the process of management of irrigation modes of agricultural crops, it is necessary to use modern information technologies (electronic office, databases, data banks, decision support systems, multimedia systems, expert systems, artificial intelligence, expert support of decisions, client-server technologies, Internet technologies, cloud technologies, etc.). And, thus, the information process in the automated system is provided on the basis of the use of information technologies.

Information required for the implementation of the main tasks of the crop irrigation management system is accumulated and processed in databases. The system databases store normative, reference, planned and calculated data for obtaining output results for crop irrigation modes [1]. As a result of the automation of the irrigation mode management process and the operational use of the system's database data, management decisions are developed for crop irrigation modes for the efficient operation of farms. Therefore, in the automated system, the stored, processed and transmitted information must be protected.

Information technology for organizing virtual computers for the user system allows increasing the security and efficiency of using computers and system resources. Electronic data processing will ensure data processing and solving the problems of the automated system.

The knowledge base contains facts describing the problem area, as well as the logical relationship of these facts. The rules used in the expert system form a system of rules. In the knowledge base, a rule determines what to do in a given situation and consists of two parts:

1) a condition that may or may not be met;

2) an action to be performed if the condition is met.

Information technologies of expert decision support use information from subject area knowledge bases and prepare solutions for the user system to solve the problems of assessing situations and substantiating the logic of choosing solutions for crop irrigation regimes. Knowledge bases are developed to formalize the decision-making process in the expert system. An expert system is an information system based on the use of artificial intelligence, and which enables users of the system to receive consultations for making management decisions on crop irrigation regimes. Information technology of expert systems makes it possible to use it as an advisory system. Information technology of expert systems allows you to substantiate the reasoning systems offered to users, in the processes of obtaining management decisions on crop irrigation regimes, based on the knowledge base and database.

Information technology decision support is an interactive system that is intended for users of the system making management decisions on crop irrigation regimes. Users of the system use their experience and knowledge, database information, as well as the knowledge of specialists from the knowledge base of the expert system, and thus, the decision support system develops options for decisions on crop irrigation regimes for users of the system, based on data analysis. Thus, the decision support system interactively supports the activities of users of the system in the process of making management decisions on crop irrigation regimes and forecasting crop irrigation regimes.

Client-server technology provides: remote access to system databases; support for multi-user mode; making changes to the client and/or server parts; protecting databases from unauthorized access at the server level [2]. Server virtualization is used to run multiple virtual servers on one physical server, and an operating system with applications is installed on each virtual computer.

Multimedia technologies are used to process text, graphic, audio and video information.

Information telecommunication technologies are designed to provide access to all types of information services using the Internet, local networks, video conferences, security systems, and so on.

Internet technologies provide the exchange of electronic documents via the Internet using computer technologies and security protocols. For safe operation of personal computers of users of the system with the Internet, it is necessary to use firewalls, i.e. programs designed to prevent intrusion from the Internet into personal computers of users.

Cloud technologies are designed to provide IT resources as a services. Cloud technology is a complex computer network in which information resources are stored remotely, through a remote server, and thus, users of the system get the opportunity to process and store information on the Internet. Cloud computing is a data processing technology in which computer resources are provided to users as an Internet service.

When using information technologies in an automated system, the problem of information security arises, associated with threats to the system's information resources.

To organize and implement the information process in the system, it is necessary to organize and ensure the security of the information process in the automated system for control irrigation regimes. Information security is the main part of information technology. The security of the information process determines the availability, integrity and confidentiality of information in the automated system for control irrigation regimes. To do this, it is necessary to ensure the protection of stored and processed information in the system databases. Information security shows the degree of protection of the information system.

The results of the application of information technologies are information services provided to users of the automated system.

The use of information technologies implies the participation of meliorators, agronomists and farmers in the automation of the process of control crop irrigation regimes and making management decisions on crop irrigation regimes.

The efficiency of automation of the process of control crop irrigation regimes is due to the fact that by introducing modern information technologies, mathematical models, increasing the efficiency of management decisions on crop irrigation regimes, crop yields increase due to taking into account daily changes in the external environment (air temperature, relative air humidity, soil moisture, precipitation and total solar radiation).

Conclusions

Automation of the process of managing crop irrigation regimes, based on information technologies and mathematical methods, is a pressing issue: for regulating the water regime of soils; maintaining soil moisture in the root zone at the level of maximum field moisture capacity; operational planning and forecasting of crop irrigation regimes; operational adoption of management decisions on crop irrigation regimes; obtaining planned yields.

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სიმონ პოჩოვიანი

რეფერატი

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