Oleksiy Sadovoy
associate professor
Vasyl Hruban
associate professor
Natalia Potryvaieva
professor
Mykolaiv National Agrarian University, Ukraine
sadovuyos@mnau.edu.ua
hrubanva@mnau.edu.ua
potrivaeva@mnau.edu.ua

Innovative energy-saving technologies in irrigated farming systems in post-war recovery

Introduction. According to the FAO, Ukraine's agricultural resource potential allows feeding 450-500 million people, but today only a third of its potential is used. This is due to a number of factors, primarily related to climate change. Since 1991, the area of the risky agricultural zone in Ukraine has increased by 7% . At the same time, the area with excessive and sufficient atmospheric moisture decreased by 10% and occupies only 7.6 million hectares of arable land. Thus, 77% of Ukraine's arable land needs constant irrigation. According to forecasts, further climate changes will worsen the conditions of natural moisture supply . As a result, the role of irrigation in the production of agricultural products will only grow and contribute to the rapid recovery of Ukraine in the post-war period.

Materials and Methods. The sustainable development of irrigated agriculture in the conditions of post-war recovery is possible only under the condition of developing new complex universal energy- and resource-saving systems and complexes. To reduce energy resources in irrigated agriculture, it is necessary to provide for the development of innovative technologies for circular sprinklers, based on the use of a solar power plant, an automated system for determining soil moisture in different areas of the field, irrigation rates, a system for applying fertilizers, plant protection products, growth stimulants, and chemical meliorants together with irrigation water and the use of a modernized backup power source. The main direction of irrigation development is the development of resource-saving technologies, improvement of operational reliability and energy efficiency of hydromelioration systems, reduction of capital and operational costs, rational use of resources. Research on the integration of a solar power plant into the power supply system of a sprinkler is of significant scientific and practical importance. This innovative implementation will reduce the consumption of fossil energy resources by up to 50%. The development and integration of a system for the preparation and application of water-soluble fertilizers, chemical ameliorants, plant protection agents, and growth stimulants together with irrigation water will increase the efficiency of their use to 80-96%, reduce soil compaction by the undercarriage of agricultural machinery, reduce the cost of agricultural products by up to 20%, and increase productivity agricultural crops up to 20%. The development and implementation of a system for automatically controlling the operation of the sprinkler depending on the moisture availability of soil areas, determined by the system of soil moisture sensors with GPS modules and current data from the weather station, and accordingly differentiated irrigation rates will reduce water consumption by 15-20%. Modernization of the cooling system of the backup diesel generator will allow the use of irrigation water for the operation of the cooling system instead of air, which will reduce diesel fuel consumption by up to 10%. Adapting the operation of the sprinkler with the proposed technical solutions in the system of precision agriculture will lead to an increase in the yield

of agricultural crops by almost 20% due to the coordinated introduction of nutrients and water, taking into account soil moisture and current weather station data. Analytical studies of the characteristics of modernized systems of energy supply and control of technological parameters, power from a solar power plant, application of agrochemicals with water and management taking into account soil moisture will be performed, by developing mathematical models, their verification and modeling of work processes.

Experimental Materials. At the first stage of the project, a system of simultaneous application of fertilizers with irrigation water was developed on the basis of Zimmantic sprinklers, which allows to reduce the consumption of fuel and energy resources by up to 50%, and to increase the efficiency of their work by up to 17% compared to existing modern models of sprinkler equipment, which is a value for the economy and society. During the work on the first stage of the project, a mobile station was designed for the preparation and supply of fertilizers to the spraying system. The pipeline system for moving fertilizers with irrigation water was calculated, and the pressure at the last point (nozzle) was determined. The dependence of the speed of movement of the machine and the pressure in the pipeline for the optimal operating mode was determined.

Results. The substantiation of promising energy- and resource-saving technologies of irrigation systems in the conditions of post-war reconstruction will provide an opportunity to determine the best technological and technical solutions for increasing the energy efficiency of resource-saving circular sprinkler machines. For this purpose, for the first time in Ukraine, an innovative sprinkler irrigation range is being created using alternative energy sources and smart technologies for circular sprinkler machines. The development of a multifactorial mathematical model of the operation of a sprinkler using power systems from a solar power plant, application of fertilizers, plant protection agents, growth stimulants, chemical meliorants with water and differential irrigation taking into account soil moisture will allow to reduce the consumption of water, agrochemicals, energy resources, mechanical and chemical load on the soil. The development of an automatic system for the preparation and introduction of fertilizers, growth stimulants, plant protection agents, and chemical meliorants into irrigation water will allow to increase the utilization rate of the active substance to 80-96%, reduce soil compaction by the undercarriage of machine-tractor units, as well as energy consumption by up to 20% due to reduction of mechanized technological operations. Theoretical studies will be performed using the laws and methods of classical hydraulics, mechanics, electrical engineering, mathematical modeling, etc.

Conclusion: In further studies, it is planned to carry out analytical studies of the characteristics of modernized systems of energy supply and control of technological parameters, power from a solar power plant, application of agrochemicals from water and management taking into account the humidity of the foundation, by developing mathematical models, their verification and modeling of work processes. The obtained analytical and experimental data allow to optimize and improve the operating parameters of circular sprinkler machines, which makes it possible to minimize the consumption of energy and water resources, fertilizers, plant protection products, growth stimulants, and damage to the mechanical loads on the base.

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