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Systems analysis of practice of irrigation farming

Objective.Explore the current practice of irrigated agriculture using the methods of system analysis and offer a set of measures for its improvement on the example of pilot territories in the Kherson region.Methods.Analytical, statistical, system analysis.ResultsResearch on the methods of system analysis (DPSIR, SWOT analysis, Causal Loop Diagram) has established that in order to achieve sustainable production on irrigated lands, ensuring the efficient use of resources and preserving the natural environment, it is necessary to develop mechanisms of economic and legislative influence that would stimulate the introduction of innovativeTechnologies of control of technological processes and means of modern agromonitoring.ConclusionsSystem analysis has shown that according to the existing practice of irrigated farming, the economy is profitable and has no incentive to implement resource-efficient technologies.

Key words: practice of irrigated agriculture, system analysis, agromonitoring, resource efficiency, DPSIR, SWOT-analysis, Causal Loop Diagram.

Formulation of the problem.Driving agrarian production on irrigated lands in the new economic and social conditions is characterized by a diverse practice of using these lands by new private companies.They have different economic and logistical capabilities, knowledge about the management of irrigated agriculture technologies.Under the existing legislation, the issue of controlling the quality of land use was not regulated, the research-based technologies were not stimulated, resulting in preconditions for neglecting the environmental safety and preservation of the natural environment [3-5, 17].

In order to achieve sustainable production on irrigated lands, ensuring efficient use of resources and preserving the natural environment is a prerequisite for the development of mechanisms of economic and legislative influence that would encourage water users to more adequately treat the use of natural resources, to implement innovative technology of technological controlProcesses and means of modern agromonitoring.

The purpose of the research is to study the current practice of irrigated agriculture using the methods of system analysis and to propose mechanisms for its improvement on the example of pilot territories in the Kherson region.

Research methods.The research was conducted on pilot sites of 4 different types of ownership companies located in Chaplinsky, Genichesk and Kakhovsky districts of the Kherson region.The research methodology involves a systematic study of the practice of irrigated agriculture, which was seen as a complex open system that changes in time and space.The following systems analysis methods were used:

DPSIR [driving forces] - pressure (pressure) - state changes - state of influence - response (response, reaction)] is a method of conceptual modeling that characterizes the functioning of the system's components in general, depending on the externalAnd internal factors of influence, response to the consequences of these influences in society and production [7-9, 13];SWOT analysis [strengths - weaknesses - opportunities - threats] provides an opportunity to benchmark the various practices of irrigation and determine the risks that may occur if one or another practiceWill continue [6, 14]; Causal Loop Diagram is a method of causation diagrams used to analyze the interaction of various factors affecting the function of the system and its state [13, 15, 16].

Research results.The above-mentioned methods have been used to analyze irrigation farming in pilot farms in the Kherson region, which use intensive irrigation practices and profit from the cultivation of profitable crops (soybeans, corn).The first in the work was the method of conceptual modeling of DPSIR, the result of which is the visualization of the links between the components of the system.The model of the functioning of the components of the irrigated agriculture system contains the following components of external influences - "driving forces": climate change, legislative framework in the field of water and land management, market conditions for prices for agricultural products and material and technical resources.As internal factors that create direct "pressure" on the system, the existing practice of irrigated farming is considered.Today it is formed depending on the organization of private land use in the absence of a modern agro-monitoring system in the context of the unsatisfactory technical state of irrigation systems and is characterized mainly by an unsatisfactory level of management, which leads to inefficient management of irrigated agriculture technologies.These factors influence the processes occurring in the subsystem "soil - plant - atmosphere".The result of these impacts is the decline in soil fertility, the yield of crops, much lower than the potential level, the deterioration of the ecological and land reclamation state.In order to prevent and eliminate the pressure on the irrigation system, corrective action is needed.

In our opinion, such regulatory complex actions include: regulation and improvement of methods for charging services for water supply for irrigation;An increase in the amount of rent for the use of irrigated land;Creation of conditions for attracting investments in the reconstruction and modernization of irrigation systems;Improvement and development of the agrometeor monitoring system;Creation of mechanisms for implementation of innovations for resource-efficient management in irrigated agriculture;Dissemination of new knowledge and best practices among irrigated agriculture specialists.

The next method of system analysis used to evaluate the practice of irrigated agriculture was SWOT-analysis.According to his method, the definition of strengths and weaknesses, opportunities and threats, which were grouped under such blocks: natural-economic, technological and technological, economic, environmental and organizational-legislative.

For the pilot areas under study, the common strengths are: favorable geographic location, extensive experience in agricultural production, high soil fertility potential, and sufficient technical capacity of the territory to grow heat-loving crops.

Weaknesses of their activities is a violation of the structure of crop rotation, vyroschu- ing the most profitable crop on a background of intensive use of irrigation, ineffective water management due to lack of operational management of irrigation, the application does not fully land improvement measures to preserve and restore soil fertility.The results in this practice tachi use zroshuva- these lands is changing agrophysical and water-physical properties of the soil, which reduces the humus content and the development of degradation processes in the soil.The negative impact on soil fertility of proven spoken not only impaired the structure of crop rotation and management technologies, but also non-satisfactory technical condition of irrigation systems and sprinkler technology.Therefore in the overwhelming majority of farms spend excessive watering or, in certain periods of the growing season do not provide voice-vodopodachu derivatives due to the limited possibilities of pumping stations.

In order to overcome the problems in the modern practice of irrigated agriculture in the state, there are the following possibilities: reconstruction and modernization of irrigation systems, implementation of operative management of irrigation;Improvement and development of the agro-monitoring system for monitoring the state of the soil and obtaining objective information on the state of crops;Introduction of scientifically grounded crop rotation structures;Achieve a potential yield level;Creating mechanisms at the legislative level to ensure the sustainable development of irrigated agriculture.

Under the current practice of irrigated agriculture, such threats may arise: water shortages, soil fertility reduction, outflow of material and technical equipment due to its aging, and lower profits on farms.

According to the results of the analysis of modern conditions and activities of farms, it has been established that such practice is typical for large and medium-sized agricultural enterprises in the zone of the Steppe of the Southern.

The next method of analysis of irrigated agriculture was the Causal Loop Diagram method.He was able to illustrate the interaction of factors among themselves and their impact on profit in irrigated agriculture (Fig. 1).

Fig.1. Scheme of the influence of external factors on profitability in irrigated agriculture using the method of causation (CLD)

As a result of the analysis, two balance-of-interest drivers have been identified: the impact of the market and the amount of expenses on the use of resources, depending on their quantity and price.This balance may be broken due to the imperfection of the legislative framework, which determines the conditions for the payment for water supply services, the cost of land lease and energy resources.The effect of this factor is intensified due to the imperfection of the agromontrol system, which can fix in a timely manner the unsatisfactory condition of water use and encourage the use of measures to improve the state of soil fertility and the ecological and land reclamation status of the land.The results of the research show that for the purpose of achieving sustainable use of growth, an appropriate legislative framework for the formation of fees for services on the use of resources should be developed and the modern agro-monitoring system should be organized.

To quantify the conditions for the sustainable use of irrigation, the dependence of the profit on the cost of different types of resources (water cost for irrigation, fuel and lubricants, depreciation charges on the grid and sprinkling equipment, network maintenance, land rentSites).Calculations were made on the example of soybeans, which in the studied territories occupied more than 30% of the crop rotation, with yields of 3 t / ha, irrigation rate - 3500 m3 / ha.The results of the dependence were analyzed on the basis of actual data as of January 2015, the indicators of the simulated profit under the probable changes in the cost of resources are shown in Fig.2-4.

Fig.2. Formation of the profit of farms depending on the value of the technical maintenance, the cost of fuels and lubricants

Fig.3. Formation of profit of farms depending on the value of land

Fig.4. The formation of income of farms depending on the cost of the payment for water supply services

With the growth of the market price of soybeans from 7700 UAH / tonne without changing other indicators of the business will always be profitable and at the current prices for agricultural products and resource costs will not be stimulated to introduce a resource-efficient practice of using water and land resources.

In the event of changes in costs, only depreciation charges and network maintenance, sprinkling equipment, and the cost of the fuel and lubricants of the farm will not be profitable if these rates increase to 9250 UAH / ha (Fig. 2).

The value of the rent in accordance with the law is no more than 3% of the normative monetary valuation of land and in the conditions of the Kherson region in specific cases is 501 UAH / ha.Therefore, changing only this value, the economy may become unprofitable, provided the value of land is 10.6 thousand UAH / ha (Fig. 3).

The main leverage of resource-efficient management can be to increase the value of rent for land use.A similar effect will be achieved by introducing a pernicious tax for irrigated land to cover the costs of operating inter-farm irrigation systems [1, 2].

With the increase, only fees for water services up to 3.15 UAH / m3 of the economy will be non-profitable (Figure 4).

To ensure the sustainable use of irrigated land in southern Ukraine, it is necessary to study the existing practice of irrigated agriculture as a complex open dynamic system, which is affected by natural, technological, organizational, economic, environmental, external and internal factors.

Conclusions

It has been established that under the existing system of payment for water supply services for irrigation and lease conditions of irrigated farms intensively using irrigation, they are not interested in introducing resource-efficient technologies in irrigated agriculture.Growing the most profitable agricultural crops and significant levels of their yields provide high returns to farms and do not encourage them to invest in the introduction of innovative resource-efficient technologies.The continuation of this practice leads to the development of degradation of soil processes, deterioration of the ecological and land reclamation status and the sustainable functioning of agro-landscapes.

To achieve resource-efficient sustainable management in irrigated agriculture, a set of measures has to be proposed at the national and regional levels: to improve the legislative and normative bases on water and land resources on irrigated lands by increasing the level of rent with a simultaneous increaseTenancy tenancy dates for 15-20 years and a pogether fee for irrigated land use;Create ground and space agro monitoring systems based on the state of the land, soil, ecological status of the territory and practice of irrigated land use;To stimulate the introduction of operational methods of irrigation management and agro-amelioration measures for the restoration and preservation of soil fertility through a system of preferential lending, leasing programs for the purchase of sprinkler technology, etc.

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