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**BASIC CONSTRUCTION PRINCIPLES FOR MULTI-FUNCTIONAL
HYDRO AGROLANDSCAPE SYSTEMS**

Abstract. Based on the principles of natural analogies, the necessary diversity, the ability of soil formation and the integration of knowledge, multifunctional hydroagrolandscape systems have been developed, including multifunctional systems (crop rotation fields and irrigation technique), which ensure the fulfillment of the ecological and economic functions of the soils of hydroagrolandscape systems. Multifunctional hydro-agrolandscape systems for the purposeful regulation of the soil-forming process on irrigated crop rotation fields by designing crop rotation and an irrigation system on irrigated lands (hydro-agricultural landscape system) with the linkage of agricultural crops to irrigation equipment and technology, which move along with agricultural crops according to the rotational scheme, adopted in the crop rotation, ensure the maximum possible use of solar energy for the soil-forming process in specific natural and climatic conditions. The environment-forming functions of a multifunctional hydro-agrolandscape system are provided on the basis of the use of integral criteria to ensure the agroecological sustainability of irrigated crop rotations (hydroagrolandscapes), taking into account geoecological restrictions, that is, the weighted average irrigation rate (water demand deficit) of agricultural crops in the crop rotation should not exceed the deficit of the ecological water requirement of agricultural land systems.

Thus, the design of highly productive hydrolandscape systems requires ensuring compliance with not only the principles of the necessary diversity and natural analogies, based on the creation of se-rotations with mobile irrigation techniques to control and regulate soil-forming processes, that is, the soil as an object of influence (reclamation) performing an ecological function, and agricultural crops as a subject perform an economic function, requires the need, on the basis of the principle of knowledge integration, to form ways of regulating the natural process that provide targeted regulation and control of soil-forming processes as environment-forming systems.

Keywords: principles, design, system, hydro-agricultural landscape, crop rotation, crops, irrigation technique, function, design, soil formation.

Introduction. One of the main elements of the technology of irrigation of agricultural crops is the method and technique of irrigation, which, along with the system of agriculture, control the factors of plant life and the soil-forming process in hydroagrolandscape systems. The irrigation technique is, in essence, the closing link in the general water supply system for agricultural crops and, unlike other elements of irrigation systems, is not linear, but areal in nature, and, therefore, has a direct effect on all components of natural landscapes - surface layer of the atmosphere, plants, soil, surface and groundwater. The influence of irrigation technique on the atmosphere is expressed in an increase in humidity and a decrease in the lack of saturation of the surface air layer; on the soil - in an increase in moisture; on vegetation - in an increase in transpiration and productivity; to groundwater - to increase moisture exchange between soil and groundwater; to surface waters - in the discharge of surface waters. Moreover, the nature and degree of this influence depends on the methods and techniques of irrigation and the characteristics of natural and economic conditions.

In this regard, the development and substantiation of methods and techniques for irrigation, taking into account the biological characteristics and requirements of the soil-forming process, ensuring the rational use of water, land and other material resources, as well as the minimum negative impact on the natural environment, are one of the most important tasks of irrigated agriculture. in the arid zone.

At present, the involvement of water and land resources in the process of agricultural production, in particular in irrigated agriculture, where agricultural crops are considered the object of reclamation, leads to a deterioration in soil fertility and the soil-forming process, which have become the main reason for the rapidly progressive deterioration of the ecological situation of hydro-agrolandscape systems [1; 2; 3].

Analysis of research on the problem.

1. Comprehensive arrangement of natural landscapes with a variety of vegetation covers, providing the design of highly productive hydro-agrolandscape systems, is mainly based on two principles of nature management:

- the principle of the necessary diversity, that is, the crop rotations created within the hydro-agrolandscape systems should be as diverse as possible in their composition, this is confirmed by the «rule of monoculture» by Yu. Odum, that is, firstly, the crop rotation should include many agricultural crops, secondly, created by man to control the water regime of soils, it should be as diverse as the conditions for the formation of the water regime of soils in different parts of crop rotation fields;

- the principle of natural analogies, that is, the application of directions of resource use technologies (irrigation techniques), which, if possible, reproduce the natural processes of functioning of the components of nature, should ensure the eco-compatibility of equipment and technologies with nature and the repeatability of the natural regime in a long-term cycle.

2. For a correct understanding of the goals and objectives of irrigated agriculture, that is, the reclamation of agricultural lands, in order to clarify scientific views and worldview, it is necessary to determine the value system and designate the objects of influence in order to ensure the ecological sustainability of the natural system and the economic purchasing power of soils, as an integral component of the Earth in the process of the productive force of agriculture, which acquire the ability through the soil to serve as a nutrient medium and habitat for green plants, that is, the soil as an object of influence (reclamation) performs an ecological function, and agricultural crops, as a subject, perform an economic function, which requires the need for purposeful regulation and management of soil-forming processes in hydro-agrolandscape systems for the preservation, restoration and reproduction of soil fertility.

3. Modern hydro-agrolandscape systems, consisting of crop rotations and irrigation systems, are designed for the use of one type of irrigation technique with special design water supply regimes, that is, for example, the principle of operation of the drip system of soil layer moistening is aimed at local and precise moistening of the root layer of soil, where the activity of the soil-forming process stops and after a few years it will lose its purchasing value as a result of the violation of biochemical processes in hydro-agrolandscape systems.

Thus, the design of highly productive hydroagrolandscape systems requires ensuring compliance with not only the principles of the necessary diversity and natural analogies, based on the creation of crop rotations with mobile irrigation techniques to control and regulate soil-educational processes, that is, the soil as an object of influence (melioration) performs an ecological function, and agricultural crops as a subject perform an economic function, but it also requires the need, on the basis of the principle of knowledge integration, to form methods for regulating the natural process that provide targeted regulation and control of soil-forming processes as environment-forming systems.

Purpose of the study – on the basis of the principles of natural analogies, the necessary diversity, the ability of soil formation and the integration of knowledge, to develop a multifunctional hydro-agrolandscape system for the purposeful regulation of the soil-forming process in irrigated crop-rotation fields by designing a crop rotation and an irrigation system on irrigated lands (hydro-agrolandscape system) with reference to agriculture agricultural crops to irrigation technique and technology, which move along with agricultural crops according to a rotational scheme, adopted in crop rotation, which ensure the maximum possible use of solar energy for the soil-forming process in specific climatic conditions.

Materials and research methods. A multifunctional hydroagrolandscape system is a combination of an irrigation system and crop rotation, which can perform one and the same task in different ways and irrigation techniques, taking into account the biological characteristics of crops, characterized by different indicators of efficiency indicators, providing an optimal soil-forming process in the rotation cycle corresponding to the energy resources of natural systems.

A modular multifunctional system (crop rotation fields and irrigation technique) is a hormonal set of agricultural crops and irrigation technology, united by intrasystemic connections to perform a set of functional tasks set by certain conditions, that is, water supply, soil fertility reproduction, regulation of the geological and biological cycles of water and chemicals that provide ecological and economic functions of soils of hydroagrolandscape systems.

At the same time, the development of a multifunctional hydro-agrolandscape system is based on the principles of natural analogies to preserve the possibility of reproduction of natural processes of functioning of landscape components, the necessary diversity, where cultural crop rotations should be as diverse as possible in their composition of agricultural crops, the ability of soil formation - to perform ecological and economic functions within the systems (crop fields and irrigation techniques) and knowledge integration - the process of synthesizing knowledge of natural and applied sciences in the formation of a scientific base for modeling the components of hydro-agrolandscape systems.

Environment-forming functions of a multifunctional hydro-agrolandscape system are provided on the basis of using integral criteria to ensure agroecological sustainability of irrigated crop rotations (hydroagrolandscapes), taking into account geoecological restrictions, that is, the weighted average irrigation rate (water demand deficit) of agricultural crops in the crop rotation (O_p^{cp}) should not exceed the

ecological norm deficit water requirements of agricultural land (O_p^3) hydroagrolandscape systems:

$O_p^{cp} \leq O_p^3$ или $O_p^{cp} / O_p^3 = 1.0$ [2]. For agro-ecological substantiation of the optimal composition and structure of crop rotation, the following system of equations can be used [2]:

$$\sum_{i=1}^n O_{pi} \cdot \alpha_i \leq O_p^3; \quad \sum_{i=1}^n \alpha_i = 1.0,$$

where O_{pi} - irrigation rate of the accompanying crop (water consumption deficit) crop rotation; α_i - share of participation of i accompanying crop rotation.

The use of a multipurpose approach to the design of a multifunctional hydro-agrolandscape system with methods of organizing and managing the economy, covering a whole range of measures aimed at creating a crop rotation with mobile irrigation techniques, providing targeted management and regulation of the soil-forming process, should ensure the eco-compatibility of technology and technology with nature and the repeatability of natural regime in a multi-year cycle.

Research results. To implement the proposed principles and geoecological constraints in the complex arrangement of hydro-agrolandscape systems, a method of creating a crop rotation with mobile irrigation techniques is proposed to control and regulate the soil-forming process, including the cultivation of crops that are part and structure of crop rotation with irrigation techniques, differ in that that the design of the crop rotation and irrigation system on irrigated lands (hydro-agro-landscape system) is carried out with the reference of agricultural crops to irrigation techniques, which move along with agricultural crops according to a rotational scheme adopted in crop rotation, where the average consumption of solar energy for the soil-forming process is not should be less than the optimal consumption of solar energy for the soil-forming process in specific natural and climatic conditions (figure 1).

At the same time, the methods and technologies of irrigation used for irrigation must correspond to the biological characteristics of each agricultural crop that is part of the crop rotation, and the environmental requirements for the reclamation of agricultural lands. They must not only ensure the rational use of water resources, but also create conditions for the effective use of solar radiation energy in the soil-forming process. [4; 5; 6].

Therefore, due to the technological features of the irrigation methods used in the fields of individual crops included in the crop rotation, it is necessary to take into account that it will not be able to ensure the development of the soil-forming process in accordance with the law of evolution, in connection with which it is necessary to provide for geoecological restrictions in their rotational crop rotation.

In modern conditions, a hydro-agrolandscape system (irrigation system) is designed depending on the technical capabilities of the irrigation method used for irrigating crops, that is, a sprinkler irrigation system, a drip irrigation system, an irrigation system using surface irrigation (along furrows and stripes) ,

subsoil (subsurface) irrigation system, designed to ensure the water demand of cultivated agricultural crops, which do not take into account the peculiarities of the soil-forming process on irrigated lands. In this regard, for the rational use of water resources and purposeful regulation of the soil-forming process in hydro-agrolandscape systems, depending on the type of crop rotation and biological characteristics of cultivated crops, several methods of irrigation are used simultaneously, that is, drip irrigation, sprinkling, irrigation along furrows and strips, strictly tied in the form of cultivated crops, which move together in a rotational pattern in crop rotation fields on a spatio-temporal scale, where the average-summer irrigation rate of the crop rotation field should be no more than the ecological norm of water demand of agricultural crops, providing a targeted regulation and management of solar energy consumption for the soil-forming process (figure 2) [7].

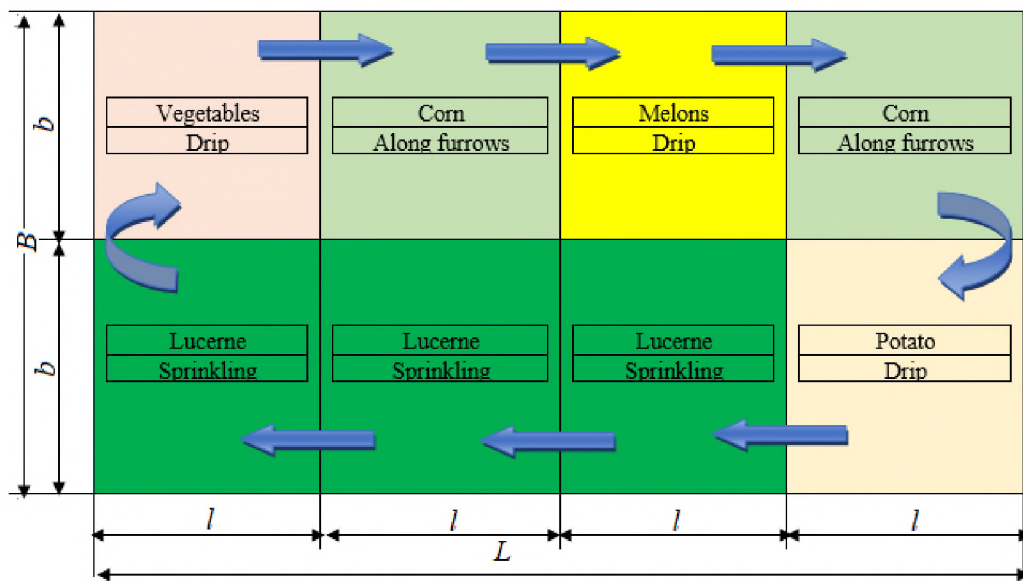


Figure 1- Modular multifunctional system (crop rotation fields and irrigation technique)

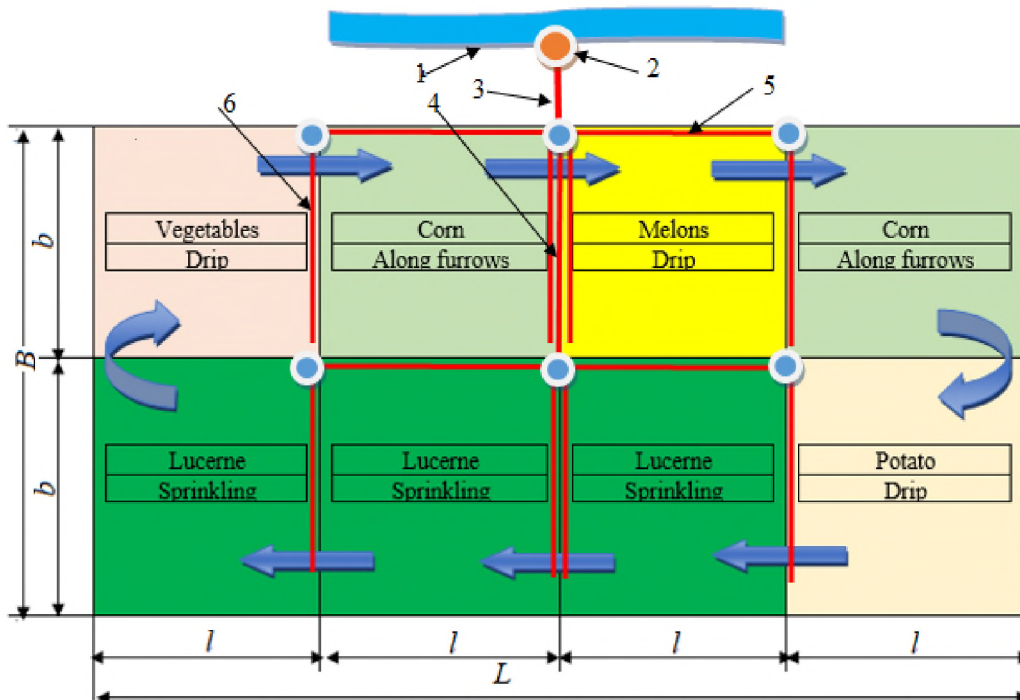


Figure 2 - Multifunctional hydro-agrolandscape system (1- irrigation source; 2- pumping station; 3- main pipeline; 4- distribution pipeline; 5- section pipeline; 6 - field pipeline)

To determine the design hydraulic parameters of a multifunctional hydro-agrolandscape system, we will use the maximum daily deficit of the rate of water demand for agricultural crops, which is determined on the basis of the bioclimatic method for determining the monthly total water consumption of agricultural crops (E_v), applied by N.V. Danilchenko [8; 9; 10; 11; 12]:

$$E_v = K_o \cdot K_v \cdot E_o,$$

where K_o – microclimatic coefficient; K_v – biological coefficient; E_o – monthly evaporation according to N.N. Ivanova [13]:

$$E_o = 0,0018 \cdot (t + 25)^2 (100 - a),$$

where t – average monthly air temperature for the period, °C; a – average monthly relative air humidity for the period, %.

The monthly ecological norm of water demand for agricultural land (E_e) is determined on the basis of the formula of M.I. Budyko [14] according to the following modification:

$$E_e = (R/L)(\sum t_m / \sum t_b),$$

where R – photosynthetically active radiation (kJ/cm²), which is determined by the formula [15]:

$$R = 13.39 + 0.0079 \cdot \sum t > 10^\circ C,$$

here $\sum t_b$ – the sum of biological active air temperatures, °C; $\sum t_v$ – sum of monthly air temperatures, °C; L – latent heat of vaporization, equal to 2,5 kJ/cm³.

The monthly deficit of the water demand rate of agricultural crops (ΔE_v) during surface irrigation and sprinkling is determined on the basis of the water balance equation, which is written in the following form:

$$\Delta E_v = E_v - (\Delta W + O_c \pm g),$$

where ΔW – active reserves of soil moisture at the beginning of the estimated month; O_c – atmospheric precipitation for the estimated month; capillary used groundwater during the growing season;

The monthly deficit of the rate of water consumption of agricultural crops under drip irrigation is determined on the basis of the water balance equation, which is written in the following form:

$$\Delta E_e = [E_v - (\Delta W + O_c \pm g)](F_{uv} / F_o),$$

where F_o – total area of the crop rotation field, ha; F_{uv} – wetted area of the crop rotation field depending on the method and technique of irrigation.

The monthly ecological norm of water demand for agricultural land is determined by the following formula:

$$\Delta E_e = (R / \bar{R} \cdot L)(\sum t_m / \sum t_b) - (\Delta W + O_c \pm g).$$

The hydraulic parameters of the multifunctional hydro-agrolandscape system, that is, the flow rate of the main pipeline (Q_m , m³/s) is determined on the basis of the arithmetic average value of the maximum monthly deficit of the water demand rate of the i agricultural crop (ΔE_i^{\max}) according to the following formula:

$$Q_m = \sum_{i=1}^n \alpha \cdot \Delta E_i^{\max} \cdot F_o / 86400 \cdot T \cdot \eta_m,$$

where α – share of i agricultural crop in crop rotation; T – number of months; n – number of crops in a crop rotation; F_o – total crop rotation area, ha; η_m – main pipeline efficiency.

The estimated flow rate of the distribution pipeline (Q_r , m³/s) and the section pipeline (Q_u , m³/s) is determined based on the maximum value of the monthly deficit of the water demand rate of agricultural

crops ($\Delta E_i^{\max} \rightarrow \max$), which are part of the crop rotation, which is determined by the formula:

$$Q_r = Q_u = \Delta E_i^{\max} \cdot N \cdot F_{CN} / 86400 \cdot T \cdot \eta_r,$$

where F_{CN} – crop rotation area, ha; N – the number of fields suspended on the distribution and sectional pipeline; η_r – efficiency of the distribution and section pipeline.

The estimated flow rate of the irrigation pipeline (Q_p) is determined on the basis of the maximum value of the monthly deficit of the rate of water demand of agricultural crops ($\Delta E_i^{\max} \rightarrow \max$), which are part of the crop rotation, according to the following equation:

$$Q_p = \Delta E_i^{\max} \cdot F_{CN} / 86400 \cdot T \cdot \eta_p,$$

where η_p – coefficient of efficiency of the distribution and sectional pipeline.

Thus, the theoretical prerequisites for the creation of a multifunctional hydro-agrolandscape system were new ideas about the ecological and economic functions of soils, as a tool for expanded reproduction of soil fertility, obtaining an optimal yield of certain crops with an economical use of all resources, preventing or compensating for damage to natural systems, which acquires as a natural conservation, and nature-restoring values.

Conclusions. The developed multifunctional hydro-agrolandscape system for the purposeful regulation of the soil-forming process in irrigated crop rotation fields by designing a crop rotation and an irrigation system on irrigated lands (hydroagrolandscape system) with the linkage of crops to irrigation equipment and technology, which move along with agricultural crops in a rotational scheme, adopted in crop rotation, which ensure the maximum possible use of solar energy for the soil-forming process in specific natural and climatic conditions, obtained as a result of the synthesis of scientific knowledge and have the following technical character:

- *manifests itself only due to the peculiarities of a person's perception with the participation of his mind* - the declared proposal has a technical solution, which must be incorporated in the design and construction stage of a hydro-agrolandscape system, which requires strict implementation during its operation;

- *is achieved only due to the observance of a certain order in the implementation of certain types of activity on the basis of an agreement between its participants or established rules* - the declared proposal, the types of activities are presented as a technical solution, only with strict adherence to ensuring the increase and reproduction of soil fertility of agricultural land;

- *consists only in obtaining this or that information and is achieved only through the use of a mathematical method, a program for an electronic computer or an algorithm used in it* - the declared proposal for the use of mathematical methods is used to determine the quantitative and qualitative parameters of hydro-agrolandscape systems;

- *due only to the peculiarities of the semantic content of information presented in one form or another on any medium* - of the declared proposal represent a control system for soil-forming processes that ensure the production of products on hydro-agrolandscape systems that make up categories and general scientific concepts: man, engineering system, material, environment, information, model, time and control, which form a method around the central cybernetic concept of the process implementation of activities [16];

- *is fun and entertaining* - the declared proposal is presented to improve the functional activity of hydroagrolandscape systems, as a mobile system that ensures the efficiency of irrigation technique, strictly tied in the form of crops in a space-time scale, according to the rotational scheme taken in the form of crop rotation.

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КӨПҚЫЗМЕТТІК ГИДРОАГРОЛАНДШАФТТЫҚ ЖҮЙЕНІ ҚҰРУДЫҢ НЕГІЗГІ ҚАҒИДАСЫ

Аннотация. Табиғи ұқсастық, әртүрліліктің қажеттілігі, топырақты құру қабілеті және білімді интеграциялау қағидаларының гидроагроландшафттық жүйеде топырақтың экономикалық және экологиялық қызметін орындау мүмкіншілігін қамтамасыз ететін, құрамына ауыспалы егістік және суару техникасына кіретін көпқызметтік гидроагроландшафттық жүйенің негізі құрылған. Көпқызметтік гидроагроландшафттық жүйеге суармалы ауыспалы егістік жүйесінде топырақтың даму жағдайын мақсатты реттеуге арналған және ол суармалы жерде суару жүйесі және ауыспалы егістік ауылшаруашылық дақылдарының түрлерін нақты суару техникасына бұйдалау жолымен жобаланатындықтан, ауыспалы егістік жүйесіндегі қабылданған ауылшаруашылық дақылдарының айналу желісі бойынша бірге жылжып отырады. Ал ол нақты табиғи-климаттық жағдайда топырақтың даму жағдайына күн сәулесінің қуатын жоғарғы мүмкіншілік деңгейінде пайдалануды қамтамасыз етеді.

Көпқызметтік гидроагроландшафттық жүйе – суару жүйесі және ауыспалы егістіктің жиынтығы болып саналады және кез келген тапсырысты, ауылшаруашылық дақылдарының биологиялық ерекшеліктеріне байланысты әртүрлі суару әдісімен және техникасымен орындауға байланысты болғандықтан, айналым оралымында топырақтың оңтайлы даму жағдайының табиғи жүйенің энергетикалық ресурсына сай келу жағдайына байланысты тиімділіктің әртүрлі көрсеткішімен сипатталады.

Құрамына ауыспалы егістік және суару техникасы кіретін мультиқызметтік үлгінің негізгі ерекшелігі – суару жүйесі және ауыспалы егістік жиынтығының, белгілі бір берілген тапсырманы орындау үшін көптеген қызметтік мәселені шешу үшін олар ішкі жүйелік байланыста болады, яғни сумен қамтамасыз ету, топырақ құнарлығының жаңғыруы, су және химиялық заттардың биологиялық және геологиялық айналымын реттеу арқылы гидроагроландшафттық жүйелерде топырақтың экологиялық және экономикалық қызмет атқаруын қамтамасыз етеді.

Көпқызметтік гидроагроландшафттық жүйенің ортаны құрушы қызметі суармалы егістік жерлердің агроэкологиялық орнықтылығы геоэкологиялық шектеулерді ескеретін интегралдық сынақ көрсеткіштерін пайдалану арқылы қамтамасыз етіледі, яғни ауыспалы егістік құрамындағы ауылшаруашылық дақылдарын суару мөлшері (жетіспейтін суды тұтыну шамасы) гидроагроландшафттық жүйедегі суармалы жерлердің экологиялық суды тұтыну мөлшерінен жоғары болмауы керек.

Сонымен, көпқызметтік гидроагроландшафттық жүйені құрудың алдыңғы шартының теориялық негізі – топырақтың экологиялық және экономикалық қызметін жаңаша түсіну негізінде, оны топырақ құнарлығын қайта өндіруді кеңейту құралы есебінде қарастыра отырып, белгілі бір ауылшаруашылық дақылдарынан оңтайлы өнім алуды қамтамасыз ететін барлық ресурс шығынын үнемдеу арқылы, табиғи жүйеге шығын келтірмеуге немесе шығынды толықтыруды, табиғатты қорғау құралына және табиғаты қалпына келтірудің маңыздылығы ретінде қарастырылуы қажет.

Жалпы қорта айтқанда, көпқызметтік гидроагроландшафттық жүйені құру тек қана табиғи ұқсастық және әртүрліліктің қажеттілік қағидасын сақтауды ғана қамтамасыз етіп қана қоймай, топырақтың даму жағдайын басқару және реттеу үшін ауыспалы егістік жүйесінің негізін жинақылық суару техникасымен бірге құру арқылы, топырақты әсер етуші нысан ретінде экологиялық қызметін, ал ауылшаруашылық дақылдарының тіршілік етуін қамтамасыз ету арқылы, экономикалық қызметін орындаушы, яғни ортаны құрушы жүйе болғандықтан, топырақ дамуын мақсатты басқаруды және реттеуді қамтамасыз етуді және табиғаты басқарудың әдісін қалыптастыруды білімді интеграциялау қағидасының негізінде қарастыру қажет.

Түйін сөздер: қағида, құрастыру, жүйе, гидроагроландшафт, ауыспалы егістік, дақыл, суару техникасы, қызмет, жобалау, топырақтың дамуы.

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ОСНОВНЫЕ ПРИНЦИПЫ КОНСТРУИРОВАНИЯ МНОГОФУНКЦИОНАЛЬНЫХ ГИДРОАГРОЛАНДШАФТНЫХ СИСТЕМ

Аннотация. На основе принципов природных аналогий, необходимого разнообразия, способности почвообразования и интеграции знаний разработаны многофункциональные гидроагроландшафтные системы, включающие мультифункциональные системы (севооборотная поля и техника полива), обеспечивающие выполнение экологических и экономических функций почвы гидроагроландшафтных систем. Многофункциональные гидроагроландшафтные системы для целенаправленного регулирования почвообразовательного процесса на орошаемых севооборотных полях путем проектирования севооборота и оросительной системы на орошаемых землях (гидроагроландшафтной системе) с привязкой сельскохозяйственных культур к технике и технологии полива, которые перемещаются вместе с сельскохозяйственными культурами по ротационной схеме, принятых в севообороте, обеспечивают максимально-возможное использование солнечной энергии на почвообразовательный процесс в конкретных природно-климатических условиях.

Многофункциональные гидроагроландшафтные системы – это совокупность оросительных систем и севооборотов, которая может выполнять одну и ту задачу различными способами и техникой полива с учетом биологических особенности сельскохозяйственных культур, характеризующимися различными показателями эффективности, обеспечивающих в ротационном цикле оптимального почвообразовательного процесса, соответственно энергетических ресурсов природных системы.

Модульная мультифункциональная система (севооборотные поля и техника полива) – гармоничная совокупность сельскохозяйственных культур и техники полива, объединенная внутросистемными связями для выполнения заданного определенными условиями множества функциональных задач, то есть водообеспечения, воспроизводства плодородия почвы, регулирования геологического и биологического круговорота воды и химических веществ, обеспечивающих экологические и экономические функции почвы в гидроагроландшафтных системах.

Средообразующие функции многофункциональной гидроагроландшафтной системы обеспечиваются на основе использования интегральных критериев по обеспечению агроэкологической устойчивости орошаемых севооборотов (гидроагроландшафтов) с учетом геоэкологических ограничений, то есть средневзвешенная оросительная норма (дефицит водопотребности) сельскохозяйственных культур в севообороте не должна превышать дефицита экологические нормы водопотребности сельскохозяйственных угодий гидроагроландшафтных систем.

При этом теоретическими предпосылками для создания многофункциональной гидроагроландшафтной системы явились новые представления о экологических и экономических функциях почвы как инструменте для расширенного воспроизводства плодородия почвы, получения оптимального урожая определенных сельскохозяйственных культур при экономном расходе всех ресурсов, недопущении или компенсации ущерба природным системам, приобретающего как природоохранное, так и природовосстановливающие значения.

Таким образом, конструирования высокопродуктивных гидроландшафтных систем требуют обеспечения соблюдения не только принципов необходимого разнообразия и природных аналогий на основе создания севооборотов с мобильными техниками полива для управления и регулирования почвообразовательных процессов, то есть почва как объект воздействия (мелиорации), выполняющий экологическую функцию, а сельскохозяйственные культуры как субъект выполняют экономическую функцию, требует необходимости на основе принципа интеграции знаний формировать способы регулирования природного процесса, обеспечивающих целенаправленное регулирование и управление почвообразовательными процессами как средообразующих систем.

Ключевые слова: принципы, конструирования, система, гидроагроландшафт, севооборот, культуры, техника полива, функция, проектирования, почвообразования.

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