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IDENTIFICATION OF ENVIRONMENTALLY SAFE TECHNOLOGY OF DEVELOPMENT OF SOLAR LAND IN PRODUCTION CONDITIONS OF KYZYLORDA REGION

Abstract. On the basis of pilot industrial work to identify environmentally friendly technologies for the development of saline lands in the conditions of production of hydroaggregant farming systems in Zhanakurgan and Kazalin districts of Kyzylorda region within the framework of the developed methodological and software allowing to conduct field research and collection of information and analytical materials for agricultural and water management organizations, the working capacity and reliability of the proposed methods for the development of saline lands have been determined, and scientific and philosophical views on the creation of innovative technological processes of agricultural production have been confirmed.

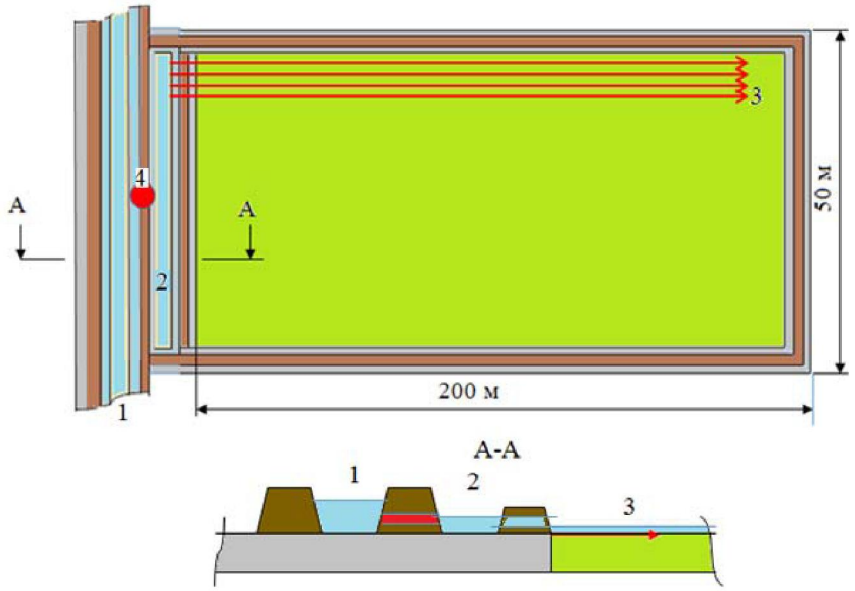
Keywords: ecology, system, safety, method, technology, development, salinity, irrigation, irrigation, norm, water demand, energy intensity, soil, soil-forming process.

Introduction. In modern conditions in arid zones of Kazakhstan, land suitable for agricultural use refers to saline soils that require agrotechnical and meliorative measures for development. In addition, as a result of secondary salinization of soil, half of which were previously used for cultivation of agricultural land, are withdrawn from agricultural circulation, which requires the need for reconstruction or reclamation. In this regard, at present one of the urgent tasks in the field of agricultural use is the development of saline and saline soils of the arid zones of Kazakhstan, taking into account geoecological constraints that ensure the preservation and restoration of the stability of landscape systems in anthropogenic activities.

Purpose of the study – to assess the efficiency of a new method for developing saline lands for carrying out pilot production in the conditions of the Togusken and Kazalin irrigation systems in Kyzylorda region [1].

Objects and methods of research. Experimental fields in the areas of the Togusken Irrigation Massif of the Zhanakurgan district and the Kazalin irrigation array of the Kazalin district with an area of one hectare have been selected for conducting a pilot production test of the technology of development of saline and secondarily saline lands of the Kyzylorda region on the basis of agreement by the heads of the farm (figure).

The soil-meliorative characteristics of the pilot production plot are given in table 1.



Scheme of the location of the experimental production site for testing the technology of development of saline and secondarily saline lands in the Kyzylorda region (1 – temporary irrigation system, 2 excavated furrows, 3 irrigation furrows, 4 water release from the temporary irrigation system to the excavated furrows)

Table 1 – Soil-meliorative characteristics of a pilot plant

Indicators	Irrigation array	
	Kazalin	Togusken
Plot area, ha	1,0	1,0
Type of soil	grayish brown	grayish
Degree of salinity	strongly saline	medium saline
The content of salts in the soil layer 0-100 cm, t/ha	241.00	125.00
Density of soil, ha/cm^3	1.35	1.22
Least moisture capacity, %	24.0	22.0
Absorption rate for the first hour, m/hour		
Coefficient of filtration, m/hour		
Depth of ground water, m	4.0-5.0	4.0-5.0
Critical depth of groundwater, m		

In accordance with the requirements of the technique of the experimental case [2], when carrying out a pilot production test of the technology of saline and secondarily saline lands development, soil samples for determination of density, minimum moisture input, soil moisture content and water-soluble salts content are taken in layers every 10 cm to a depth of 100 cm, as well as the mineralization of river and groundwater. Water permeability and filtration coefficient are determined by the Nesterov instrument. The degree and type of soil salinity was estimated by N. I. Bazilevich and E. I. Pankovoy [3].

The amount of water supplied by the temporary irrigation system was determined with the aid of the Chipoletti and Ivanov weirs, and the uniformity of the water supply of the furrow was provided by means of excavating furrows. In order to distribute water evenly between the furrows, each groove is equipped with tubes located at single levels in the excavated furrows (figure).

The experimental production site for testing the technology of developing saline and secondarily saline lands in the Togusken and Kazalin irrigation areas of the Kyzylorda region with an area of one hectare is projected with a length of 200 m and a width of 50 m, the distance between the sulcuses is 0.5 m. The experimental production fields have the form of a watered strip or Check, inside which are located through 0.50 m of the furrow.

When washing the water supply, it is fed by irrigation grooves, which ensure an even distribution of the washing norm along the length and width of the strip or check.

To determine the evo-transpiration of agricultural crops, we adopted a bioclimatic method KAZ [4].

To assess the direction of the formation of the water and salt regimes of experimental production, the equations of water and salt balances are used, which are written in the following form [5]:

$$\Delta W = O_C + N + O_p \pm g - E_v;$$

$$\Delta S = (S_H - S_K) = S_H + S_p \pm S_g - S_K,$$

where ΔW - change in moisture reserves in the estimated soil layer, mm; O_c - atmospheric precipitation, mm; O_p - irrigation rate, mm; g - moisture exchange between soil and groundwater, mm; N - washing norm, mm; E_v - total evaporation, mm; ΔS - change in salt reserves in the estimated soil layer, t/ha; S_{oc} - supply of salts with atmospheric precipitation, t/ha; S_{np} - supply of salts with washing norms, t/ha; S_{op} - supply of salts with irrigation norms, t/ha; $\pm S_g$ - the number of salts supplied or discharged in the process of moisture exchange between soil and groundwater, t/ha; S_{np} - removal of salts by washing norms, t/ha; $S_н$ - the content of salts in the soil layer at the beginning of the calculation period, t/ha; $S_к$ - the content of salts in the soil layer at the end of the calculation period, t/ha;

To determine the meteorological conditions of a pilot production test of the development of saline and secondarily saline lands of the Togusken and Kazalin irrigation systems of Kyzylorda region, information-analytical materials of the Akkum and Kazaly meteorological stations were used (table 2).

Table 2 – Meteorological conditions of a pilot production test of the development of saline and secondarily saline lands of the Togusken and Kazalin irrigation systems of the Kyzylorda region

Month	Years	Meteorological station Akkum			Meteorological station Kazaly		
		T, °C	a, %	O_C, mm	T, °C	a, %	O_C, mm
1	2	3	4	5	6	7	8
I	2015	10,6	82	17,7	-13,5	82	18,0
	2016	-13,0	81	15,2	-15,4	77	10,3
	2017	-5,7	82	13,9	-7,4	81	21,3
II	2015	-5,7	82	22,6	-8,6	82	6,5
	2016	-15,3	74	0,3	-18,6	74	0,0
	2017	-8,8	79	25,5	-12,4	76	4,4
III	2015	1,6	76	6,3	-1,2	81	14,8
	2016	0,9	67	5,8	-2,3	77	3,3
	2017	2,1	78	17,2	-0,9	76	20,2
IV	2015	13,4	61	41,3	11,8	67	36,9
	2016	11,6	63	64,4	10,9	59	3,1
	2017	15,3	38	1,2	14,7	44	2,0
V	2015	19,2	44	8,9	18,2	53	23,2
	2016	21,0	43	25,5	21,3	40	4,1
	2017	19,9	25	0,0	19,9	28	0,0
VI	2015	26,1	32	0,0	24,7	41	0,0
	2016	25,2	30	2,4	24,6	41	0,0
	2017	26,3	24	0,4	26,1	25	0,0
VII	2015	27,5	32	0,0	26,0	42	2,8
	2016	28,4	37	4,2	27,5	42	6,3
	2017	29,5	27	1,8	29,1	30	0,0

Продолжение таблицы 2

1	2	3	4	5	6	7	8
VIII	2015	24,6	34	0,0	23,9	44	0,3
	2016	23,4	36	4,5	23,3	41	4,2
	2017	25,4	36	0,0	24,8	32	0,0
IX	2015	15,3	43	9,3	13,9	55	9,8
	2016	18,9	36	2,8	18,3	42	0,6
	2017	19,5	36	0,0	19,2	45	3,0
X	2015	7,9	51	18,4	6,6	59	3,6
	2016	11,0	34	0,0	11,0	41	0,0
	2017	7,7	49	3,1	7,3	56	9,2
XI	2015	3,4	77	7,6	2,5	78	19,4
	2016	1,3	69	10,5	0,8	66	5,3
	2017	-2,6	69	0,4	-2,7	69	7,8
XII	2015	-2,9	78	7,1	-3,2	84	9,7
	2016	-9,4	86	3,5	-8,5	82	0,0
	2017	-5,4	66	17,2	-5,2	76	13,2

On the basis of the data in table 2, the energy resources of the hydroagrolandscape systems of the Togusken and Kazalin irrigation systems of the Kyzylorda region were determined in the years of pilot production tests of the technology for the development of saline lands, that is, the biologically active sums of air temperatures ($\sum t > 10^{O}C$),volatility (E_O) and the radiation balance of the day surface (R) (table 3).

Table 3 – Energy resources of the hydro-agro landscape systems of the Togusken and Kazalin irrigation systems of the Kyzylorda region in the years of the pilot production test of the technology of development of saline lands

Years	Month	Meteorological station Akkum			Meteorological station Kazaly		
		$\sum t > 10^{O}C$	E_O , мм	R, kJ/cm^2	$\sum t > 10^{O}C$	E_O, mm	R, kJ/cm^2
2015	IV	402,0	103,5	19,38	324,0	79,2	15,99
	V	595,2	196,9	28,71	564,2	157,9	27,85
	VI	783,0	319,6	37,76	741,0	262,3	36,57
	VII	852,5	337,4	41,12	806,0	271,5	39,78
	VIII	762,6	292,3	36,78	740,9	241,0	36,57
	IX	459,0	166,6	22,15	417,0	122,6	20,54
Annual		3854,3	1416,3	185,90	3592,3	1134,5	177,3
2016	IV	348,0	89,2	16,69	327,0	95,1	15,79
	V	651,0	213,3	31,23	660,3	231,5	31,86
	VI	756,0	317,5	36,26	738,0	305,6	35,63
	VII	880,4	323,4	42,23	852,5	287,8	41,15
	VIII	725,4	269,9	34,79	722,3	247,8	34,87
	IX	567,0	222,0	27,20	549,0	199,1	26,50
Annual		3927,8	1435,3	188,4	3848,8	1366,9	185,8
2017	IV	459,0	181,2	21,79	441,0	158,9	20,89
	V	616,9	272,1	29,28	616,9	261,3	29,23
	VI	699,0	360,0	33,18	783,0	352,5	37,10
	VII	914,5	390,3	43,41	902,1	368,8	42,74
	VIII	787,4	297,3	37,38	768,8	303,6	36,43
	IX	585,0	228,1	27,76	576,0	193,4	27,31
Annual		4061,8	1729,0	192,8	4087,8	1593,5	193,7

As can be seen from table 3, the energy resources of the hydroagrolandscape systems of the Togusken and Kazalin irrigation systems of the Kyzylorda region in the years of pilot production testing of the technology for the development of saline lands are quite high, that is, the annual volatility reaches 1134.5 to 1729.0 mm, due to high biologically active air temperature (3592,3-4087,8°C) and radiation balance (177,3-193,7 kJ/cm^2), which render the evaporation capacity of the natural system of the region.

According to the RSE «Kazgidromet» and RSU «Aralo-Syrdarya Basin Inspection for Regulation of Water Resources Use and Protection» of the Committee on Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan, the mineralization of atmospheric precipitation and water of the Syr Darya River in the years of the pilot production test of the technology of saline and secondary saline lands of Toguskensky and Kazalinsky irrigation areas of Kyzylorda oblast are given in table 4 [6].

Table 4 – Mineralization of atmospheric precipitation and water of the Syr Darya River during the years of pilot production tests of the technology of saline and secondarily saline lands of the Togusken and Kazalin irrigation systems of Kyzylorda region (Information about the state of the environment and health of the population of the Aral Sea area. Almaty, 2015-2017)

Array	Indicators	Meteorological station	Years		
			2015	2016	2017
Togusken	Mineralization of atmospheric precipitation, g/dm^3	Akkum	0,06	0,07	0,07
	Mineralization of river water, g/l	Tyumenaryk	1,301	1,315	1,298
Kazalin	Mineralization of atmospheric precipitation, g/dm^3	Kazaly	0,06	0,06	0,06
	Mineralization of river water, g/l	Kazaly	1,489	1,497	1,468

Thus, the above methodology of experience and the collection of information and analytical materials make it possible to evaluate the results of a pilot production test of the development of saline and secondarily saline lands of the Togusken and Kazalin irrigation systems of the Kyzylordaregion to determine their reliability and reliability.

Results and their discussion. Water balance studies on the Togusken and Kazalin irrigation systems of the Kyzylorda oblast have important applied value for the assessment of soil-meliorative processes in the development of saline lands for cultivating agricultural crops (table 5).

As can be seen from Table 5, the water balance of the irrigated lands of the Togusken and Kazalin irrigation canals is entirely determined by the washing norms that are carried out in the early spring, when the average daily air temperature rises above 5°C and irrigation norms to compensate for the deficit of water consumption of crops, as well as atmospheric precipitation. At the same time, during the non-vegetation period, atmospheric precipitation has a significant effect on the replenishment of soil moisture reserves prior to washing.

Thus, the incoming part of the water balance of the experimental production field is: atmospheric precipitation (O_C), wash rate (N) and irrigation norm (O_P), the amount of which is within 1282,2-1441,9 mm. The expenditure part of the water balance is formed by the total evaporation (E_v) and infiltration (g), which mainly occur in the process during the washing period, that is, varies within 1274,2-1471,4 mm.

According to the results of the calculation, the water balance error for the years of the pilot production survey was from -364,3 till 99,8 mm, which is an acceptable value and does not cause a negative impact on the reclamation state of irrigated land during the washing of saline lands.

The salt balance of the pilot production survey on the development of saline lands in the areas and irrigation tracts of Kyzylorda Oblast was determined by the following formula [5]:

$$\Delta S = S_H + (S_{OC} + S_{np} + S_{op}) - (S_g + S_y),$$

where ΔS - changes in salt reserves in the estimated soil layer, t/ha; $S_н$ - stock of salts in the soil layer at the beginning of the balance sheet period, t/ha; S_{np} - Supply of salts with washing norms, t/ha; S_{oc} - Supply of salts with atmospheric precipitation, t/ha; S_{op} - Supply of salts with irrigation norms, t/ha; $\pm S_g$ - removal of salts by infiltration water, t/ha; S_y - removal of salts by harvest, t/ha.

Table 5 – The water balance of the pilot production survey on the development of saline lands in the areas and irrigation tracts of the Kyzylorda region

Indicators	Years		
	2015	2016	2017
Togusken irrigation array			
The incoming part of the water balance			
Precipitation (O_C), mm	139,2	139,1	83,5
Wash rate (N), mm	600,0	600,0	600,0
Irrigation rate (O_P), mm	702,7	596,0	642,5
Total ($П$)	1441,9	1335,1	1326,0
The expenditure part of the water balance			
Total evaporation (E_v), mm	991,4	1004,7	1210,3
Infiltration (g), mm	480,0	480,0	480,0
Total (P)	1471,4	1484,7	1690,3
Balance ($Б = П - P$)	-29,5	-149,6	-364,3
Kazalin irrigation array			
The incoming part of the water balance			
Precipitation (O_C), mm	145,0	37,2	81,0
Wash rate (N), mm	600,0	600,0	600,0
Irrigation rate (O_P), mm	629,0	645,0	665,2
Total ($П$)	1374,0	1282,2	1346,2
The expenditure part of the water balance			
Total evaporation (E_v), mm	794,2	956,8	1115,5
Infiltration (g), mm	480,0	480,0	480,0
Total (P)	1274,2	1436,8	1595,5
Balance ($Б = П - P$)	99,8	-154,6	-249,3

The volume of salts brought with washing, irrigation and atmospheric precipitation and carried out beyond the design contour by infiltration waters are calculated by equations [5]:

$$S_{np} = C_n \cdot N; \quad S_{op} = C_o \cdot O_p; \quad S_{oc} = C_{oc} \cdot O_c; \quad S_g = S_o \cdot \exp(-\frac{\beta}{\alpha} N),$$

where C_n - washing water mineralization, g/dm^3; C_o - mineralization of irrigation water, g/dm^3; C_{OC} - mineralization of atmospheric precipitation, g/dm^3; α - salt recovery index; β - coefficient of precipitation acceleration.

Calculation of the total salt balance of the Togusken and Kazalin irrigation systems of the Kyzylorda region is closely related to the components of the water balance, since the movement of salts in the medium of the aeration zone occurs in the form of a water-salt solution. At the same time, taking into account a rather small amount of precipitation, that is, during the study years it fluctuated within 37,2-145,0 mm and their mineralization, which was 0,06-0,07 g/dm^3 ,the supply of salts with atmospheric precipitation (S_{oc}), as well as the removal of salts from the harvest (S_y) can be neglected when predicting the salt balance of the pilot planta.

The content of salts in the soil layer at the end of the balance sheet period ($S_к$) was determined by the formula:

$$S_K = S_H \pm \Delta S = S_H + (S_{OC} + S_{np} + S_{op}) - (S_g + S_y).$$

Therefore, the water-salt balance of the Togusken and Kazalin irrigation systems of the Kyzylorda oblast was compiled by an analytical method, mainly using the salt balance equation for the concrete calculation schemes of the soil layer of hydroagrolandscape systems (table 6).

Table 6 – Salt balance of the pilot production survey
on the development of saline lands in areas and irrigation areas of Kyzylorda region

Indicators	Years		
	2015	2016	2017
Togusken irrigation array			
The income part of the salt balance			
Stock of salts in the soil layer at the beginning of the balance sheet period ($S_н$), t/ha	86,700	70,35	55,350
The receipt of salts with washing norms ($S_{пр}$), t/ha	7,806	7,890	7,788
Supply of salts with irrigation norms ($S_{ор}$), т/га	9,142	7,837	8,339
Total ($S(П)$)	16,948	15,727	16,127
The expenditure part of the salt balance			
Removal of salts by infiltration water ($\pm S_g$), t/ha	35,448	31,877	31,957
Total ($S(Р)$)	35,448	31,877	31,957
Balance $\Delta S(Б) = S(П) - S(Р)$	68,200	54,200	39,520
Stock of salts in the soil layer at the end of the balance sheet period ($S_к$), t/ha	70,350	55,350	38,250
Kazalin irrigation array			
The income part of the salt balance			
Stock of salts in the soil layer at the beginning of the balance sheet period ($S_н$), t/ha	148,60	121,9	96,190
The receipt of salts with washing norms ($S_{пр}$), t/ha	8,934	8,982	8,808
Supply of salts with irrigation norms ($S_{ор}$), т/га	9,366	9,656	9,765
Total ($S(П)$)	18,300	18,638	18,573
The expenditure part of the salt balance			
Removal of salts by infiltration water ($\pm S_g$), t/ha	46,800	46,738	39,663
Total ($S(Р)$)	46,800	46,738	39,663
Balance $\Delta S(Б) = S(П) - S(Р)$	120,100	93,800	75,100
Stock of salts in the soil layer at the end of the balance sheet period ($S_к$), t/ha	121,900	96,190	73,200

As can be seen from table 6, when developing saline lands for cultivating agricultural crops in the Togusken irrigation array, the desalinization of the soil in the first year of the pilot production survey was 18,50 t /ha, in the second year – 19,15 t/haand in the third year -14,41 t/ha, and in the Kazalin irrigation array in the first year of the pilot production survey was 28,50 t /ha, in the second year – 28,10 t/haand in the third year - 20,04 t/ha, which were provided on the basis of «soft» management of hydrochemical processes through joint washing and irrigation.

To assess the hydrothermal regime during the development of saline lands, an «index» of dryness was used in the following form [5]:

$$\overline{R} = R / L(O_C + N + O_p \pm g),$$

where L - Specific heat of vaporization, assumed constant and equal 2.5 kJ/cm^2).

At the same time, the calorific value of agricultural crops obtained from irrigated lands can be determined by the following expression [7]:

$$C_k = 100 \cdot Y_i \cdot q_{ki} \cdot F_i ,$$

where q_{ki} - caloric content of agricultural products, kcal / kg or kJ/kg; Y_i - yields of agricultural crops, centner/ha; F_i - area of irrigated land occupied by individual crops, ha.

To assess the effectiveness of the use of environmental services for water resources for growing crops, a coefficient characterizing the water costs that provides 1000 kJ of energy value (mm / 1000 kJ), that is, $K_{cki} = C_k / \Delta E_y$, where its quantitative value in the conditions of the Togusken and Kazalin irrigation systems of Kyzylordaregion is given in table 7.

Table 7 – Energy resources of a pilot production survey
on the development of saline lands in areas and irrigation tracts of Kyzylorda region

Indicators	Years		
	2015	2016	2017
Togusken irrigation array			
Radiation balance (R), kJ/cm^2	185,9	188,4	192,8
Precipitation (O_C), mm	139,2	139,1	83,5
Wash rate (N), mm	600,0	600,0	600,0
Irrigation Rate (O_p), mm	702,7	596,0	642,5
«Index of dryness» ($\overline{R}$)	0.770	0.842	0.918
Energy costs for soil formation (Q_n), kJ/cm^2	129.7	127.6	125.4
Productivity of land ($У$), t/ha	4,50	4,80	4.75
Energy intensity of agricultural crops (C_k), 10^6 kJ	83,70	89,28	81,40
Coefficient of water consumption ($K_в$), mm/t	320,4	278,1	279,2
Coefficient of energy intensity (K_{cki}), 1000 kJ/mm	53,05	56,87	61,39
Kazalinirrigation array			
Radiation balance (R), kJ/cm^2	177,3	185,8	183,7
Precipitation (O_C), mm	145,0	37,2	81,0
Wash rate (N), mm	600,0	600,0	600,0
Irrigation Rate (O_p), mm	629,0	645,0	665,2
«Index of dryness» ($\overline{R}$)	0.792	0.926	0.848
Energy costs for soil formation (Q_n), kJ/cm^2	122.5	120.8	123.3
Productivity of land ($У$), t/ha	3,20	3,50	4.10
Energy intensity of agricultural crops (C_k), 10^6 kJ	59,12	64,66	76,26
Coefficient of water consumption ($K_в$), mm/t	429,4	356,3	328,3
Coefficient of energy intensity (K_{cki}), 1000 kJ/mm	43,03	50,42	55,65

With the development of saline lands, the hydrothermal regime of the soil ($\overline{R}$)in the Togusken irrigation array was 0,770-0,918, but in the Kazalinskiy massif - 0,792-0,926, that is, optimal heat and moisture availability were ensured, which contributed to an increase in energy costs for the soil-forming process (Q_n) till 120,8-125,4 kJ/cm^2, that is 85 % of radiation balance (R) of day surface.

Thus, due to the «soft» management of the hydrochemical regime of soils with the use of reclamation "irrigation-irrigation" measures, which formed biological and ecological features of functioning of saline soils in landscape systems that ensure conservation and restoration of their natural and ecological sustainability, water use efficiency was ensured, which is indicated by the quantitative value of the water consumption coefficient ($K_в$)and energy intensity (K_{cki}),as an integrated indicator characterizing the soil-meliorative state of saline lands during their development for cultivating agricultural crops.

Based on the systematization and systematic analysis of long-term materials of pilot production studies conducted in the mid-saline soils of the Togusken irrigation system (Zhanakurgan district) and strongly saline soils of theKazalin irrigation (Kazalin district) of Kyzylorda region in the period 2015-2017, their qualitative and quantitative indices, characterizing the reliability of the scientific view, formed on the basis of the ecosystem approach to nature management and the definition of technological which is characterized by the following characteristics: the existence of an action or a set of actions that are performed on the basis of parallel-sequential action and the use of substances, that is, water resources and biological characteristics of agricultural crops (table 8).

Thus, the proposed method for the development of saline lands on the basis of parallel-sequential action, that is, washing and cultivating agricultural crops that serve as a device for carrying salts out of the root layer of soil, is not only limited by the desalinizing effect, but also provides for the formation of high and high-quality biological products of agricultural in view of their salt tolerance, which increases the possibility of cultivating various crops for the needs of agriculture (food supply) and food security, as well as the ecological sustainability of the ecosystem of the region.

Table 8 – Results of a pilot production survey
on the development of saline lands in areas and irrigation tracts of Kyzylorda region

Indicators	Years		
	2015	2016	2017
Togusken Massif (medium saline soils)			
The salt content in the soil layer is 0-100 cm at the beginning of the growing season, t/ha	86,700	70,350	55,350
Washing rate, m^3/ha	6000,0	6000,0	6000,0
The salt content in the soil layer is 0-100 cm after washing	61,208	46,073	29,915
Type of cultivated salt tolerant crops	wheat	wheat	corn
irrigation norm, m^3/ha	7027,0	5960,0	6425,0
Productivity of land, t/ha	4,50	4,80	4,75
The salt content in the 0-100 cm layer at the end of the growing season, t/ha	70,35	53,91	38,250
Type of soil salinity according to the classification of N.I. Bazilevich and E.N. Panovoy	medium saline soils	slightly saline	
Kazalin array of irrigation (heavily saline soils)			
The salt content in the soil layer is 0-100 cm at the beginning of the growing season, t/ha	148,60	121,9	96,190
Washing rate, m^3/ha	6000,0	6000,0	6000,0
The salt content in the soil layer is 0-100 cm after washing	112,534	85,484	63,435
Type of cultivated salt tolerant crops	barley	barley	wheat
irrigation norm, m^3/ha	6290,0	6450,0	6652,0
Productivity of land, t/ha	121,9	95,14	73,200
The salt content in the 0-100 cm layer at the end of the growing season, t/ha	heavily saline soils	slightly saline	

Conclusion. To test and validate the scientific and philosophical view of the development of the ecosystem method for the development of saline lands, many years of pilot production studies have been carried out in the conditions of the Togusken and Kazalin irrigation systems of the Kyzylorda region in the framework of a bilateral agreement with farmers.

Experimental production studies in the conditions of the Togusken and Kazalin irrigation systems of the Kyzylorda region were carried out on the basis of the developed methodological and software that allow conducting field research and gathering of information and analytical materials of agricultural and water management organizations that support the production activities of the Zhanakorgan and Kazalin districts of the Kyzylorda region.

The results of pilot production studies have shown that the developed method for the development of saline soils on the basis of parallel-sequential action, that is, washing and cultivation of crops that serve as a device for carrying salts out of the root zone of the soil, is not only limited by a desalinizing effect, and high-quality biological products of agricultural crops, taking into account their salt tolerance, which increase the possibilities of cultivation various agricultural crops to meet the needs of agriculture (food supply) and food security, as well as the ecological sustainability of the ecosystem of the region allow rational use of the energy resources of the natural system for the purposeful regulation and management of the soil-forming process of hydroagricultural systems, and to ensure their consistent productivity in the process of their use for development of agricultural production.

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ҚЫЗЫЛОРДА ОБЛЫСЫНЫҢ ӨНДІРІСТІК ЖАҒДАЙЫНДА ТҰЗДАНҒАН ЖЕРЛЕРДІ ИГЕРУДІҢ ЭКОЛОГИЯЛЫҚ ҚАУІПСІЗ ТЕХНОЛОГИЯСЫМЕН ТАНЫСУ

Аннотация. Қызылорда облысының Жаңақорған және Қазалы ауданының жек шаруашылықтарының өндірістік гидроагроландшафттық жүйелердегі, тұзданған жерлердіигерудің экологиялық қауіпсіз технологиясымен танысу мақсатында дайындалған әдістемелік және бағдарламалық қамтамасыз етудің шеңберінде жүргізілген тәжірбелік-өндірістік зерттеудің негізінде, егістік алқабтарда жүргізілген тәжірбелік зерттеуге және ауылшаруашылық және сушаруашылық мекемелерінен жыйнақталған ақпараттық-талдау мәліметерін жинауға қол жеткізу арқылы, өндіріске ұсынылып отырған тұзданған жерлерді игерудің әдісінің жұмыс атқару қабілеті және сенімділік дәрежесіанықталды және ауылшаруашылық өндірісіне ұсынылған жаңашыл технологиялық үдерістің ғылыми және әлемдік көзқараста шынайылығы дәлелденген.

Түйін сөздер: экология, жүйе, қауіпсіздік, әдіс, технология, игеру, тұзданған, шаю, суғару, мөлшер, суды тұтыну, қуат сыйымдылығы, топырақ, топырақтың даму үдерісі.

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ИДЕНТИФИКАЦИЯ ЭКОЛОГИЧЕСКИ БЕЗОПАСНОЙ ТЕХНОЛОГИИ ОСВОЕНИЯ ЗАСОЛЕННЫХ ЗЕМЕЛЬ В ПРОИЗВОДСТВЕННЫХ УСЛОВИЯХ КЫЗЫЛОРДИНСКОЙ ОБЛАСТИ

Аннотация. На основе проведенияопытно-производственного исследования для идентификации экологически безопасной технологии освоения засоленных земель в производственных условиях гидроагроландшафтных систем фермерского хозяйства Жанакурганского и Казалинского районов Кызылординской области в рамках разработанных методологического и программного обеспечения, позволяющих проведения опыта в полевых исследованиях и сборов информационно-аналитических материалов сельскохозяйственных и водохозяйственных организаций, определены работоспособность и надежность предложенного способа освоения засоленных земель и подтвержден научный и мировоззренческий взгляд о создании инновационного технологического процесса сельскохозяйственного производства.

Ключевые слова: экология, система, безопасность, способ, технология, освоение, засоление, промывка, орошение, норма, водопотребность, энергоемкость, почва, почвообразовательный процесс.

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