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SCIENTIFIC BASIS OF RESTORATION AND DEVELOPMENT IN OF IRRIGATION UKRAINE IN THE CURRENT CONTEXT

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The article highlights the current state and problems existing in the irrigation sector that caused a significant decrease in the efficiency of irrigated land use. The scientific principles of irrigation restoration on the way to its sustainable functioning and development have been considered, which became the basis for the development of «Irrigation and drainage strategy in Ukraine up to 2030»

Keywords: irrigation, restoration, development, engineering infrastructure, management, strategy

Formulation of the problem. One of the topical issues of the present is the achievement of sustainable development of the agrarian sector of Ukraine's economy. Global climatic changes that have caused the growth of the territory with manifestations of climate drought and desertification processes, together with a significant deficit of natural moisture, have created in Ukraine conditions under which the sustainable cultivation of crop production without irrigation is unproductive, and in the south of the country in Kherson, Zaporizhya, Mykolaiv and Odessa regions are impossible [1-3, 5].

The political, financial and economic crisis in the country, the imperfection of the modern water management system and existing legislation negatively affected the state of water and land use. In the background of these processes, there was a significant reduction in the areas of actual irrigation, which undermined its impact on reducing the dependence of agricultural production on weather conditions.

Today, the level of use of existing potential of irrigated infrastructure is close to the critical one. That is why irrigation is a prerequisite for adapting the agrarian sector to climate change and ensuring Ukraine's food security.

The scientific and conceptual framework for irrigation renewal and development has become the basis for the development of an «Irrigation and Drainage Strategy in Ukraine up to 2030», prepared jointly with a team of experts from the World Bank, the Food and Agriculture Organization of the United Nations in cooperation with Coordination Council established under the Cabinet of Ministers of Ukraine.

The purpose of the research is to analyze the state and main trends of the development of the

irrigation sector in Ukraine at the present stage and to substantiate the scientific principles of its restoration and sustainable use in conditions of climate change.

Analysis of recent research and publications. The analysis of world experience shows that today irrigation plays a decisive role in ensuring the sustainability of agriculture in the face of natural warming due to climate change. The study of various aspects of rational use of irrigated lands, the sustainable functioning of irrigation systems, in particular through the restoration and modernization of the objects of their engineering infrastructure, is devoted to a number of scientific studies of domestic and foreign scientists. The international organizations such as the United Nations Economic Commission for Europe (UNECE), the Intergovernmental Panel on Climate Change (IPEC), the Food and Agriculture Organization of the United Nations (UN FAO), the International Commission on Irrigation and Drainage (ICID)) etc. [4, 7-10].

According to the Association Agreement between Ukraine and the European Union, Directive 2000/60 / EC of the European Parliament and of the Council of 23 October 2000 «On the establishment of the framework for Community action in the field of water policy», Ukraine is obliged to implement measures aimed at achieving sustainable management of all water resources. The scientific and conceptual framework for the rehabilitation and development of irrigation is part of the solution to this priority task.

Research results. According to preliminary expert estimates, about 2/3 of the territory of our country is in conditions of insufficient natural water supply. Climate change is manifested

mainly due to the increase in air temperature at the background of the existing rainfall, and this negatively affects the conditions of farming, especially in the southern region of the country.

It should be noted that over the past decades in Ukraine, the area of dry and very dry zone has increased by 7% and covers 11.6 million hectares of arable land, and arid and insufficiently humid areas have shifted to the north of the country. At the same time, the area of percolated lands decreased by almost 10% and occupies 7.6 million hectares (Table 1, Fig. 1). In Ukraine, agriculture accounts for 18.7 million hectares of arable land (60%) in the conditions of a significant deficit of annual climatic balance of more than 150 mm, which causes a high need for irrigation.

Especially acute issue of irrigation is in the Steppe zone, where the deficit of climatic water balance is 360-480 mm, and the probability of

years with a significant deficit of moisture during the growing season is 90-95%.

In the case of insufficient water supply, the yield of agricultural crops directly depends on the ability of the irrigation systems to function effectively, that is to provide water supply at the right time and sufficient to grow high and sustainable yield crops. Achievement of this is possible provided that the engineering infrastructure of the systems is in good working order.

Unfortunately, the current situation in the irrigation sector is of a crisis nature and leads to further deterioration of the state of the existing engineering infrastructure. The process of decay accelerated by a number of ill-considered measures during the reform of the agrarian sector of Ukraine's economy, namely:

– in accordance with the Resolution of the Cabinet of Ministers of Ukraine of August 13,

1. Estimation of annual climatic water balance and relative areas of zones of Ukraine with different levels of hydrothermal provision

№ zone	Scale of CWB, mm	Qualitative evaluation	Relative area of the zone, % of the total territory of Ukraine		
			1961-1990	1991-2016	+ to 1961-1990
I	More than 50	Excessively humid	12,5	4,5	- 8,0
II	-50 – (-50)	Humid	32,0	30,0	-2,0
III	-50 – (-150)	Deficiently humid	10,0	16,0	6,0
IV	-150 – (-300)	Arid	23,0	20,0	-3,0
V	-300 – (-450)	Dry	18,5	22,0	3,5
VI	Less than -450	Very dry	4,0	7,5	3,5



Fig. 1. The zonation of the territory of Ukraine by the annual climatic water balance

2003, № 1253, the inter-farm network located on the balance of liquidated collective agricultural enterprises was transferred to the ownership of local governments, which created the prerequisites for the sharp deterioration in the level of exploitation of inland irrigation networks by different owners (Table 2) and, as a result, reduction of irrigation areas, theft and destruction of networks;

2. Ownership of farm reclamation systems

Owner	Area (ha)	% of total area
Village Councils	949 470	36%
Not yet transferred to village councils (without the owner)	835 630	32%
Private and collective agricultural enterprises	407 070	16%
Ownerless land	373 230	14%
State property	55 330	2%
Total:	2 620 730	100%

– separate plots of land within technologically integral irrigated arrays were allocated without proper regulation and determination of responsibility for misuse of reclaimed land, resulting in the destruction of the integrity of the entire reclamation complex;

– the establishment of a minimum lease term for irrigated land, which is insufficient for

the return on investment, and does not encourage investors to invest in restoration and development.

Unlike farm networks, inter-farm infrastructure, due to the more responsible attitude of the State Agency for Water Supply to its maintenance and operation, is in a slightly better condition. Data from the latest inventory carried out by the State Agency of Ukraine for Water Supply in 2013 show that the composition of inter-farm irrigation systems includes 423 main water intake structures, 1730 pumping stations, and 96 reservoirs with a useful volume of 463 million cubic meters. The length of the permanent irrigation network is 7.3 thousand kilometers, including the canals – 3.3 thousand kilometers and pipelines – 3.9 thousand kilometers [5].

The general engineering infrastructure of irrigation systems, which in most cases lasted for about 50 years, completely exhausted its technical resource, and some objects reached their limit state, in which their further exploitation is impossible or inappropriate (Table 3). This is mainly the case with the hydraulic structures of the internal irrigation network, which, as a result of unsuccessful political and economic transformations in the country, remained without an effective owner and were subject to decay, destruction and looting [3, 5, 6, 12, 13].

As a result, due to the significant reduction of budget financing, the lack of proper financial resources for water users to restore the engi-

3. The main reasons of non-use farm irrigation networks

Administrative unit	Actual irrigated land, thousand hectares	Total land out of use, thousand hectares	Including reasons:				Area of irrigated land, where it is possible to restore reclamation systems, thousand hectares
			Unsatisfactory technical condition of the network, thousand hectares	Lack of sprinklers, thousand hectares	Subject to retirement, thousand hectares	Unsatisfactory technical condition of pumping equipment, thousand hectares	
1	2	3	4	5	6	7	8
Vinnitsya	23,8	22,6	11,1	20,2	8,4	10,8	13,0
Volyn	0,5	0,5			0,5		
Dnipropetrovsk	198,7	163,0	136,4	37,0	55,6	12,5	80,4
Donetsk	122,3	105,3	61,0	8,9	32,9	2,0	14,8
Zakarpatska	0,9	0,9	0,3	0,6			0,9
Zaporizhyya	240,7	191,9	130,2	48,2	13,5		172,2
Kyiv	43,9	23,5	19,2	13,7	13,7	9,2	16,7
Kirovograd	40,7	25,2	18,9	24,9	13,1	18,0	27,2
Lugansk	54,1	48,7	41,7	48,2	35,3	8,5	13,3
Mykolaiv	190,3	138,3	115,8	111,7	47,0	32,5	36,5

End of table 3

1	2	3	4	5	6	7	8
Odessa	226,9	187,8	105,8	46,6	0,5	0,7	175,2
Poltava	50,8	50,8	4,3	21,9	23,5	1,1	23,6
Sumy	1,2	1,2			1,2		
Kharkiv	82,4	74,8	62,7	57,4	55,5	12,7	14,4
Kherson	426,8	135,3	59,0	66,1	1,4	8,8	108,9
Khmelnysk	1,3	1,3			1,3		
Cherkasy	63,2	56,4	13,0	26,6	16,7		39,7
Chernigiv	0,5	0,5			0,5		
AR Crimea	401,6	242,9			40,8		147,1
Totally in Ukraine	2170,5	1470,8	925,7	660,2	361,4	122,1	884,5

neering infrastructure of irrigation systems, and the purchase and renovation of the park of sprinkling equipment, there was a significant reduction in actual watering areas – today only about 20% of the available irrigated areas are watered lands (Table 4) [3, 5, 6].

The outdated pump equipment on irrigation systems has expired its normative lifetime and, as a result, the actual efficiency of pump units has

decreased to 0.6, that is steel at 20-25% lower than their nominal values. Because of this, the water supply process is characterized by high energy consumption (up to 400 kWh / thousand m³).

The constant increase in the cost of electricity consumed to supply water to irrigation, due to the imperfect payment system, creates a situation where water users, agricultural producers, farmers can not pay for these services and irrigate their land.

The imperfection of existing legislation and the ineffectiveness of the management system require the settlement of institutional, legislative, managerial and organizational issues to facilitate the investment required to restore irrigation infrastructure as a basis for increasing the effective use of water and land resources in the country and further enhancing agricultural production.

On the basis of the performed complex of research on the restoration and development of irrigation in Ukraine it is proposed to implement using the following basic provisions:

- The expansion of irrigation areas should be carried out primarily through the reconstruction and modernization of irrigation systems on lands that were previously watered with the maximum use of existing farming networks;

- Modernization and reconstruction of irrigated systems should provide for the predominant application of low-pressure spray systems and drip irrigation, including subsoil, as well as anti-filtering measures on channels using geomembrane coatings;

- Increased energy efficiency of irrigation should be ensured by the use of pumped-and-power equipment with a controlled drive and the transfer of energy supply to the use of renewable sources (wind, solar) of energy with their location on the lands of the water fund;

- Irrigation restoration should take place for unconditional compliance with ecological safety

4. Availability and use of irrigated lands in Ukraine

Region	Availability of irrigated land, thousand hectares	Irrigated in 2016	
		thousand hectares	%
Vinnitsya	23,82	3,8	15,95
Volyn	0,50	–	–
Dnipropetrovsk	198,68	27,9	14,04
Donetsk	122,32	4,1	3,35
Zakarpatska	0,88	0,6	68,18
Zaporizhyya	240,40	45,9	19,09
Kyiv	43,90	9,8	22,32
Kirovograd	40,69	2,8	6,88
Lugansk	60,30	0,5	0,83
Mykolaiv	190,30	26,0	13,66
Odessa	226,86	40,3	17,76
Poltava	51,20	1,7	3,32
Sumy	1,20	–	–
Kharkiv	82,38	6,4	7,77
Kherson	426,80	292,2	68,46
Khmelnysk	1,30	–	–
Cherkasy	63,18	10,6	16,78
Chernigiv	2,10	–	–
AR Crimea	397,30	–	–
Totally in Ukraine	2178,30	472,6	21,70

requirements, taking into account the ecological and reclamation state of irrigated lands, the direction of soil processes and regimes, the level of soil fertility, the possibilities of manifestation of salinity processes, salinization, groundbreaking, hydromorphization of land and quality of irrigated water;

- In order to ensure the effective operation of the internal network of irrigation systems, organizations of water users who are required to receive and manage these networks on a royalty-free basis should be established. There may be two main options for the transfer of farmland networks – before restoration or after recovery. In the first case, the organization of water users will rely on the task of its restoration, in the second – only to ensure effective operation. The status, basic rights and obligations of water users organizations should be regulated by a special law of Ukraine «On Water Users Organization». The development and adoption of this law is one of the priority tasks;

- Implementation of irrigation rehabilitation and development projects should be preceded by institutional reform of the water sector. In the process of its implementation, the key provisions of the EU Water Framework Directive should be implemented, first of all, the functions of forming and implementing water policy should be separated from the functions of infrastructure management and provision of services;

- Tariffs for water supply services for irrigation should be formed with the participation of all

stakeholders and cover all water supply costs, ie their amount should be sufficient to transfer irrigation to self-sufficiency;

- Irrigation areas in Ukraine should be brought to a level where their role in eliminating the dependence of crop production volumes from unfavorable weather conditions is restored. According to expert estimates, such an irrigation role is ensured in the southern region of Ukraine, provided that the irrigation area is increased to 1.5-1.7 million hectares;

These and other provisions are the basis of the «Strategy for the rehabilitation and development of irrigation and drainage in Ukraine up to 2030», developed jointly with the experts of the World Bank and FAO and recommended for consideration and approval by the Cabinet of Ministers of Ukraine.

Conclusions. The proposed scientific principles for the restoration and development of irrigation in Ukraine in modern conditions provide for an integrated approach with the simultaneous implementation of measures for the modernization of land reclamation systems, institutional reform and legislative support.

Implementation of the Strategy will enable to create favorable conditions for attraction of investments for restoration of the potential of irrigation and drainage systems and thereby increase the area of irrigated agricultural land to 1.5-1.7 million hectares, increase the stability of the agrarian sector of the economy to climate change while raising the level of ecological safety irrigation.

Bibliography

1. *Scientific bases of protection and rational use of irrigated lands in Ukraine* / S. Balyuk, et al. Kyiv: Agrarian Science, 2009. 624 p.
2. *Technical and technological principles of irrigation restoration in Ukraine* / Romaschenko M. I., et al. // *Reclamation and water management*. 2006. Issue 93. pp. 21-33.
3. *Concept of Irrigation Recovery and Development in the Southern Region of Ukraine* (edited by M.I. Romashchenko) K.: «Comprint» CPU, 2014. 28 p.
4. Carlos Garsez-Restrepo, Douglas Vermillion, Giovanni Munoz. *Transfer of management of irrigation systems / World experience and results*. FAO report on water issues. Rome: 2007. 63 p.
5. *Soil melioration (systematics, perspectives, innovations): a collective monograph*. / Balyuk S.A., et al. Kherson: Grin D. S., 2015. 668 p.
6. Romashchenko M., Dekhtiar O. *Irrigation Reform in Ukraine: Organizational and Legal Aspects* / 2nd World Irrigation Forum (WIF2) «Water Management in a Changing World: Role of Irrigation in Sustainable Food Production.» 6-12.11 2016. Chiang Mai, Thailand. W1.3.01. -11r
7. Svendsen, Mark, Jose Trava. *Participatory Irrigation Management: Benefits and Second Generation Problems. Lessons from an International Workshop held at CIAT, Cali, Colombia, 9-15 February 1997*. The Economic Development Institute of the World Bank, Washington, DC.
8. *Comprehensive Assessment of Water Management in Agriculture. Water for Food, Water for Life. Comprehensive Assessment of Water Management in Agriculture*. London: Earthscan, and Colombo: International Water Management Institute. 2007
9. Hrabrin Bachev. *Agricultural water management in Bulgaria*. Institute of Agricultural Economics, Sofia, 1st of August 2010. Online <https://mprapub.uni-muenchen.de/24535/> MPRA Paper No. 24535, posted on August 23, 2010.

10. Renault D and Makin I.W. Modernizing Irrigation Operations: Spatial Differentiated Resource Allocations Research Report 35. International Water Management Institute. P O Box 2075, Colombo, Sri Lanka. 1999

11. Managing the process of restoration and sustainable use of irrigation / Romaschenko M I. et al. // Reclamation and water management. 2014. Issue 101. P. 137-147.

12. Scientific principles of agriculture development in the steppe of Ukraine / Romashchenko M I., et al. // Bulletin of Agrarian Science. 2015. № 10. P. 5-9.

13. Restoration of the functional capacity of irrigation systems. Kruchenyuk V.D., et al. // Bulletin of Agrarian Science. 2016. № 3. P. 49-52.

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**Научные основы восстановления и развития орошения в Украине
в современных условиях**

В статье освещено современное состояние и проблемы, существующие в секторе орошения, которые повлекли существенное снижение эффективности использования орошаемых земель. Рассмотрены научные основы восстановления орошения на пути к его устойчивому функционированию и развитию, которые стали основой для разработки «Стратегии орошения и дренажа в Украине на период до 2030 года»

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Наукові основи відновлення та розвитку зрошення в Україні в сучасних умовах

У статті висвітлено сучасний стан та проблеми, що існують у секторі зрошення, які призвели до істотного зниження ефективності використання зрошуваних земель. Розглянуто наукові основи відновлення зрошення на шляху до його стійкого функціонування та розвитку, які стали основою для розробки «Стратегії зрошення та дренажу в Україні на період до 2030 року»