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# Scientific Retrospective of the Farm Irrigation Systems Efficient Use

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## Abstract

This article presents the results of a scientific-practical research on Russian agribusiness ameliorative department efficiency. There are the results of the analysis and retrospective of domestic and foreign views on the agriculture effectiveness and, in particular, the irrigated agriculture efficiency, Organization for Economic Co-operation and Development (OECD) countries' experience. The methodological approaches to understanding the economic development effectiveness are clarified and an extended classification of efficiency types is proposed. The author's approach to the farm irrigation systems efficient use concept is presented. The agricultural economic efficiency structure has been determined. The factors that can contribute to increasing the investment attractiveness and efficiency of irrigated agriculture are identified. Theoretical and methodological approaches to assess the irrigated agriculture effectiveness, considering the problems identified in the process of this study, are proposed.

**Keywords:** economic efficiency, irrigation systems, types of efficiency, economic development, agricultural production, efficiency methodology, irrigated agriculture efficiency.

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## 1. Introduction

The concept of efficiency is quite complex and multifaceted. The economic efficiency indicator is used for performance measurement: of a country, region, industry, enterprise, workforce, employee, expenses, etc. Efficiency often acts as a leading goal of economic development.

The most common approach in the scientific literature is that efficiency is only the ratio of the result and the cost of obtaining this result, it does not always convey the diversity of this indicator.

First, the effectiveness should be distinguished by the level of the study object. When the enterprise mainly aims at profit, then the profitability indicator may be considered as a particular criterion of efficiency. However, one indicator is not enough for the study

and for the enterprise effectiveness evaluation. Moreover, when it comes to the study of the functioning effectiveness and competitiveness [5] of the most significant economic objects of analysis, scientists and practitioners are faced with the need to elaborate the concept of ``efficiency'' in order to identify a system of indicators reflecting the this indicator content. Under Russian natural and climatic conditions, the irrigation development contributes to solving important socio-economic and environmental objectives of Russian sustainable development. They are: improving food security by reducing the economic risks associated with crop losses due to instability of weather conditions; an increase in the tax base as a result of the increase in the output of agricultural enterprises, in the processing industries and implementing organizations; creating new jobs and improving the social conditions of the rural population.

Therefore, the concept of efficiency is expanding in terms of the mandatory environmental and social factors consideration, especially in terms of the life and the natural environment quality.

## 2. Research Question

Regional (at any level) or state's socio-economic results cannot be unambiguously reduced to a single performance parameter.

The gross domestic product (GDP) or gross regional product (GRP) of any territory cannot act as a universal measure for assessing the results of this territory economic activity.

The initial interpretation of efficiency was tied exclusively to the enterprise's activities. One of the first mentions of efficiency appeared in D. Ricardo writings, the political economy classic. The scientist associated this concept with the result of a certain type of cost. The category of ``efficiency'' was further developed in the G. Emerson work ``The Twelve Principles of Efficiency''. Efficiency, according to G. Emerson, is closely interrelated with the enterprise's functionality [10].

V. Pareto, the neoclassical direction representative, understood the efficiency as the economy state disallowing changes in favor of one of the participants in the economic process, without worsening the position of the counterparty.

The merit of P. Drucker [4] should include the distinction between the notion of effectiveness and efficiency (as a reflection of the organization socio-economic activities).

Individual attention should be given to the general country's economy efficiency concepts of E.J. Dolan and D.E. Lindsay, who believed that the national economy becomes

effective only when the demands of its consumers are satisfied to the maximum extent subject to limited resources [3].

It should be noted that the socio-economic development of society objectively necessitates the new methodology and methods for evaluating effectiveness emergence.

In the twentieth century, the international statistical standard ``The Frascati Manual'' [12] was developed to assess the effectiveness of science and innovation.

The tendency of the state to increase social spending has led to the ``efficiency audit'' emergence. It is a qualitatively new direction, which further gave rise to the emergence of such effectiveness areas as the effectiveness of education, health care, sports, etc.

All the numerous efficiency interpretations can be represented in the form of the following classification of economic efficiency types (Table 1), showing that economic efficiency is not just a complicated and complex category, but can be adapted to the various tasks facing researchers.

TABLE 1: Classification of economic efficiency types.

| Principle of classifying | Efficiency types |
|---|---|
| By type of evaluation: | production; technological; financial; social; ethical; legal; organizational; communication; ecological. |
| By the structure: | individual; group; organizational; industry; regional; economic. |
| By calculation time: | planned; predictable; current; final. |
| By purpose: | absolute; comparative. |
| By magnification: | primary; multiplication. |

Source: compiled by the authors.

A special role in the efficiency theory and methodology plays the evaluation of the agriculture effectiveness.

Given the sectoral focus of this indicator, the economic efficiency of agriculture (as a sector) can be represented as a figure (Fig. 1).

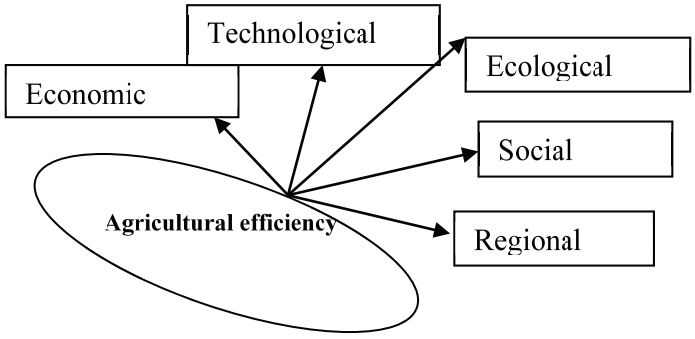


**Figure** 1: The structure of the agriculture economic efficiency. Source: authors drawing.

The agricultural production efficiency most often refers to the overall performance of financial and agricultural enterprise economic activities. Efficiency, in turn, is a complex category and consists of a number of private assessment indicators: labor productivity, income level, product quality, profitability, number of new jobs created, etc.

The main criterion of this efficiency type is the maximum production of agricultural products at the lowest cost of living and materialized labor. The efficiency of agricultural production is a complex indicator, which is measured by using a system of such private criteria as: labor productivity, capital productivity, cost, profitability, yield, productivity, etc.

A special place in the agricultural enterprises efficiency methodology occupies the evaluation of this indicator in irrigation. In the domestic scientific literature, the main approaches to the irrigated land use efficiency methodology development are represented by the works of I. Aidarov. [1], Vikulova O.I. [2], Konopleva E.A. [11], Krasnoshchekova V.N. [6, 7], Olgarenko G.V. [8], Olgarenko D.G. [7, 9, 17], Shchedrin V.N. [16], in foreign experience, these are researches of K.E.B. Gibson, H.S. Yang, D. Eisenhauer, J.B. Gates, P. Nasta, B.S. Farmaha, P. Grassini [18], D.R. Bennett, R.V. Riewe, T. Entz, S.A. Woods [19], J. Reca, C. Trillo, J.A. Sanchez, J. Martinez, D. Valera [20].

So, the peculiarities of the Krasnoshchekov V.N. methodological approach should include an integrated approach that takes into account the comprehensive requirements for the rational use of natural resources, depending on the characteristics of natural and climatic conditions. According to Krasnoshchekov V.N. it is necessary to approach the economic efficiency of objects of land reclamation systematically and take into account the result not only of individual system components, but also of the landscape in general (including the external effects from the measures taken) [10].

The scientific approach of academician Aidarov I.P. to the category of agricultural land reclamation efficiency comes under notice. Thus, he believes that the further development of hydrotechnical amelioration is the most effective in regions characterized by high potential soil fertility, despite the fact that the land irrigation and drainage cost in the total amount reaches 30--60 % expenses for individual regions [1].

A special contribution to the theory and methodology for evaluating the irrigated agriculture effectiveness was made by ``Methodological recommendations on the assessment of the ecological and economic efficiency of investment projects for agricultural land reclamation'' developed in 2015 by Federal State budget scientific institution All-Russian Scientific Research Institute ``Raduga'' under the guidance of the doctor of agricultural sciences, professor Olgarenko G.V. [13]. Guidelines contain a description of methods for evaluating the effectiveness of agricultural land reclamation investment

projects (MIP), based on the calculation of three final efficiency types: budget, commercial and public.

The irrigation system functions as part of a multifactor natural complex; it is its integral part; shows its specific functions in the interaction process with the natural environment and, essentially, is a complex natural-technical object, the agricultural landscape integral part. In the aspect mentioned above, the ameliorative system (including the irrigation system) is an integrated natural-technical complex, an integral part of the agricultural landscape that provides for the circulation regulation of water, matter, energy and information within its borders.

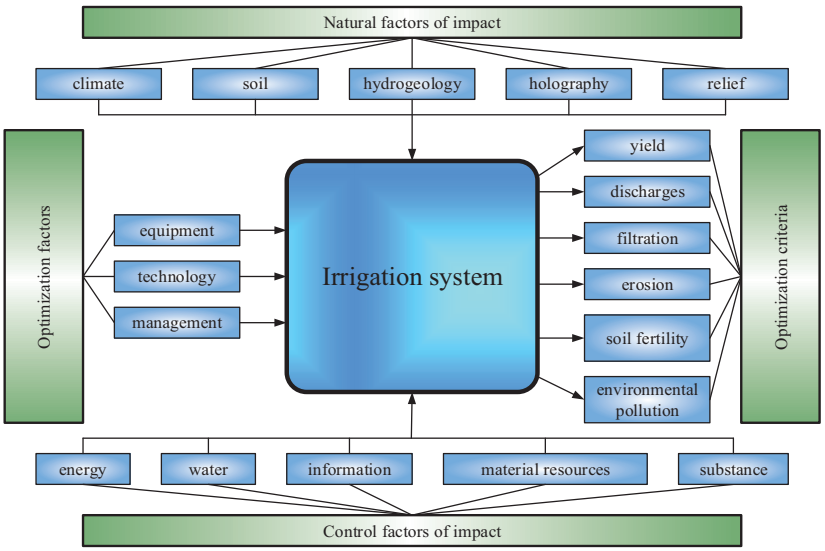


**Figure** 2: Functional-structural diagram of the irrigation system.

The irrigation and drainage systems technical condition and operational efficiency is determined by a external and internal influential factors complex: climatic (external factors influencing the technical state of the HMS -- uncontrolled) and technical and operational (internal factors influencing the technical condition and functioning of the HMS -- controlled), including: technical-technological and organizational-managerial.

External (uncontrollable) impact factors: climatic, soil, hydrogeological conditions and qualitative composition of ground and surface waters of the natural-climatic zone in which the hydro-reclamation system is located and operates.

Internal (production) impact factors: the technical level of the irrigation and drainage system, ameliorative and sprinkling equipment, technical means and equipment when the facility is commissioned; technological regulations and mode of irrigation and drainage system operation.

In the work of Ward F.A. [15] five factors that can contribute to increasing the investment attractiveness and efficiency of irrigated agriculture are highlighted. Most of these factors are related to pricing mechanisms for irrigation water.

These factors are:

- water pricing based on paying capacity;
- cross-subsidization, (in case of payment for water by other water users);
- the irrigation water price, when forming it below the marginal supply cost, which is caused by an increase in demand for irrigation water and infrastructure for its provision;
- the opportunity for irrigators to renegotiate water supply contracts after their infrastructure development.

The recommendations relating to payments for ecosystem services in the context of integrated water management developed by the UN in 2007 introduce the concept of payment for ecosystem services (PES), which implies complexity in the use of natural resources.

## 3. Conclusion

Thus, domestic and foreign concepts of the efficiency of agriculture and, in particular, the efficiency of irrigated agriculture, reviewed above, the following conclusions can be drawn:

- the majority of the stated scientific approaches consider the final efficiency, while its current value is underestimated;
- in the available domestic and foreign literature, the industrial economic efficiency is most often considered either in isolation from its regional component, or this component is not reflected in detail in the guidelines;
- most approaches to assessing the irrigated agriculture economic efficiency ignore the labor potential and labor resources influence, as the main source of productivity growth and labor intensification;
- existing guidelines do not consider the relationship between the irrigated agriculture economic efficiency and the economic security of development [14].

In the of irrigation systems functioning course, operational management of the ameliorative regimes of irrigated and drained lands is ensured in an optimization mode

in order to obtain scientifically grounded, economically viable agricultural crops; soil fertility preservation and improvement; ensuring the normal land ameliorative condition; reliable technical condition of buildings and of all equipment, under mandatory conditions for the preservation of the natural environment and the creation of social conditions for rural population production and labor activities.

To ensure the irrigation system normal operation and functioning, it is necessary to monitor a significant number of parameters characterizing the technological process.

Criteria for assessing environmental conditions:

- soil fertility assessment (physico-chemical and particle size distribution, humus, erosion resistance of the soil);
- the depth of groundwater, the degree of their mineralization, chemical composition;
- condition of groundwater;
- salinity and alkalinity of the soil;
- acidity (alkalinity) of the soil solution (pH);
- humus content;
- particle size distribution of the soil;
- eroded soil;
- land subsidence;
- irrigation water quality;
- irrigated fields surface condition.
- relief of the irrigation system (slopes, drillings, the presence of forest belts).

On a technical condition:

- assessment of the irrigation system technical level, technical means and irrigation technology selection;
- assessment of pipeline networks and open channels condition (throughput, condition, clogging, local resistance);
- operational characteristics of irrigation equipment;
- the state of the collector-drainage network (water utilization factor for surface irrigation systems);
- state quality of pumping stations, their technical and economic characteristics, utilization rate;

- the volume of repair and maintenance works, their frequency and planned timeliness, quality;
- the supply, transportation and distribution of irrigation water, working hours, echnological operations quality;
- the irrigation system provision with equipment, controls, computer equipment.

According to the technological regulations implementation of the irrigation system operation:

- assessment of the state of the irrigation system operation and water consumption management regimes;
- relevant fulfillment of irrigation terms and water supply norms;
- provision of the irrigation system with qualified personnel and in the required volume;
- compliance with the operational technologies of irrigation system and its individual elements, the system of control and accounting of the operation of the irrigation system;
- water consumption planning and management, and repair and maintenance work technologies (provision of water in the required volume, availability of spare parts, repair equipment and tools, compliance with safety rules);
- social conditions during the operation of the irrigation system (availability of sheds, transport, communications; condition of access roads, especially in bad weather).

Socio-economic factors:

- raising the living and medical care standards;
- increase the conditions for the comfort of living of the population;
- increasing the level of cultural and community services for the population;
- increasing the level, forms and security of recreational services to the population of the region.

All of the above requires improving procedural and methodological approaches to assessing the farm irrigation systems efficient use, taking into account the current features of the agricultural socio-economic development in the Russian Federation.

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