INDICATOR-BASED EVALUATION SYSTEM FOR INCREASING SYNERGIC EFFICIENCY OF LAND RESOURCE USE

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Abstract: This article analyzes the issue of increasing the efficiency of land resource use through a synergistic approach. A methodology developed on the basis of an indicator system for assessing synergistic efficiency is presented, which allows taking into account economic, environmental and social indicators of land resources. As a result of practical analyses conducted in the Kashkadarya region, the interrelationships of indicators and their synergistic effect are determined. This system is an important tool for making strategic decisions in sustainable land resource management.

Keywords: Land resources, indicator assessment, synergistic efficiency, integrated approach, sustainable management, multi-criteria analysis, Kashkadarya region.

Introduction: Land resources are considered one of the strategic factors in the economic, ecological and social life of mankind. Especially in countries with an agrarian economy, the effective use of land resources plays an important role in ensuring the country's food security, increasing employment and achieving regional development. While traditional approaches are usually aimed at assessing the economic efficiency of land area through separate indicators, based on today's requirements, there is a need to assess it based on multi-factor, interrelated indicators through a synergistic approach. Understanding the synergistic efficiency of land resources is not only a joint analysis of the productivity obtained from the land area, but also the level of ecological sustainability, social benefits and technological coverage of this area. That is, the basis of this approach is to determine the high level of benefit resulting from their mutual harmony and joint effect, rather than the sum of individual indicators. In this article, an indicator assessment system is developed for increasing the efficiency of land resource use using the example of the Kashkadarya region. The methodology aims to identify synergistic outcomes through the integration of economic, environmental, and social indicators. The results will serve to formulate scientifically sound approaches to integrated land resource management and planning.

Literature review: In recent years, indicator systems have been widely used to assess the efficiency of land resources. In international practice, the indicator

system developed by FAO, OECD, and UNEP allows for a joint assessment of the environmental and economic aspects of land resource use. For example, the "Land Resource Efficiency Framework" model recommended by FAO (2020) aims to assess indicators such as water consumption, soil degradation, and CO_2 emissions in addition to land productivity. In modern approaches, the interaction between indicators — synergistic relationships — is of great importance. In particular, the indicator assessment models proposed by D. Bosselman (2019) and R. McKinney (2021) identify the interaction of various factors and analyze the possibility of achieving complex efficiency. This approach is especially relevant for the agricultural sector, helping to identify the multi-purpose use of land. Although there are a number of studies on the economic efficiency of land resources in Uzbekistan, an indicator assessment system based on a synergistic approach has not yet been sufficiently developed. In particular, A. Kholmirzayev (2022) analyzed agro-economic indicators in assessing land fertility, while M. Turdiyev (2023) developed an approach that takes into account environmental safety. However, multi-criteria, mutually integrated and synergistic assessment systems are not sufficiently used in practice. In this regard, the indicator assessment system proposed in this study creates the opportunity to comprehensively analyze the efficiency of land resource use not only by individual indicators, but also by taking into account their synergistic effect. This serves as an important scientific and practical basis for formulating sustainable development strategies.

Research methodology: In this study, an indicator assessment system was developed based on a synergistic approach to increasing the efficiency of land resource use. The object of the study was selected as the activities of dehkan farms and farmers in districts with high agricultural potential of the Kashkadarya region. The main goal was to assess the efficiency of land resource use through complex indicators and determine a synergistic index based on their interaction. At the first stage, the selection of indicators was carried out. The indicators were divided into three main areas:

- Economic indicators: land fertility (sum/ha), gross product volume, level of profitability.
- Environmental indicators: soil degradation rate, water consumption (m^3/ha), agrochemical use rate.
- Social indicators: land ownership rate, labor force employment, local income growth dynamics.

At the second stage, empirical data on all indicators were collected. This was based on data from the Kashkadarya regional agricultural department, statistics

department, and land cadastre organizations. In addition, questionnaires and field observations were conducted in 60 dehkan farms. At the third stage, the indicators were normalized and a separate synergistic efficiency index was calculated for each farm. At this stage, multi-criteria decision-making methods (MCDM — Multi Criteria Decision Making) — in particular, TOPSIS, AHP, and Entropy Weighting approaches — were used. The indices were evaluated in the range from 0 to 1, which allowed them to be compared and grouped. Finally, correlation analysis, regression models, and clustering (k-means clustering) methods were used to determine the relationship between the indicators. This approach allowed for an in-depth analysis of what factors are important for effective land resource management.

Analysis and results: The results of the analysis showed that there is a large difference in the level of land resource use and results among dehkan farms in the Kashkadarya region. Based on the synergistic efficiency indices, farms were divided into three categories: farms with high (0.7 and above), medium (0.4–0.69) and low efficiency levels (below 0.4). Farms with high efficiency usually:

- using modern agricultural technologies,
- introduced water-saving technologies,
- land tenure rights are clear and stable,
- and their economic results were at a high level.

For example, in several dehkan farms in the Koson district, land productivity was 17–20 million soums/ha, soil degradation was low, and water consumption was normal. The synergy index in these farms was estimated at 0.8–0.9, which indicates that the indicators are well-coordinated. On the contrary, farms with a low level of efficiency had high indicators (for example, productivity), but very low environmental or social indicators. This proves the superiority of the synergistic approach: efficiency should be assessed not only on the basis of yield or profit, but on the basis of complex factors. The results of the correlation analysis showed that there is a significant correlation between the indicators. In particular, farms with a high level of environmental sustainability also have high economic results, which proves the correctness of decisions made on the basis of a synergistic approach. A positive correlation was also found between technological investment and labor employment. These results suggest that the indicator assessment system serves as an important tool for determining synergistic efficiency. It allows assessing the benefits of land resources not only at the economic level, but also at the environmental and social levels.

Conclusion and suggestions: The results of the study showed that traditional approaches to assessing the efficiency of land use are insufficient. As a result of assessing only on the basis of productivity or economic benefits, the sustainability and long-term potential of the land are neglected. Therefore, it is necessary to analyze the economic, environmental and social aspects of land resources in a synergistic manner through an indicator assessment system. The indicator system proposed in the study allowed for a deep and multifaceted assessment of the efficiency of resource use. In particular, by identifying the interrelationships between indicators, it was possible to identify synergistic effects. This serves to make management decisions based on a reasonable and long-term perspective.

Based on the research, the following proposals were developed:

1. Indicator evaluation systemIntegration into the activities of the Ministry of Agriculture and the Land Resources Management Agency;
2. Develop a synergistic efficiency index for each farm and create a continuous monitoring mechanism;
3. Environmental sustainability and technological innovationdevelopment of specialized territorial strategies for land use, taking into account;
4. Farms that have achieved high synergistic efficiencyencouragement through preferential financial and technical assistance;
5. Expand the use of digital platforms and artificial intelligence-based systems in assessing the efficiency of land resource use.

In conclusion, the approach to determining synergistic efficiency based on indicator assessment is an important tool for rational management of land resources, ensuring agricultural sustainability, and making strategic decisions.

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