E-ISSN: 2997-9366
American Journal of Management Practice
https://semantjournals.org/index.php/AJMP

| Research Article

Check for updates

# Statistical, Econometric and Methodological Analysis of Relative Efficiency of Production in Agriculture

**Khayitova Rushana Uktamovna**
*Doctor of Philosophy (PhD) in Economics, Uzbekistan*

**Abstract:** This research focuses on the statistical assessment of the relative efficiency of agricultural production in Uzbekistan through the application of economic–mathematical and econometric modeling. The research analyzes key internal and external factors affecting efficiency, their statistical grouping, dynamics of economic indicators, and develops multifacto econometric models. Regional differences in relative efficiency are identified, agricultural output is forecasted using the Holt–Winters model, and recommendations are proposed to optimize production structures and improve resource efficiency.

**Key words:** relative efficiency, agriculture, econometric model, statistics, forecasting, labor resources, investment, Holt–Winters model, efficiency indicators.

This is an open-access article under the CC-BY 4.0 license

The concept of relative efficiency in agriculture is considered one of the most complex categories in economic analysis. It is based on the multifaceted relationship among indicators such as the dynamics of production resources, territorial distribution of crop types, opportunity costs, labor intensity, land productivity, and the level of technological advancement. According to the theory of comparative advantage formulated by D. Ricardo, if each region specializes in producing goods for which it has the lowest opportunity cost, overall economic efficiency increases significantly. This theory is particularly relevant to agriculture because each type of resource in the sector is limited and strongly dependent on natural and climatic conditions.

Analyses based on real statistical data from Surkhandarya and Kashkadarya regions show notable differences in their crop specialization. The agro-climatic zones of Surkhandarya offer optimal conditions for producing vegetables, melons, and greenhouse products. In contrast, Kashkadarya demonstrates high productivity in wheat cultivation, supported by large cropland areas, mechanization levels, meliorative conditions, and the composition of labor resources.

The complexity of statistical methods used for evaluating relative efficiency stems from the multifactor nature of agricultural processes. Considering the correlation among resources, stability of regression equations, variance analysis, structural shifts, randomness, and external factors helps increase the accuracy of efficiency assessments. This approach enables the identification of resource utilization models and the development of optimal production strategies.

The globalization of the world economy, characterized by the formation of an integrated economic space, requires the effective use of human, informational, ecological, institutional, and technological factors to enhance overall productivity, including agricultural output. Efficiency is viewed as a fundamental economic category common to different socio-economic formations. It broadly characterizes productivity, the effectiveness of production processes, and the functioning of production systems or management models. Efficiency is determined by comparing the results of economic activity (effects) with the production costs (causes) that generated those results.

The issue of evaluating the efficiency of agricultural production has remained central in academic and practical research over the past decades. Its relevance today is even greater due to the deepening of market relations in the national economy. For many years, the sector suffered from price liberalization challenges, nonequivalent exchange between agriculture and other sectors, limited credit resources, and macroeconomic instability. The implementation of national projects in agriculture helped address these problems. However, comprehensive research on the relative efficiency of crop cultivation under the conditions of various regions in the country is still insufficient.

In our research, the economic efficiency of agricultural production has been evaluated through econometric methods. From this standpoint, the essence and nature of relative efficiency, its dynamics, and the prospects for agricultural production have been examined using statistical indicators.

Agricultural production efficiency reflects a socio-economic relationship related to obtaining the maximum amount of output from each hectare of land while minimizing labor expenditure. In general, the efficiency of agricultural production depends on the effective use of economically significant resources such as land, capital, labor, and entrepreneurial ability. Relative efficiency expresses the extent to which resources are used during the expansion of production. It shows the degree of implementation of production relations in the presence of certain economic results.

Relative efficiency also includes elements of social development and ecological effectiveness aimed at improving living standards, ensuring maximum satisfaction of food needs with optimal production costs, and preserving soil fertility and environmental sustainability.

The relative efficiency of agriculture has been studied by many local scholars. According to Academicians V. Qobilov and S. G‘ulomov, the multilevel modeling of agricultural management and its scientific concept emphasize the rational use of land-water and other resources in the production, processing, and sale of agricultural products and raw materials. The methodological foundations of econometric modeling in the development of national economic sectors have also been explored in the works of S. G‘ulomov.

Agriculture is a strategic sector of Uzbekistan’s economic system, accounting for 38.5% of the gross domestic product. As noted in the dissertation, about 4.2 million people are employed in the sector. The dynamics of crop yields, resource efficiency, and regional specialization have become major issues of state policy. The classical theory of comparative advantage by Adam Smith and David Ricardo is highly applicable to agriculture.

According to statistical data (Surkhandarya–Kashkadarya comparison):

| Region | Wheat (thousand tons) | Vegetables (thousand tons) |
|---|---|---|
| Surkhandarya | 670 | 915.3 |
| Kashkadarya | 744.1 | 495.9 |

These figures clearly show that Kashkadarya has a comparative advantage in wheat production, while Surkhandarya has an advantage in vegetable cultivation.

Multiple internal (land quality, soil fertility, labor skills, technical equipment, agronomic measures) and external factors (climate change, government policy, market prices, global demand, energy prices) influence agricultural efficiency. These factors jointly shape the production model.

Using the statistical grouping method, regions can be differentiated by their level of resource utilization. Surkhandarya holds an advantage in irrigated lands, whereas Kashkadarya leads in mechanization. These differences allow scientifically justified crop placement strategies. Grouping results reveal that efficiency indicators are unevenly distributed across regions.

A multiple regression model plays an important role in determining resource efficiency. The equation

$$\mathbf{Y = \beta_0 + \beta_1 K + \beta_2 L + \beta_3 S}$$

evaluates production volume based on investment (K), labor (L), and land area (S). Statistical significance tests (t-statistics, p-values) reveal which factors have the greatest impact. Research results confirm that investment and land area have the strongest influence on production output.

In forecasting statistical models, the Holt–Winters method is among the most effective tools for projecting agricultural production, as it accounts for seasonality, trends, and random variations. Using smoothing coefficients α, β, and γ, the model stabilizes time-series data and provides accurate forecasts. Based on 10-year data from Surkhandarya and Kashkadarya, forecasts for 2026–2027 reveal a positive trend, indicating stable growth and improved resource utilization.

The results of these models are crucial for crop placement, water resource planning, and investment policy. In conclusion, future policy should focus on managing rising production costs by leveraging market price growth to ensure profitability and sustainability in the agricultural sector. Scientific analysis of the factors affecting efficiency creates opportunities for implementing unified state, scientific, technical, and investment policies in agriculture and food security, integrating sectoral information systems into a unified “Digital Agriculture” platform, establishing one-stop service systems for producers, and improving the quality of life in rural areas.

**References:**


1. Ricardo, D. (1817). *On the Principles of Political Economy and Taxation*. London: John Murray.
2. Smith, A. (1776). *The Wealth of Nations*. London: W. Strahan and T. Cadell.
3. Qobilov, V., & G‘ulomov, S. (2005). *Agricultural Management and Multi-level Modeling*. Tashkent: Science Publishing House.
4. G‘ulomov, S. (2010). *Economic Modeling and Econometric Methods in Sectoral Development*. Tashkent: Economics Publishing.
5. United Nations Food and Agriculture Organization (FAO). (2022). *Agricultural Productivity and Resource Efficiency in Developing Countries*. Rome: FAO Publications.
6. World Bank. (2023). *Uzbekistan Agricultural Sector Review: Productivity, Resource Use and Market Integration*. Washington, DC: World Bank Group.
7. Ministry of Agriculture of Uzbekistan. (2023). *Statistical Yearbook of Agriculture*. Tashkent: Ministry of Agriculture.
8. Statistical Agency under the President of the Republic of Uzbekistan. (2023). *Regional Agricultural Output: Surkhandarya and Kashkadarya*. Tashkent: Statistics Agency.
9. Holt, C. C., Modigliani, F., Muth, J., & Simon, H. (1960). *Planning Production, Inventories, and Workforce*. New Jersey: Prentice-Hall.
10. Winters, P. R. (1960). Forecasting sales by exponentially weighted moving averages. *Management Science, 6*(3), 324–342.