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Multi-Season Optimization Of Farm Production In The Context Of Water Scarcity

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Abstract. In today's world, especially in the context of the pandemic, the problem of providing the population with quality and safe food is relevant, and in this regard, it is important to increase agricultural production. Therefore, the article describes the implementation of modern innovative management strategies based on multi-stage optimization of the production structure of agricultural farms, radical improvement of organizational and economic mechanisms of farm production processes, assessment of the impact of exogenous and endogenous factors on water production, water resources. farm production in times of shortage, in which the development of proposals and recommendations for the efficient use of water.

Purpose - Development of scientific proposals and practical recommendations for optimal development based on the strategy of diversification of farm production.

Design/methodology/approach -The research used statistical analysis, empirical evaluation, economic-mathematical, regression and correlation analysis, factor analysis methods.

Originality/value - The appropriateness and originality of the approaches and methods used in the study are determined by the fact that the statistical data are based on the data of the State Statistics Committee of the Republic of Uzbekistan and other officially published practical data and the relevant conclusions, recommendations are implemented by relevant organizations.

Keywords: farms, diversification, econometric analysis-econometric model, optimization, efficiency.

Introduction

In order to meet the demand, agriculture will need to produce almost 50 percent more food, feed and biofuels in 2050 than in 2012, according to the FAO's latest estimates from the United Nations (UN). As production expanded by 15% in 2005/07 and 2012, demand for agricultural products is expected to increase by approximately 63% from 2013 to 2050 [21]. In this regard, in developing countries, diversification of agricultural production as an important strategy is used as one of the mechanisms for household food security and poverty reduction.

Interest in agricultural diversification as an alternative to development in the global economy is due to a variety of factors, including the sudden pandemic and moderate recovery in global growth, the failure of many unexpected geopolitical conflicts, risks to financial stability and catastrophic weather shocks, trade tensions and Focusing on diversifying farm production in overcoming problems such as rising food prices [22] The development of scientific proposals and practical recommendations to improve the scientific and methodological framework for increasing the global prestige of farms is one of the current issues.

In the context of rapid socio-economic reforms in the Republic of Uzbekistan, large-scale work is being carried out in our country to strengthen the material and technical base of agriculture, and most importantly, to increase the efficiency of the farming movement, which is becoming an increasingly decisive force in the country's development. The presence of elements of risk and uncertainty in the context of market relations requires the use of multi-criteria optimization methods in agricultural production. Therefore, the efficient use of scarce water resources necessary for the national economy of the country and the acceleration of work on optimal development on the basis of the strategy of diversification of agricultural production based on the creation of optimization models reflecting the production structure of agricultural enterprises.

Literature review

Theoretical and methodological bases of agricultural economics management, development of multi-sectoral economy in rural areas, theoretical and methodological problems of using scarce resources in agriculture were studied by foreign scientists M.D. Boexli [1], D.D. Osborn [2], P.D. Barry. [3], E. Castle [4], Ian Hodge [5], R. Gasson [6], R.-E.Stake [7], Defra [8], D.North [9] and others. mentioned

CIS economists VA Kundius [10] VI Butov, VG Ignatov, NO Ketova on scientific developments and practical problems in studying the development of economic and mathematical modeling and trends in improving the economic efficiency of agricultural production [10] [11] D.D.Boldorjiev [12], A.G.Granberg [13], V.Demyanenko [14], N.P.Ketova [15], E.Serova [16], V.Ya.Uzun, Sufficient attention is paid to the works of R.I. Schniper [17], V.A. Uspensky [18] and A.K. Yasterebova [19].

Some aspects of the formation and development of agrarian relations, the study of problems of agricultural production in agrarian markets in a market economy in the agricultural sector of the economy, the effective application of economic-mathematical and econometric methods in agricultural enterprises [20]. is of great theoretical and practical importance in finding the most effective ways to improve utilization and reduce production costs. However, it should be noted that a separate study on the optimal use of scarce resources in the sustainable development of agriculture using multidimensional optimization methods and on this basis to increase the productivity of farms and dehkan farms has not been fully studied and determines the relevance of the chosen topic.

Research method

The analysis of complex economic objects with a number of different characteristics leads to the need to introduce the concepts of local and global optimality criteria. At the same time, the global criterion is mathematically constructed in the form of a scalar objective function, which generalizes the objectives in different directions and represents a set of non-adjacent specific objective functions (local criteria) in the form of a vector function.

Contradictory optimization criteria are used in the formulation of multivariate optimization problems. For example, 2 or more criteria are involved in an issue at the same time: maximizing profits, minimizing costs, and so on.

The concept of Pareto optimality is used in solving multidimensional optimization problems.

Pareto optimality is that it is not possible to improve the value of one criterion without degrading the value of at least one of the remaining criteria.

The mathematical model of the multivariate optimization problem is constructed as follows:

It is required to find the optimum for the criteria K:

$$y = f(x) = (f_1(x), f_2(x), \dots, f_K(x)) \to opt \qquad (1)$$

$x = (x_1, x_2, \dots, x_N) \in X$ - A vector solution that satisfies M boundary conditions.

$y = (y_1, y_2, \dots, y_K) \in Y$ - target function vector.

However X solutions space, Y while the target space or criteria space.

$g(x) \geq 0$ - boundary conditions define a set of possible solutions to the problem.

In addition, a number of other definitions and concepts are introduced in the problem of multivariate optimization.

It was possibleDcollectiong (x) satisfying boundary conditionsxis defined as a set of vector solutions, ie,

$$D = \{x \in X \mid g(x) \geq 0\} \qquad (2)$$

In this case, the image of D - the possible area in the target space is defined as follows:

$$Y_f = f(D) = \bigcup_{x \in D} \{f(x)\} \qquad (3)$$

In the dissertation work, one of these methods, the method of sequential concessions (method posledovatelnyx ustupok) is studied in detail.

The essence of this method is that all local criteria are pre-divided into colors in terms of importance. Then the best solution is found on the most important criteria. In the next step, the best solution is found for the next important criterion, while the value of the first important criterion is reduced to a predetermined amount, i.e., the first criterion is given a side.

Thus,F1The criterion is the main criterion andF1 ,..., Fms become less important. First in importanceF1the criterion is minimized and its minimum valueF_{1min}determined.

ThenF1criteriaΔ1≥0 the possible reduction value of the concession is determined andF2the smallest value of the criterion is sought.F1the criterion is introduced as an additional boundary condition.

This process is continued until the value of the concessions set by the decision maker is reached and an optimal solution is obtained.

Thus, the optimal solution is the solution obtained at the very end of the following sequence:

1) F_1 min=min $F_1(X)$, $X \in D$;

2) F_2 min.=min $F_2(X)$, $X \in D$, $F_1 \leq F_1 \min + \Delta_1$;

etc.

m) F_m min.=min $F_m(X)$, $X \in D$, $F_i \leq F_i$ min+ΔI, i=1,2,...,m-1.

The leading criterion method is used to minimize the full cost in the implementation of the business plan for the production of various products, to maximize the production of a set of products when limiting the resources used, and to address a number of other issues.

Results

The large-scale reforms implemented during the years of independence of the Republic of Uzbekistan have become an important basis for strengthening national statehood and state sovereignty, security and law and order, inviolability of borders, rule of law, human rights and freedoms, interethnic harmony and religious tolerance. forgiveness has created the necessary conditions for the realization of the creative potential of our citizens.

Our country maintains a stable high growth rate of GDP due to maintaining macroeconomic balance, deepening structural and institutional changes on the basis of the adopted medium and long-term programs.

In particular, the current structure of the gross regional product of the Syrdarya region of the Republic of Uzbekistan (hereinafter - GRP) shows that the last twelve years (2008-2019) have shown a stable trend. In particular, due to the steady growth of 111.1% in 2018, 110.1% in 2019 and 103.6% in 2020 due to the global pandemic, this figure is expected to reach 105.2% by the end of 2021.

The study addressed the issue of multidimensional optimization of production processes of agricultural enterprises in the Syrdarya region of the Republic of Uzbekistan. According to him, the target criteria are the maximization of profits (F1) and an alternative criterion is the minimization of water consumption (F2).

The boundary conditions in question are arable land (ha), labor costs (man / day), mineral and organic fertilizers (t / ha), water resources (m^3 / ha).

Economic-mathematical model of multivariate optimization problem:

Objective function:

The first local criterion

$$F_1 = \sum_{j=1}^{n} C_j \cdot X_j \to \max$$

The second local criterion

$$F_2 = \sum_{j=1}^{n} V_j \cdot X_j \to \min$$

Boundary conditions

$$\sum_{j=1}^{n} a_{ij} \cdot X_j \le A_i$$

Non-negative condition of variables

$$X_j \ge 0$$

Based on the method of consecutive concessions, the problem was solved on 10 options.

Initially, it was determined how much water resources would be saved by reducing farm profits from 1 percent to 6 percent.

In the following options, the profitability of agricultural enterprises is determined by increasing their resources.

The optimal point of convergence of the two criteria is that the profit of agricultural enterprises amounted to 898.36 billion soums. soums. Further reduction in profits will not lead to a reduction in water resources. This is the saturation point.

All agricultural products (potatoes, rice, tomatoes, cucumbers, carrots, fruits, melons) are in demand, except for cotton (due to the existence of a state order, it has permanent arable land). The solution to the problem is given in Table 1 below.

Table 1 Options for optimizing the production structure of farms in the Syrdarya region[1]

Options for maximizing farm profits				
1	**2**	**3**	**4**	**5**
$F_1^* = 995{,}65$ $F_2 = 4{,}005$	$F_1^* - 0{,}02F_1^* = 975{,}74$ $F_2^{*1} = 4{,}005$	$F_1^* - 0{,}03F_1^* = 965{,}78$ $F_2^{*2} = 3{,}63$	$F_1^* - 0{,}05F_1^* = 945{,}88$ $F_2^{*3} = 3{,}47$	$F_1^* - 0{,}06F_1^* = 898{,}36$ $F_2^{*4} = 3{,}05$
Options for minimizing water consumption on farms				
6	**7**	**8**	**9**	**10**
$F_1 = 398{,}36$	$F_1^{*1} = 499{,}9$	$F_1^{*2} = 507{,}1$	$F_1^{*3} = 521{,}38$	$F_1^{*4} = 995{,}65$

[1]Developed by the author

$F_2^* = 1{,}668$	$F_2^* + 0{,}02F_2^* = 1{,}702$	$F_2^* + 0{,}03F_2^* = 1{,}71$	$F_2^* + 0{,}05F_2^* = 1{,}75$	$F_2^* + 1{,}4F_2^* = 4{,}005$

The analysis of Table 1 shows that when solving the problem of maximizing the profitability of farms, the total profit of farms in the region amounted to 995.65 billion soums. soums. At the same time, water consumption on farms amounted to 4,005 thousand m^3.

Using the sequential side-by-side method of multi-criteria optimization, it is calculated how much water resources can be saved by consistently reducing farm profits by 1 percent. If the profits of farms in the region are reduced by 1%, the consumption of water resources will decrease by an average of 0.375 thousand m3 to 3.63 thousand m3. This process was carried out to reduce farm profits by 6%. As a result, the consumption of water resources was saved on average up to 0.955 thousand m^3. Further reduction of farm profits will not lead to water savings. Because:

- First, the optimal level of irrigation of all types of agricultural crops has been achieved, and saving water resources can lead to a decrease in crop yields;

- Second, the basic microeconomic law, ie the law of diminishing returns, was identified. Accordingly, a decrease in one resource (farm profit) leads to a change in another resource to a certain extent, and any subsequent reduction in it does not affect a change in another resource.

Discussion

As a result of addressing the issue, which is the opposite of the issue discussed above, we have identified how the increase in water resources can affect the benefits of farms? To do this, we increased the consumption of water resources by 1% in each option. In the initial solutions, the profit of farms amounted to 499.9 billion soums. soums. In the last option, ie when the consumption of water resources by farms is increased by 14% compared to the optimal option, the maximum level of profit in the optimal solution of the problem is 995.65 billion. soums.

It is necessary to develop the practice of directing investments of commercial banks in the formation of corporate structures in the form of holdings and industrial clusters and the financing of projects in them through the integration of manufacturing enterprises in the national economy. Particular attention should be paid to the involvement of technologically and cooperative enterprises engaged in the production of competitive high-capacity products in domestic and foreign markets, as well as the introduction of projects aimed at covering all stages of reproduction and increasing the financial and production capacity of enterprises.

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