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Imitation Model of Activity of the Industrial Complex

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Abstract: ***In order to improve the management of the silk industry of the republic, deepen market relations and increase the export potential of enterprises of the silk complex, a simulation model of the silk complex has been developed. The article discusses the development of models and algorithms in order to predict the structure of the feed base for sericulture, the production of grains and cocoons consisting of several blocks.***

Keywords: ***imitation model, optimization, silk complex, development of model, linear model.***

I. INTRODUCTION

The main objectives and areas of activity of the Association “Uzbekipaksanoat” are determined to improve the nutritional base of sericulture based on effective interaction with the relevant government bodies and local executive authorities on the provision of irrigated land to strengthen the forage base of the industry.

Particular attention is paid to the production of grills and silkworm cocoons, harvesting and their primary processing by introducing highly productive breeds and hybrids of the silkworm, establishing production of high-quality grills, modernizing existing and creating new raw silk production facilities, and organizing the deep processing of silkworm cocoons.

In increasing the efficiency of sericulture, an important role is played by an increase in the volume of selected grains and the strengthening of the forage base, an improvement in the mulberry's work plantation and the establishment of new mulberry plantations. The specific structure and dynamic development of the silk industry cause certain difficulties in implementing forecasts for the structure of the nutritional base for sericulture, the volume of grains and cocoons. There can be various variants of forecast calculations [1], which complicates management decision making.

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For optimal functioning of the silk complex, it is advisable to use information technology, which includes mathematical models, an information base, and a complex of computer programs [2]. To solve this problem, models and algorithms have been developed to predict the structure of the feed base for sericulture, the production of grains and cocoons consisting of several blocks.

II. SIMULATION MODEL OF THE PRODUCTION COMPLEX

At the current time *t*, the types of activities (development strategies) of enterprises are selected. This process is described using boolean variables. $\delta^{П}_{кб}, \delta^{П}_{г}, \delta^{П}_{к}, \delta^{П}_{ш}, \delta^{К}$ и $\delta^{И}$, taking the value 0 or 1, depending on the made choice.

Introduction of these variables is due to the need to display the property of adaptability of the enterprise: it can choose either an alternative or a mixed strategy from the listed set of activities. Accordingly, we can assume that the enterprise model uses a flexible production function, which allows to display changes in the specialization of the object under consideration. In the formulas below, for zero values of these variables, production volumes and costs assume a zero value, which corresponds to zero profit for this type of activity, for their single value, these indicators are calculated.

Block 1. Consumption of a silk complex.

Consumption function consists of a structural equation

$D = \lambda_1 + \lambda_2 П + \lambda_3 П_{-1} + \lambda_4 (W' + W'')$,

where

D - consumption;

$П$ - profit;

$П_{-1}$ - profit for the previous period;

W' - ages in the agricultural sector of the silk complex;

W'' - wages in the industrial sector of the silk complex.

The payroll function consists of a structural equation

$W = \gamma_1 + \gamma_2 (Y + T) + \gamma_3 (Y + T)_{-1}$.

Here

Y - silk production;

T - indirect taxes.

Identity

$Y + T = D + I$,

where I - investment.

Block 2. Education resources.

The developed dynamic model of the problem includes the choice of a scientifically grounded optimal scheme and the type of planting, taking into account the grade and natural loss of the mulberry stands, expressed in the dynamic development of this process.

$$\begin{cases} \dot{F} = -Fh - S^{+} \\ \dot{F}_1 = Fh - S^{-} \end{cases},$$

Where

F - is the expected area of exploited plantations;

F_1 is the area occupied by mulberry plantations to be written off;

S^{+} is the area of exploited plantations;

S^{+} id the area of plantations not suitable for further exploitation;

h - Heavyset function.

Block 3. Resource allocation

The activities of the silk complex are formalized in the following paragraphs.

1. The distribution process, carried out by the silk complex, is represented in the form of n activities, each of which is associated with a specific type of production (food supply, greening, cocoons, silk product).

2. Each activity is described by a column vector A_j, components of which characterizes the result of activity and the cost of resources for the production of a unit of production.

3. As an indicator of the result of production selected profit from the sale.

4. For the production of the silk complex, m types of resources are allocated. In aggregated form, they can be divided into labor, material and energy. The amount of resource type *i* is indicated by $b_{i.}$

In the conditions of limited resources, an activity with less resource-intensive activities are considered effective.

Taking into account the formalization made, models for the distribution and redistribution of resources have been proposed, taking into account obtaining maximum profit:

a) Linear model of resource allocation. The system activity indicator is described by the view function

$$F(x) = \sum_{i=1}^{n} a_{ij} x_j, i = 1.$$

At the same time, the conditions of limited and full use of resources are expressed in the following form:

$$\sum_{j=1}^{n} a_{ij} x_j = b_i, i = 2,3,...,m.$$

Nonnegative values of variables:

$x \geq 0$.

Required to find a vector of non-negative intensities $x = (x_1, x_2,..., x_n)$ areas of activity of the subsystem that provides the specified value of the indicator F, subject to the use of all allocated resources.

To solve the problem, a computer program for the implementation of a linear model has been developed.

b) Model of optimal resource allocation.

Optimality criterion:

$$F = \sum_{i=1}^{n} a_{ij} x_j \rightarrow \max, i = 1.$$

Limiting conditions:

$$\sum_{i=1}^{n} a_{ij} x_j \leq b_i \ .$$

Non-negative values of variables:

$x \geq 0$.

To implement the model developed software. As a result of the implementation, solutions are found for different values of resource constraints.

Block 4. Production activities

The output of the silk complex products is denoted by Q, which can be described using the production function with full interchange of resources.

$$Q = F(x_1, x_2,..., x_n) = \sum_{i=1}^{n} a_i x_i \ ,$$

Where x_i is resources for forage.

Cocoon production can be described by a neoclassical production function.

$$Q = F(x_1, x_2,..., x_n) = \prod_{i=1}^{n} x_i^{a_1}, \sum_{i=1}^{n} a_i \leq 1 .$$

Production of silk products is described by the production function, taking into account the full complementarity of resources:

$$Q = F(x_1, x_2,..., x_n) = \min \left\{ \frac{x_1}{a_1}, \frac{x_2}{a_2},..., \frac{x_n}{a_n} \right\}.$$

III. INFORMATION SUPPORT OF THE SILK COMPLEX

To implement the models, an information and dialogue system (IDS) has been developed, which contributes to the following functions:

- database maintenance;
- choice of a specific strategy for finding the area for new plantings and the cancellation of the area occupied by mulberry stands not suitable for further exploitation;
- selection of a scientifically-based optimal scheme and type of planting, taking into account the grade and natural decline of mulberry plantations;
- forecast of the production of grains and cocoons.

Maintaining a database is designed to create and update user databases in the form of sets of documents. It includes modules:

- access password analysis;
- download data to the information database;
- data correction in the information base;
- view data in the information database;
- print data from the information database;
- delete data from the information database.

Criteria for the effectiveness of the introduction of IDS are:

- Significant reduction in the timing of input, accounting and information processing;
- Operational formation and visual presentation of input information;
- improving the efficiency and efficiency of the submission of reference and summary documentation;

- Operational formation and visual presentation of output documentation.

IV. RESULT ANALYSIS

The following requirements should be met in the development of the simulation model:

- the area occupied by mulberry trees of different varieties and different ages, also planted in two ways, should be equal to the entire nutrition area;

Table I. Forecast indicators of the development of the forage base of the cocoon industry in the republic

Indicators	2021	2022	2023	2024	2025
Nutrition base: mulberry plantations (%)					
White (1-5 years)	9,0	4,9	5,9	8,6	9,3
Hibryd (1-5 years)	13,0	13,0	135,2	13,0	14,0
White (6-10 years)	8,9	8,7	8,3	8,1	8,9
Hibryd (6-10 years)	53,2	5,0	50,9	59,6	5,4
White (11-15 years)	7,1	7,0	7,8	8,6	8,5
Hibryd (11-15 years)	5,7	5,3	5,9	5,5	5,2
White (16-20 years)	6,0	6,4	7,9	7,3	7,8
Hibryd (16-20 years)	4,2	4,8	4,0	4,4	4,7
White (21-30 years)	8,2	8,9	8,6	8,9	8,1
Hibryd (21-30 years)	5,0	5,0	5,9	5,7	6,6
Mulberries planted in one row (%)					
Хасаки (1-5 years)	2,1	2,0	2,3	2,4	2,6
Hibryd (1-5 years)	15,6	15,0	15,0	15,8	15,6
Хасаки (6-10 years)	9,1	9,2	9,5	9,8	9,0
Hibryd (6-10 years)	6,1	6,7	6,2	6,6	6,0
Хасаки (11-15 years)	8,1	8,3	8,5	8,7	8,9
Hibryd (11-15 years)	5,8	5,9	5,7	5,7	5,2
Хасаки (16-20 years)	7,3	7,3	7,4	7,5	7,6
Hibryd (16-20 years)	5,8	5,7	5,2	5,4	5,5
Хасаки (21-30 years)	9,9	9,2	9,5	9,8	9,8
Hibryd (21-30 years)	6,8	6,6	6,5	6,3	6,3

Table II. Prediction of industrial indicators of the main products in silk nets in Uzbekistan

Indicators	2019	2020	2021	2022	2023	2024	2025
Nutrition base (mulberry trees)	14,3	12,1	12,4	12,5	11,6	13,3	15,5
	8	9	8	8	7	4	8
Wet cocoon	8	6	8	2	14	1	,3
Dry cocoon	6	7	7	7	6	6	8
Immature cocoon	8	11	12	8	5	6	7
Silk yarn	8	9	11	12	9	5	6
Finished Fabrics	11,5	12,2	12.4	11,8	11,7	11,7	13,3

- mulberry leaves from the nutrition area should feed existing silkworms;
- the total workforce required for the production of cocoons should not exceed the existing workforce;
- the amount of investment allocated for the production of cocoons should not exceed the current amount of investment;
- the total amount of cocoons should not be less than the number of cocoons manufactured under the contract;
- the nutrition area of silkworms should not be less than the required standard area;
- all prepared wet cocoon should be dried;
- the total amount of dry cocoons obtained from wet cocoons should not be less than the number of dry cocoons made under contract;
- the value of all variables must not be negative.

The imitation model has been implemented based on forecasts of the further development of the silk industry in 2021-2025 and results are obtained to determine the efficiency of cocoon production (see Table I and Table II).

V. CONCLUSION

Developed software allows silk industry specialists to carry out multivariate forecast calculations. On the basis of the developed models, it is possible to determine the optimal variant of the structure of the feed base, the forecast of the economic indicators of the production of greenery and cocoons based on computer technology. The principles of systemic development, standardization, compatibility, and efficiency were used in the development of SIDS. Therefore, it is typical and it can be used in all levels of management of the silk complex of the agro-industrial complex.

The developed simulation model allows simulation experiments, i.e. by varying the values of the control parameters; it is possible to obtain various lines of activity of enterprises, contributing to an increase in production efficiency.

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