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INNOVATIVE BUSINESS PROCESSES MANAGEMENT ASPECTS OF AGROINDUSTRIAL ENTERPRISES ON THE BASIS OF ECONOMIC-MATHEMATICAL SIMULATION

Questions of the economic and mathematical simulation of control of dynamic business-processes are examined. Basic approaches to the solution of the problems of optimal control in the multistage systems are investigated. The economic and mathematical model of the optimization of control of innovation processes in agroindustrial enterprises is developed.

Keywords: economic and mathematical simulation; optimal control; dynamic business-processes; innovation processes; control in agroindustrial enterprises.

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АСПЕКТЫ УПРАВЛЕНИЯ ИННОВАЦИОННЫМИ БИЗНЕС-ПРОЦЕССАМИ АГРОПРОМЫШЛЕННЫХ ПРЕДПРИЯТИЙ НА ОСНОВЕ ЭКОНОМИКО-МАТЕМАТИЧЕСКОГО МОДЕЛИРОВАНИЯ

Рассмотрены вопросы экономико-математического моделирования управления динамическими бизнес-процессами. Исследованы основные подходы к решению задач оптимального управления в многошаговых системах. Разработана экономико-математическая модель оптимизации управления инновационными технологиями на агропромышленных предприятиях.

Ключевые слова: экономико-математическое моделирование; оптимальное управление; динамические бизнес-процессы; инновационные технологии, инновации, управление на агропромышленных предприятиях.

Introduction. In today's market conditions, the economic condition of Ukraine, which has a significant share of the agricultural sector, largely depend on the effective planning and management of the enterprises activity of agroindustrial complex (AIC). A typical agro-industrial enterprise is a complex organizational and production system, elements of which are constantly changing and are in a complex interaction between each other.

The implementation of state acts and regulations (in particular, The concepts of scientific, technological and innovative development of Ukraine, Laws of Ukraine "On scientific and technical activity", "Programs of the Cabinet of Ministers of Ukraine and the Strategy for Sustainable Development" Ukraine-2020", "On innovative activity", "On priority directions of science and technology development"," On special regime for investment and innovative activity of technological parks", other laws of Ukraine [1—6]), requires the solution of improving their organizational and administrative activity on the basis of integrated automation and optimization of innovative technology (**IT**) management from the enterprises of agroindustrial complex of Ukraine. An effective solution of the related problems requires from the enterprises of agroindustrial complex of Ukraine to meet the new challenges to improve their organizational and management through integrated automation and optimization of innovative processes. Achieving the goals in the context of increasing competition among agricultural enterprises causes volume growth and increasing of production processes complexity, analysis, planning, management, internal and external relationships with suppliers, intermediaries, etc.

The effective solution of related problems with these processes is impossible without proper information of innovative technologies management in the agribusiness companies, implemented in the form of computer information management system [7]. The purpose of the system, first and foremost, is optimization the management of agricultural enterprises, which is based on a comprehensive study of the relevant dynamic processes within a certain period of time, and making management decisions for the enterprise, as well as on the development and implementation of appropriate economic and mathematical models, methods and algorithms for solving problems of adaptive management optimization in the conditions of risk and uncertainty with the use of modern information technologies [8].

The Law on the priority directions of innovative activity in Ukraine defines the legal, economic and organizational bases of formation and realization of the innovative activity priority directions [9], which gives an opportunity for the further development and implementation of innovative technologies in all sectors of national economy, including and the agro-industrial complex of Ukraine. Under this Law, innovative renovation of industrial, agricultural and service sectors with respect to development of new knowledge-intensive products and services with high competitiveness in the internal and external markets are defined as priority directions of innovative activity. According to the strategic priority directions of innovative activity in Ukraine for 2015—2020 years, the Supreme Council of Ukraine has declared high-tech development of agriculture and processing industry as a priority area of innovative activity at the national level [9].

Methodology and research methods. The concept of "innovative activity" is directly related to the concept of "innovation". In the economic literature, the term "innovation" is interpreted as the transformation of the potential scientific and technological progress in the real one, which is embodied in new products and technologies [4]. The innovative product is characterized by the highest level of technology, new consumer qualities of the goods or services compared to the previous product.

With due regard to USSR 31279-2004 innovation is the end result of the activities for the implementation of new or improved product in the market, technological process, organizational and technical measures used in practice. Innovative activity — the activity directed to the use and commercialization of the research and development results, launching process of new competitive goods and services [10].

Agroindastrial innovations include:

1) introduction of new technological processes of agricultural production;
2) introduction of new methods of production management;
3) reduction to practice of the new crops production;
4) introduction of new technologies of agricultural products processing and others.

Technology — a set of methods and tools to achieve the desired result; method of resources converting into the desired product. The purpose of technology is the production of the product, for example material technology creates a material product. The technology is called the description of production processes, instructions for their implementation and technological rules, requirements, maps, graphs, etc.

The main goal of any technology as a subject of activity is to identify the physical, chemical, mechanical and other trends to identify and use in practice the most efficient and economical manufacturing processes, requiring the least amount of time and material resources. Thus, bases of technological processes design (types of processing, choice of raw materials, the processing quality, etc.), methods of mechanical processing of raw materials, manufacturing methods of different types of products, product storage processes, biologization of crop production technologies and management of productive plant processes, the introduction of a "closed" (non-waste) technology on dairy, pig and poultry farms that will provide an opportunity to minimize or completely eliminate waste production and to implement measures to improve the ecological purity of the product and a healthier environment are the subject of the research and development in agricultural technology.

Organization of the research. Having said the above, the rationale of the research is determined by the fact that in the new conditions of the global and domestic economy, which are characterized by the dynamics of innovative processes at enterprises, including the agricultural sector, new holistic concepts, mathematical models, methods and algorithms for dynamic optimization of innovation processes adaptive management, which are based on modern economic and mathematical models and information technologies are needed.

Results and discussion. Issues of economic and mathematical simulation and optimal management of the economy have been studied by many scientists. However, despite the variety of works devoted to the management of the company, the existence of various economic and mathematical models and methods for developing of optimal solutions, business process modeling methodologies, the economic and mathematical simulation problem of IT management optimization at agribusiness enterprises has not been solved yet. Therefore, the development of economic-mathematical model of innovative process management optimization at agribusiness enterprises is a relevant topic for the research.

Discrete economic and mathematical models and methods of management are increasingly becoming important in the theory and practice of various economic systems and processes optimization. This is due to the fact that many phenomena in economy have discrete nature, as in practice information on the state of the system; its processes and management are carried out at discrete points in time, step by step. Modelling of the dynamics of the economic system based on differential equations is based on a fairly approximate description of real economic phenomena and does not give the edge on the use of discrete multi-step equations. As a result, the economic system dynamics equations are often formalized from the outset in a discrete multi-step form. Time in such models is considered to host the final series of discrete numeric values with the specified initial point t_0, the interval between any two neighboring time points equal τ and end time point T. As usual, we suppose: $t_0=0$, $\tau=1$ and then time takes only integer values. In this case, for the description of the system (object) we use multistage discrete (recursive) equation

$$x(t+1) = f(t, x(t), u(t)),\ t \in \overline{0,T-1} = \{0,1,\ldots,T-2,T-1\} \tag{1}$$

providing that

$$x(0) = x_0, \tag{2}$$

where $x(t) \in \mathbf{R}^n$ is a phase vector object $(t \in \overline{0,T})$; $u(t) \in \mathbf{R}^p$ is an input control $(t \in \overline{0,T-1})$; $f\colon \overline{0,T-1} \times \mathbf{R}^n \times \mathbf{R}^p \to \mathbf{R}^n$ is a vector-function, for example, continuous in all its variables; $\mathbf{R}^k$ – k-dimensional vector space.

Then the multi-step recurrence relation (1), together with the initial condition (2) and restriction of control, having the form

$$u(t) \in U(t),\ U(t) \subset \mathbf{R}^p, \tag{3}$$

as well as a restriction on the final state of the system

$$x(T) \in X(T), \tag{4}$$

give a dynamic description of the corresponding object behavior, for example, the considered economic system.

As a quality criterion or an objective function in management optimization issues for systems of type (1) — (4) so-called terminal functional is usually considered $F{:}\mathbf{R}^n \to \mathbf{R}^1$, where values for all final states of the phase vector is $\bar{x}(T) = x_{u(\cdot)}(T) \in \mathbf{R}^n$, corresponding to admissible realizations of the input control $u(\cdot) = \{u(t)\}_{t \in \overline{0,T-1}}$, $(\forall\, t \in \overline{0,T-1},\ u(t) \in U(t))$ at the predetermined time interval $\overline{0,T}$, forming by virtue (1)–(4), are determined by the formula

$$F(x_{u(\cdot)}(T)) \;=\; g(\bar{x}(T)), \tag{5}$$

Where the function $g : \mathbf{R}^n \to \mathbf{R}^1$ is, for example, continuous or differentiable as a function of many variables.

There are the following main approaches to research management optimization problems in such multistep systems.

The first approach is based on the Bellman optimality principle and leads to the necessity of solving functional equations of a special type. Advantages and possibilities of dynamic programming, developed on the basis of this approach are well known, and it is adequately reflected in the literature [11—14].

The second — variational approach, which is based on the dissemination of ideas and methods of mathematical programming in multi-step tasks and merges with the maximum principle of
L.S Pontryagin, developed for solving optimal control problems in differential systems (continuous-time). This approach is commonly referred to as "a discrete maximum principle".

It is known that mathematical programming is associated with the tasks of efficient using and allocation of scarce resources, which are reduced to finding the conditional extremum of functions of several variables with constraints in the form of equalities and inequalities. In mathematical programming effective computational methods are developed to solve extreme tasks with a large number of variables and constraints on them. The above is also true of linear programming tasks, which methods are widely used for economic-mathematical modeling and has had a strong impact on other areas of mathematical programming theory.

As for the theory of mathematical programming, and for the main range of its applications a one-time, one-step choosing of the optimal solution (for example, the distribution of the program release of the needed products among several production centers, finding of the best transportation plan, the choice of an optimum variant of technology, different kinds of networks calculating, industrial enterprises placement planning, and so on.) is characterized. Note that such models and tasks are statistical tasks of constrained optimization.

However, as soon as there is a question about the development of the system (and not only in time but also in space), the management of the dynamic system, its one-step description (modeling) becomes of little use for most real practical tasks of the economy. In such problems, a decision should be made on a certain number of steps forward in time and optimization problem becomes a multi-step, dynamic. Note that this kind of problems includes, for example, long-term and operational planning tasks at the agro-industrial complex enterprises and technological processes management at the agroindustrial complex enterprises [15].

It is known that the changing nature of the problem we change and its problems. So if for one-step task the finding of the optimal solutions has basic meaning, for the multi-step tasks, along with the finding of the most optimal development program system, it is important its practical implementation, the realization of the management process.

Thus, the theory analysis and solving of multi-step optimization problems should be based on the mathematical programming theory and optimal management theory.

Of course, any multi-step task can be viewed as statistical, and to solve it we can use, for example, mathematical programming methods. However, the direct application of these methods for solving multi-step problems usually does not lead to the goal: the resulting tasks of linear or non-linear programming are often have so large dimension that they cannot be solved even with the help of modern computer technology. So here we need to develop special methods that take into account the dynamic nature of these problems and their specificity, for example, the economic content, as well as the possibility of the effective computer implementation of the simulation process and real control.

The process of the optimal functioning of economic systems is multifaceted; it includes the organization of the optimum control and planning process, monitoring and operational management of the progress, economic instruments of optimal economic activities development, and the methods of the vertical and horizontal links in the system, etc. However, the starting point of the optimal functioning of the economic system is, of course, scientifically organized process of the development and implementation of optimization economic and mathematical models. The main features of this process can be identified on the basis of the general principles of optimality with account of the hierarchical economy structure, the concepts of local and global optimality criteria and systems of optimal prices.

Decision-making in an uncertain economic environment, as a rule, leads to the need to solve some problem of the best choice in terms of incomplete information about the system. A typical situation associated with decision-making in dynamic systems is the need to organize the control procedure in the terms of uncertainty. This procedure, aimed at achieving a particular management goal, it is often necessary to accompany with the optimization process, allowing to identify guaranteed, the best or acceptable in some sense result.

Note the differences between innovative technologies management model (ITM) and the production management model (PM) in the AIC:

1) ITM model — must take into account the parameters that describe the risk factors of innovation (vector of noise or uncertainty);

2) ITM quality criteria — more complex (vector) than the only earnings in the PM model;

3) the structure of the control parameter (vector) in the ITM model — may additionally have a "scenic informal form" (as in business planning), in contrast to the formal management in PM model, etc.

In ITM model we should consider the following basic parameters:

1) the dynamics of the system;

2) the vector describing the state of the system;

3) the vector describing the management system with the corresponding restriction on the management resource;

4) the vector describing ITM risks with the corresponding restriction on their implementation;

5) the vector of ITM processes quality;

6) information capabilities of the IT subject and others.

Go to considering of the general IT management system at AIC enterprises, which is modeled by a vector discrete (recursive) multistep equation of the form:

$$x(t+1) = A(t)x(t) + B(t)u(t) + C(t)v(t), \quad x(0)=x_0, \qquad (6)$$

where $t \in \overline{0, T-1} = \{0,1,2,...,T-1\}$ — period of time (month, quarter, year), when management selection carries out, $T>0$ is an integer;

$x(t) \in \mathbf{R}^n$ — phase vector characterizing the state of the system (presence of enterprise production volumes) in the period of time t; $n \in \mathrm{N}$ (where **N** is the set of all natural numbers);

$u(t) \in \mathbf{R}^p$ — vector of innovation management intensity (**IM**); $p \in \mathrm{N}$;

$v(t) \in \mathbf{R}^q$ — noise vector (risk of parameter, uncertainty or error modeling process); $q \in \mathbf{N}$;

$A(t), B(t), C(t)$ — matrix with dimensions $(n \times n)$, $(n \times p)$ и $(n \times q)$, respectively.

$A(t)=\|a_{ii}(t)\|_{i\in\overline{1,n}}$ — is a diagonal matrix that characterizes the "aging" of production during this period. $B(t)$ — "Technological matrix" of production; each j-th management method $(j\in\overline{1,p}=\{1,2,\ldots,p\})$ during the time $t\in\overline{0,T-1}$ $(T>0)$ is characterized by the vector $\{b_{1j}(t), b_{2j}(t), \ldots, b_{nj}(t)\}$;
if $b_{ij}(t) < 0$, then value $b_{ij}(t)$ determines the cost of i-th ingredient $i\in\overline{1,n}$ under j-th mode of production in the period t;
if $b_{ij}(t) > 0$, then value $b_{ij}(t)$ defines release of i-th ingredient under j-th mode of production in the period t.

$C(t)=\|c_{il}(t)\|_{i\in\overline{1,n},\, l\in\overline{1,q}}$ — boolean matrix defining the presence or absence of the noise vector effect (risk of parameter, uncertainty or error modeling process) on the values of the phase vector $x(t)$ in the time period t, i.e. on the process of the phase vector formation $x(t+1)$, where $c_{il}(t)\in\mathbf{R}^1$, $c_{il}(t)\in\{1,0\}$ $(i\in\overline{1,n},\ l\in\overline{1,q})$.

$\forall t\in\overline{0,T-1}$ containments are correct:

$$u(t)\in U_1,\quad v(t)\in V_1, \tag{7}$$

where U_1 — finite set in $\mathbf{R}^p$, i. e. finite collection of vectors in $\mathbf{R}^p$; V_1 — convex, closed and bounded polyhedron in $\mathbf{R}^q$.

Note that the containments of (7) limit the change of stimulus and noise in the system (6) on the considered interval control $\overline{0,\mathrm{T}}$.

Let us assume that $U(\overline{0,T})=\{u(\cdot): u(\cdot)=\{u(t)\}_{t\in\overline{0,\mathrm{T}-1}},\ \forall t\in\overline{0,\mathrm{T}-1},\ u(t)\in U_1\}$ – is the set of all software **IM** in the integer time interval $\overline{0,\mathrm{T}}$, and $V(\overline{0,T})=\{v(\cdot): v(\cdot)=\{v(t)\}_{t\in\overline{0,\mathrm{T}-1}},\ \forall t\in\overline{0,\mathrm{T}-1},\ v(t)\in V_1\}$ — is the set of all feasible noise realization in the time interval $\overline{0,\mathrm{T}}$.

Then for fixed and acceptable realizations of program management $u(\cdot)\in U(\overline{0,T})$ and noise $v(\cdot)\in V(\overline{0,T})$ in the time interval $\overline{0,\mathrm{T}}$, assume that $x_{\overline{0,T}}(T;x_0,u(\cdot),v(\cdot))$ — the final state (the state at time T) of the process trajectories generated by the system (1) and corresponding to the pair $(u(\cdot),v(\cdot))$. Let us assume that

$$G^{+}_{\overline{0,T}}(T;x_0,u(\cdot),V(0,T))=\{x(T): x(T)\in\mathbf{R}^n,\ x(T)=x_{\overline{0,T}}(T;x_0,u(\cdot),v(\cdot)),v(\cdot)\in V(0,T)\} \tag{8}$$

is the attainability domain [16], i. e., the set of all admissible final phase states of the system (1) corresponding to the fixed admissible program management $u(\cdot)$ $(u(\cdot)\in U(\overline{0,T}))$ and when feasible noise ranges $v(\cdot)\in V(\overline{0,T})$.

Quality of system management process (1) in the integer time interval $\overline{0,T}$ is estimated by the functional $\Phi(u(\cdot))$ whose values for fixed program management (*Innovation Management*) $u(\cdot)\in U(\overline{0,T})$ are calculated using the formula:

$$\Phi(u(\cdot))=\max_{v(\cdot)\in V(\overline{0,T})}\gamma(x_{\overline{0,T}}(T;x_0,u(\cdot),v(\cdot)))=\max_{x(T)\in G^{+}_{\overline{0,T}}(T;x_0,u(\cdot),V(0,T))}\gamma(x(T)), \tag{9}$$

where $\gamma:\ \mathbf{R}^n\to\mathbf{R}^1$ is the functional defined on the final phase vectors of the system (6), (7) assessing the quality of the IT at companies in the agro-industrial complex, modeled by the system (6), (7).

Then the task of **IT** software Min i max management at companies in the agro-industrial complex is formulated as follows: it is required to find the optimal program management $u^{(e)}(\cdot) \in U(\overline{0,T})$ satisfying the *minimax*:

$$\Phi^{(e)} = \Phi(u^{(e)}(\cdot)) = \max_{v(\cdot)\in V(\overline{0,T})} \gamma(x_{\overline{0,T}}(T; x_0, u^{(e)}(\cdot), v(\cdot)) = \min_{u(\cdot)\in U(\overline{0,T})} \max_{v(\cdot)\in V(\overline{0,T})} \gamma(x_{\overline{0,T}}(T; x_0, u(\cdot), v(\cdot)) =$$
$$= \max_{x(T)\in G^{+}_{\overline{0,T}}(T; x_0, u^{(e)}(\cdot), V(0,T))} \gamma(x(T)) = \min_{u(\cdot)\in U(\overline{0,T})} \max_{x(T)\in G^{+}_{\overline{0,T}}(T; x_0, u(\cdot), V(0,T))} \gamma(x(T)), \quad (10)$$

where $\Phi^{(e)} = \Phi(u^{(e)}(\cdot))$ is the *optimal minimax optimization result of the innovation process.*

We can consider the following specific types of γ functional under (9), (10):

1) $\gamma(x(T)) = \langle c, x(T) \rangle_n$ — vector dot product $x(t) \in \mathbf{R}^n$, corresponding to the fixed vector $c \in \mathbf{R}^n$, i. e.to use linear functional;

2) $\gamma(x(T))$ — convex function $\forall x \in \mathbf{R}^n$, i. e. to use convex functional.

As the criterion of the innovative processes integrated management optimization effectiveness at the enterprises of agroindustrial complex can be the total amount of its profits.

Summary. The dynamic model of innovative processes integrated management minimax optimization at the enterprises of agroindustrial complex allows to solve the forming problem of the optimal production program and the pricing policy of a particular AIC enterprise as the enterprise is interested in increasing the production of those products for which demand is increased and in the operational improvement of the production process of these products.

On the basis of the proposed dynamic minimax economic-mathematical model of **IT** management optimization at agribusiness companies it is possible to develop a variety of numerical methods for solving the minimax problem (10) and create a computerized information system of optimal management decision support.

Before starting the exploitation of such the development support system is also necessary to prepare input data and to generate constraints for dynamic models of **IT** management minimax optimization at agribusiness enterprises, which, along with the operational data, form the information basis for the operation of such the information system [17].

In this case, we consider the list of the required parameters:

– data on the used units of production volumes and raw materials;
– data on the nomenclative positions;
– data on the specifications;
– data on process chains;
– data on the territorial structure of the enterprise (including its divisions and affiliates);
– data on the production structure of the enterprise.

Modelling of processes to optimize management of agro-enterprises, their analysis and subsequent improvement in order to optimize **IT** is the main reserve for increasing of the competitiveness and efficiency of its work. It is also necessary to have tools that allow to collect and process the most complete and accurate information on the activities of all divisions of agro-industrial enterprises in the proposed common methodology.

List of cited sources

1. Концепція науково-технічного розвитку галузей агропромислового виробництва України на період до 2017 року (наказ М-ва аграр. політики України від 10 квітня 2012 р. № 240).
2. Про наукову і науково-технічну діяльність : Закон України від 13 грудня 1991 року №1977-XII.
3. План заходів з виконання Програми діяльності Кабінету Міністрів України та Стратегії сталого розвитку "Україна-2020" у 2015 році : Розпорядження Кабінету Міністрів України № 213, із змінами, від

22 липня 2015 р. // Офіц. вісн. України. 2015 р. № 60. Ст. 1981.

4. Про інноваційну діяльність : Закон України від 04.07.2002 № 40-IV.

5. Про пріоритетні напрями розвитку науки і техніки : Закон України від 11.07.2001 № 2623-III.

6. Про затвердження Програми розвитку інвестиційної та інноваційної діяльності в Україні : Постанова Кабінету Міністрів України № 389 від 02.02.2011 // Уряд. кур'єр. Офіц. вид. 2011. № 80.

7. Бабенко, В. О. Управління інноваційними процесами переробних підприємств АПК (математичне моделювання та інформаційні технології) : моногр. Х. : ХНАУ, Мачулин, 2014. 380 с.

8. Бабенко, В. А., Алисейко Е. В. Эффективное использование информационного ресурса при разработке стратегии инновационного развития Украины // Макроекономічне регулювання інвестиційних процесів та впровадження стратегії інновативно-інноваційного розвитку в Україні : матеріали міжнар. наук.-практ. конф. : у 3 ч. – К. : РВПС України, НАН України. Ч. 1. С. 353—356.

9. Про пріоритетні напрями розвитку науки і техніки : Закон України від 11.07.2015 № 2623-III.

10. Инновационная деятельность: толковый словарь. Термины инновационного менеджмента и смежных областей (от А до Я) / отв. ред. В. И. Суслов. 2-е изд., доп. Новосибирск : Сиб. унив. изд-во, 2007. 269 с.

11. Ашманов, С. А. Математические модели и методы в экономике. М. : МГУ, 1980. 198 с.

12. Лотов, А. В. Введение в экономико-математическое моделирование. М. : Наука, Глав. ред. физ.-мат. лит., 1984. 332 с.

13. Тер-Крикоров, А. М. Оптимальное управление и математическая экономика. М. : Наука, 1987. 216 с.

14. Погодаев, А. К., Блюмин, С. Л. Адаптация и оптимизация в системах автоматизации и управления : моногр. Липецк : ЛЭГИ, 2003. 128 с.

15. Бабенко, В.О. Концепція економіко-математичного моделювання управління інноваційними процесами переробних підприємств АПК // Бізнес Інформ. 2014. № 11. С. 130—133.

16. Шориков, А. Ф., Бабенко, В. А. Оптимизация гарантированного результата в динамической модели управления инновационным процессом на предприятии // Экономика региона. 2014. № 1 (37). С. 196—202.

17. Бабенко, В. О. Інформаційне забезпечення та моделювання оптимізації гарантованого результату управління інноваційними технологіями на підприємствах АПК // Агросвіт. 2012. № 14. С. 10—18.

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