Model of the agricultural engineering enterprise innovation program development

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Abstract. Changes in the economic and technological conditions of functioning of the agro-industrial complex of Russia impose new requirements on the production potential of agricultural engineering enterprises. It becomes necessary to implement innovative projects that create prerequisites for a successful transition of enterprises to the export model of activity. The solution of this task is possible only on the basis of the production of innovative technologies and equipment that increase labour productivity, reduce the costs of material and labour resources in the production of an enterprise of the agro-industrial complex. The paper proposes a mathematical model for the formation of an effective innovation program for an agricultural engineering enterprise. The main criteria for an effective innovation program were: maximization of the net, reduced result of the innovation program, compliance of the innovative technology and technologies (innovation projects) being implemented to the requirements of high energy efficiency, productivity (productivity). These criteria make it possible to assess the effect of integration as the main feature of strategic synergies achieved in the formation of an innovative program involving the implementation of mutually complementary innovative projects.

1. Introduction
Analysis of modern strategic planning tools [1-3; 5; 6; 7; 8] of innovation activity showed that the development of a corporate (portfolio) strategy for the innovative development of an enterprise is a methodological problem. In this regard, the article made an attempt to solve this problem on the basis of the development of a model for the formation of an effective innovation program of enterprises, which allows to determine the corporate strategy of investment development. In the face of increasing competition in domestic and foreign markets, the presence of synergistic effects should be an important feature of the innovative program being formed, among which the following ones can be determined: the development of core skills of research and development [2; 6; 9; ten; 11] new agricultural equipment, general image, etc. Under the strategic synergy in the agro-industrial complex, the authors will raise a long-term positive economic effect from the integration of special innovative projects. This effect is possible with the complementary effects of innovative projects involving the development and use of energy-saving, resource-saving equipment and technologies, technologies of breeding and keeping cattle and plants, increasing their productivity, the net economic result from their operation. It seems that the achievement of a positive effect of integration in the implementation of innovative projects in the agricultural sector is a prerequisite for the sustainable development of rural areas [5].
2. Stages and conditions for the formation of an effective agricultural engineering enterprise innovation program

The formation of an effective agricultural engineering enterprise innovation program is carried out with a centralized version of the financing of innovation. The centralized use of funds allows to expand the scope of ongoing innovations. Expanding the scope of implemented innovations (taking into account the adopted system of strategic target priorities of innovation and restrictions on the value of available funds) allows to increase the efficiency of utilization of scientific, technical, personnel, production and market potential of enterprises, to improve the projected economic result of innovation. Under the centralized option of financing innovation activity, such a composition of the innovation project portfolio is formed, which includes innovative projects that solve strategic development tasks for both individual business units and strategic development tasks for a set of business units.

The purpose of forming an effective investment program of an enterprise is to determine a corporate (portfolio) strategy that maximizes the economic result of an activity, while observing a certain risk standard to ensure the sustainability of investment development. Innovation risks are assessed by an expert method, based on the collection of information and the assessment of the overall risk for its components (types of risk). The formation of an effective innovation program should contribute to the effective use of limited funds of the trust fund (budget) of the organizational and technical development of the enterprise.

The initial base for the formation of an effective innovation program of an enterprise is made up of many acceptable innovative projects, i.e. projects that meet the requirement of the standard value of the project indicator ($NPV_{st}$), special requirements which are as follows:

- high performance (productivity);
- low energy intensity (cost);
- low resource consumption (raw materials, materials);
- high reliability of the main nodes of technical products, etc.

In order to determine the set of acceptable innovative projects, in terms of their ability to provide a given rate of return, a calculation is made of the calculated value of the project’s profitability - $NPV$ with the standard rate of return.

When meeting the requirement of a standard level of profitability $NPV_{calc} \geq NPV_{st}$ an innovative project $j$ is taken as acceptable. If the requirement for the normative level of profitability is not met, the Expert Commission (if agreed with the representatives of business units - the relevant strategic areas of agribusiness under consideration) excludes the innovative project in question from the list of effective ones.

Using $NPV_j$ indicator as a criterion for the selection of innovative projects allows you to get results and evaluate risk in monetary terms; has the property of additivity, which is a prerequisite for the formation of an effective innovation program that meets the requirements of ensuring strategic synergy. As a criterion for the formation of an effective innovation program, the criterion $NPV_p = \sum_{j=1}^{J} NPV_j$ for maximizing the economic result obtained in the operation of innovative agricultural machinery and technology was chosen.

The formation of an effective innovation program is carried out by the method of complete enumeration of innovative projects, formalized in the form of a linear programming problem. Given the discrete nature of the variables to be set, some limitations arise when solving a linear programming problem. These restrictions remove the replacement of each integer variable with boolean variables, since Any discrete programming problem can be written in Boolean variables [1; 3]. The proposed
model for the formation of an effective innovation program of enterprises is based on the implementation of the following algorithm of actions (figure 1).

A prerequisite for the formation of an effective innovation program is the compliance of the considered projects of the strategic agribusiness profiles with the requirement: $\sigma_{sp} < \text{NPV}_{ap}$ [4].

If this requirement is not fulfilled at the level of the Board of Directors of enterprises, a decision is made to refuse to form an effective innovation program (participation in the relevant strategic business profile).

**Figure 1.** The scheme of the algorithm of action in the development of an effective innovative program.
3. Mathematical formulation of the task of developing an effective innovation program

Let the Board of Directors (parent company) of the agricultural engineering holding company have the funds of a trust fund (budget) for organizational and technical development for the planning period in the amount of \( B + M \). The formation of a centralized development fund is carried out both at the expense of business units - \( B \) and at the expense of the head companies - \( M \), (centralized use of funds). The number of acceptable innovative projects - \( J \) that meet the established requirements of energy efficiency, increase productivity, etc. The total value of investment costs for innovative projects is limited by the size of the centralized fund for organizational and technical development (taking into account the limitations on the size of the Trust Fund (budget) for organizational and technical development of business units).

It is required to determine the composition and structure of an effective innovation program so that the volume of investment aimed at its implementation does not exceed the value of the trust fund (budget) of the organizational and technical development of the agricultural holding, while ensuring the creation of the maximum economic result of the innovation activity. At the same time, a limitation on the extent of risk is taken into account - compliance with the risk standard, compliance of the properties of the planned innovative projects with the specified requirements.

The formation of an effective innovation program is formalized as a linear programming problem:

\[
\sum_{j=1}^{J} NPV_j x_j \rightarrow \max_{x_j}
\]

\[
\sum_{j=1}^{J} I_j x_j \leq B + M : j = 1, J ;
\]

\[
\sqrt{\sum_{j=1}^{J} (\beta_j \sigma_{G})^2 + \sum_{j=1}^{J} \sigma_{Gj}^2 x_j^2} \leq R,
\]

where \( x_j^2 \) – Boolean indicating whether \( j \) project is planned for implementation (if \( x_j^2 = 1 \), then it is planned; if \( x_j^2 = 0 \) – it is not planned); \( I_j \) – total investment for the \( j \)-th investment project; \( \sigma_{Gj}^2 \) – the variance of the return on the project \( j \), characterizes the size of own risk; \( (\beta_j \sigma_{G})^2 \sigma_{G}^2 \) – the value characterizing the size of the systematic (market) risk for the \( j \) project; \( R \) – regulatory risk level of the innovation program of enterprises.

4. Conclusion

The result of solving the proposed linear programming problem is an effective innovation program, which makes it possible to substantiate the corporate innovation strategy of the agricultural engineering holding.

Based on the results of the formation of an effective innovation program at the level of the Board of Directors of enterprises, the compliance of the structure of the innovation project portfolio with the adopted system of strategic target priorities for the innovation development of an enterprise in the agricultural sector of the economy is checked. The composition of the strategic profiles of agricultural engineering (list of business units) and the list of priority innovative projects on them are also approved, the decision is made to allocate funds to business units from the Centralized Fund (Budget) for organizational and technical development of the enterprise.

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