Formation of a database on agricultural machinery for modeling the production cost

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Abstract. The article deals with the problem of adequate provision of information to heads of agricultural enterprises in the daily management decisions related to the plant growing industry. The work purpose is to determine the possibilities of automating the agricultural products cost calculation and the use of the obtained data in solving practical optimization problems in real time. For this, the following tasks were solved: - to formulate an algorithm for forming a database for calculating the cost; - to determine the sources of information for the formation of a database on agricultural machinery for modeling the cost of agricultural products; - to identify the main evaluation criteria and features of their application when optimizing the applied technology based on cost modeling; - determination of the software products capabilities to optimize production processes. The formed database on agricultural machinery and modeling of the production cost of production allow the head of the enterprise in a flexible mode to adjust the results of production activities, justifying their decisions using digital information. Integration of this tool into an optimization system operating in real time, allowing the use of multiple criteria for assessing the results of an enterprise's performance, will avoid multiple errors associated with a lack of initial information for decision-making in the implementation of agricultural activities.

Keywords: database, optimizing, technological maps, crops cultivation, production costs, agricultural machinery.

1 Introduction

The modern acceleration of the pace of production has affected not only industry, but also agriculture. The head of an agricultural enterprise of any level has to make a large number of production decisions every day that affect the final result of the activity, which in reality will manifest itself only after a few months [1-7]. Because of this time gap, most of these decisions have to be made in conditions of uncertainty due to the lack of reliable information. Based on this, the goal of the modern IT industry is to create a system for providing information in real time with elements of optimization, forecasting, collecting information from the Internet with automatic verification of their reliability, and using cloud technologies for data storage [8-14].

One of the components of this future system is real-time modeling of the cost of production. Solving the optimization problem at the same time, the manager, thanks to this approach, has the opportunity to choose the best option when formulating a shift task for the machine operators. In this case, optimization criteria can be very different: minimization of the final cost of manufactured products, maximum loading of expensive equipment, fast execution of a technological operation, etc. In this case, the only limitation is, as practice shows, the preservation of the priorities of the choice of actions for a long time. Otherwise, with a constant change in the decision-making basis, the final result of the optimization system will be worse than in its absence [15-21].

2 Materials and methods

We tried to correct this shortcoming and adapt the technological map to modern requirements using the program for calculating technological maps in crop production, developed at the Department "Economic Theory and Economics of the Agro-Industrial Complex" of the Samara State Agrarian University. Although attempts at such adaptation appeared in the periodicals, they were far from perfect and suffered from a number of shortcomings.

As a basis for the optimization model, you can use programs for calculating technological maps in crop production. They are a database of agricultural machinery that can be used in agricultural production in a variety of ways. Each of these alternatives has its own set of characteristics, which ultimately affect the formation of the cost of production (Figure 1) [22-29].

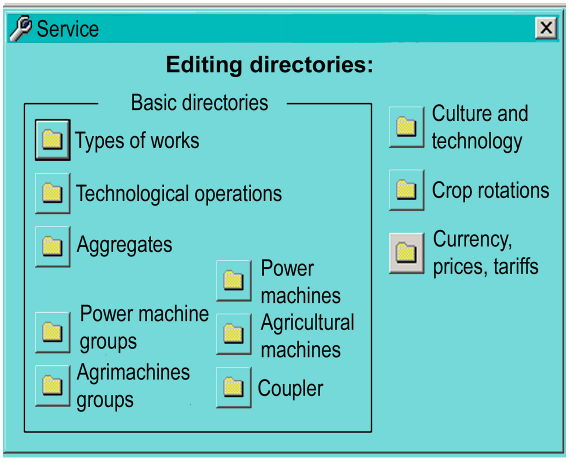

Fig. 1. Initial menu of database formation.

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3 Results and discussion

The main condition for the adequate operation of the cost modeling system is the formation of a database on the equipment used on the basis of reliable information about the performance of the units, the amount of production costs [30-35]. In the conditions of the Russian Federation, the most preferred source of information about their work is test tests carried out by the Zonal Machine Testing Stations. Their task is to analyze the capabilities of technology in the conditions of the region for the most common technologies for the cultivation of agricultural crops. This takes into account the effect on productivity of the characteristics of common soils, temperature modes of operation, the duration of daylight hours, etc. (Figure 2) [36-42].

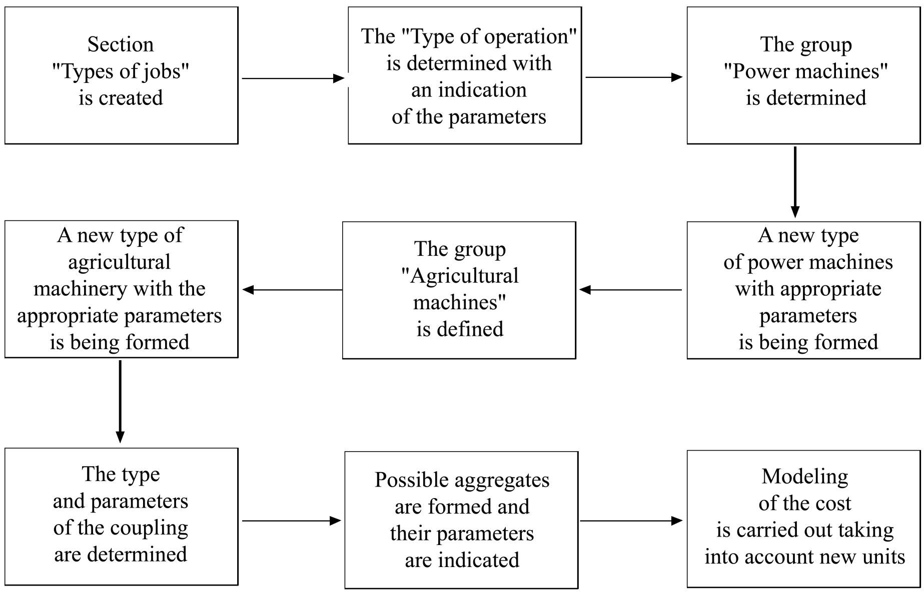

Fig. 2. Scheme of creating a new technological option.

The considered program for calculating technological maps in crop production is the various operations database, sets of equipment, technological options. The source of replenishment of this base is the reports on the testing of equipment carried out by the zonal machine-testing stations, of which there are currently eleven left (Altai, Vladimir, Kirov, Kuban, Povolzhsky, Podolsky, North-Western, North Caucasian, Siberian, Central Chernozem and State Testing Center) (Figure 3).

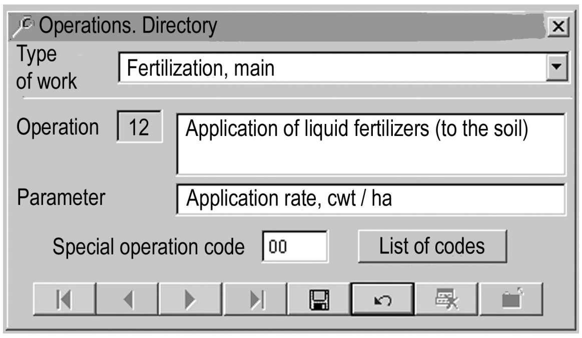

Fig. 3. Menu "Operations".

Hundreds of equipment various types tests are carried out annually. Their results can be found in the public domain. In the process of type tests in accordance with OST 10 1.1-98, the following list of assessment types is carried out: 1. Technical expertise. 2. Assessment of functional indicators: - agrosotechnical assessment; - technological assessment (for equipment for processing agricultural raw materials). 3. Energy assessment (assessment of the electric drive). 4. Assessment of product safety and ergonomics. 5. Operational and technological assessment. 6. Assessment of reliability. 7. Economic assessment [43-49] (Figure 4).

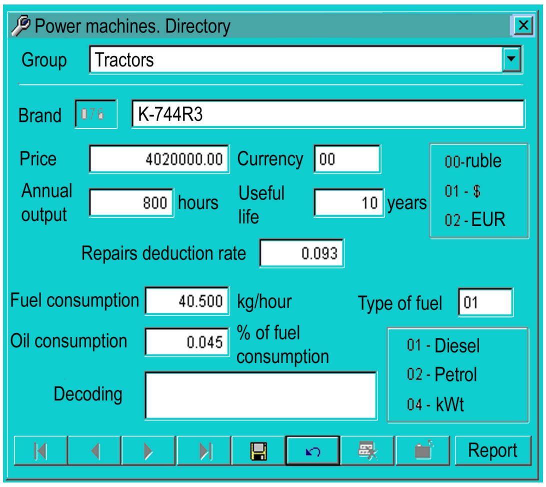

Fig. 4. Menu "Power machines"

To form a database on agricultural machinery for modeling the cost of production, it is proposed to use the following scheme (Figure 2). It allows you to create a new or use an existing set of "work-operation-aggregate" to replenish the existing database.

When creating a new operation (Figure 3), you must select the work group to which it belongs and indicate the specific parameter characteristic of this operation (application rate, processing depth, etc.)

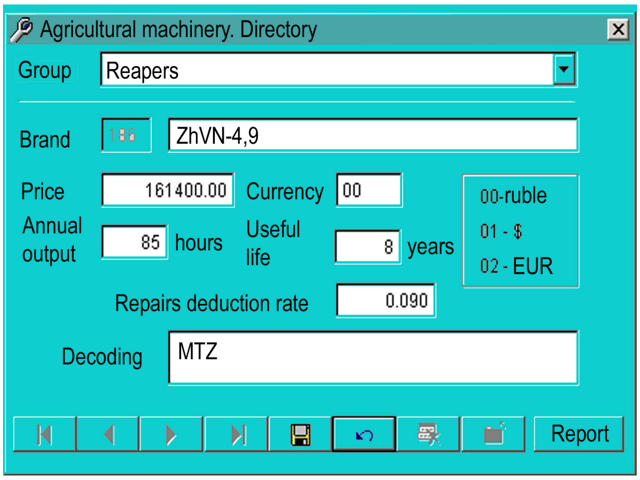

Fig. 5. Menu "Agricultural machines"

Next, a card is formed for a new type of power machines (Figure 4). In the given example, this is the Tractors group, the K-744 brand (tractor of the 5th class). Information on the cost can be obtained on the website of the Ministry of Agriculture of the Russian Federation, where monthly data on the purchase prices of the main types of equipment are published or on the basis of the current price lists of manufacturers (Figure 6).

The values of the indicators "Annual load", "Ratio of deductions for repairs", "Fuel consumption", "Oil consumption", "Fuel type" can be obtained from the reports of typical tests of agricultural machinery of zonal machine test stations. The service life is determined on the basis of the Fixed Assets Classifier (Figure 7).

The final stage is the formation of working units, the use of which is assumed according to the technology. To combine the power machine and agricultural equipment, initially in the menu "Selecting the composition of the unit" their compliance is determined within the technological option (Figure 6) and the number of agricultural machines to be coupled is indicated.

Subsequently, the values of the parameters of the units and their characteristic features are determined (the number and qualifications of workers, the shift ratio, the width of the unit and the special parameters of the operation (in this case, the plowing depth)).

To calculate the filled-in table, click on the "Calculation" button in the "New map" window.

After the calculation is completed, the "Calculation Results" window will appear on the screen, in which you can specify the necessary additional information.

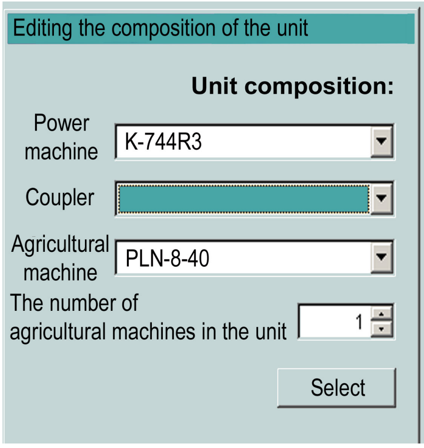

Fig. 6. Menu "Selection of the Aggregates composition"

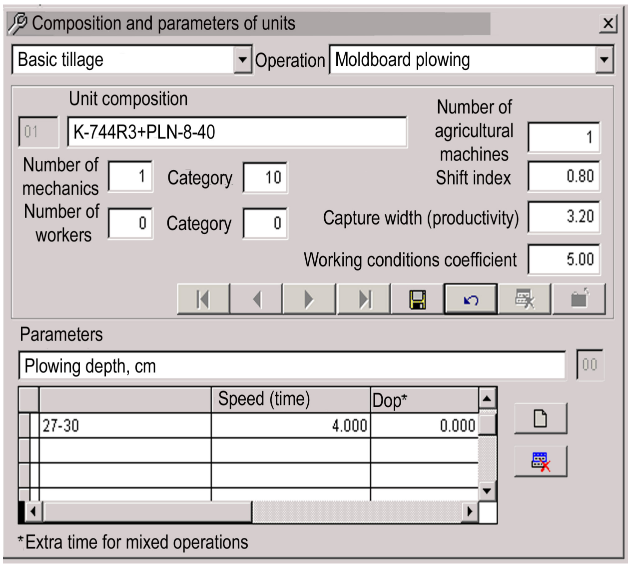

Fig. 7. Menu "Forming Aggregates"

4 Conclusion

The formed database on agricultural machinery and modeling of the production cost of production allow the head of the enterprise in a flexible mode to adjust the results of production activities, justifying their decisions using digital information. Integration of this tool into an optimization system operating in real time, allowing the use of multiple criteria for assessing the results of an enterprise's performance, will avoid multiple errors associated with a lack of initial information for decision-making in the implementation of agricultural activities.

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