UDK 62-93:631.171:658.587

APPLIED INFORMATION TECHNOLOGY FOR SOLVING THE PROBLEM OF AGRICULTURAL MACHINERY REPLACEMENT

O.V.GRYNCHAK, candidate of technical science,
B.M.MARIN

Problem definition of replacement equipment when the cost of its operation and maintenance are the minimum point and begin to grow, is a common problem that is solved as technologists and economists and mathematicians.

The relevance of the solution increases especially at a time when the depreciation of mechanization, electrification and automation of production processes in agriculture and the need to replace them reached significant levels. At the same time, the financial position of many enterprises is no stable enough to fully replace the entire fleet of machines.

Spreadsheet processor (SP) Microsoft Excel is not only a means of tabular presentation of information and model calculations with these data, such as finding the results and performance of the columns of the table. Current status of this software, which is constantly being upgraded, let's talk about the possibility of creation on its base complete mathematical models for conducting comprehensive applied engineering calculations.

The aim of the study was to (1) identify the functional properties of SP Excel, which enable building effective information technology in agricultural engineering, and (2) create an active information technology for solving one of the urgent problems of exploitation tractor fleet (ICC) in agricultural enterprises.

Research methodology. Research of Excel spreadsheet functionalities was based on the version of Excel 2010, that is part of the application package MS Office 2010. This version of the program is relatively new and is actively supported and promoted in the market of software products. This study used the method of systematic analysis of the properties of spreadsheets on speed and accuracy, volumes of placed information, convenience of tools for building user interface with the environment in solving practical problems.

To build the application of information technology method for constructing systems (systematic synthesis method) was used/ The method allowed to identify all the interacting elements of the problem and find the most appropriate means of representation in the model as their own, and interaction of these elements.

Since the function estimates the total cost of operation of tractors and agricultural machines $E(t)$ is a nonlinear convex function of time of machines and equipment operation, then let's find its extreme value equating to zero its first derivative:

$$dE/dt = 0 \quad (1)$$

followed by solving the equations with one unknown *t*.

The value of *t* found this way is the solution of the optimization problem, since the minimum value of function is achieved in this point.

The research results.

Problem. It is necessary to determine the optimal lifetime of equipment, if we know the fixed and variable costs of servicing equipment, parameter changes in costs over time and the initial cost of the equipment. Costs are described with certain function, depending on the lifetime term.

To build the applied information technology for solving the problem of machinery and equipment replacement, as study shows, it's advisable to use the total cost function *E(t)*, which has the form:

$$E(t) = a + bt^n + A/t, \quad (2)$$

where a – fixed cost, b – variable cost for equipment maintenance, n – parameter of cost changing in time, A –initial cost of the equipment.

To discover extremum let us find first derivative of this function and equate it to zero:

$$E'(t) = nbt^{n-1} + A/t^2 \quad (3)$$

$$nbt^{n-1} + A/t^2 = 0. \quad (4)$$

It's possible to find the analytical solution of the above equation, but feature of application of information technology we built consists of no need to do so. To find the solution we can use one of the Excel functions, "Goal Seek".

Appearance of created information technology's user interface is shown in Figure.

In addition to the exact solution of replacement equipment problem developed information technology makes possible also clearly see the tendency of the total cost function behavior on the graph associated with a model that describes its behavior.

Typically, information technology are developed for solving the entire class of similar tasks. Therefore, the model must provide that the problem will be solved for any values of the parameters a, b, n and A, that include the appropriate range of permissible values. The values of these parameters must be variables rather than fix as constants in the formula for calculating values of the total cost function and its derivative. It is advisable to insert these values in some cells of the spreadsheet's worksheet and to use reference to them in formulas.

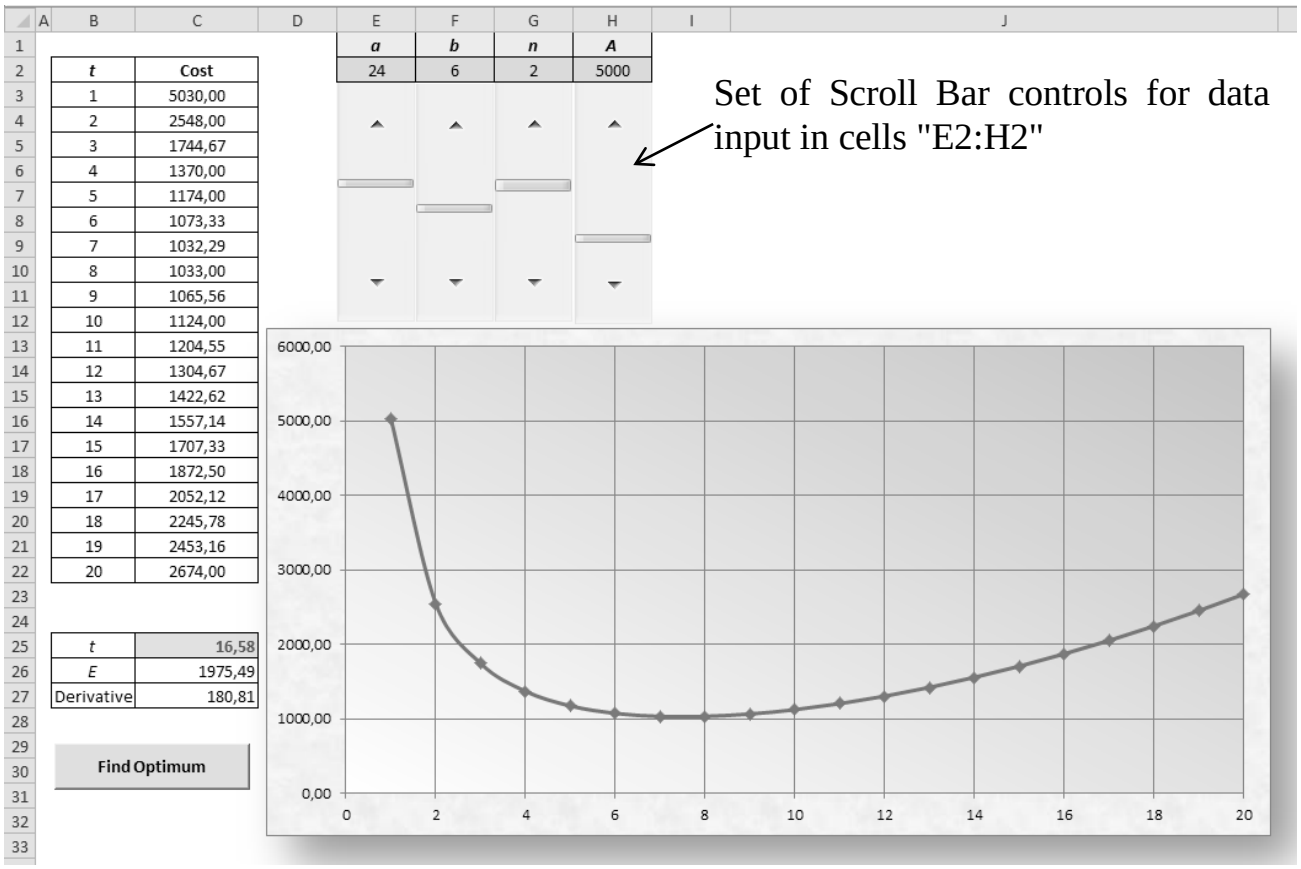

Figure. User interface of applied information technology of the tractors and agricultural machines optimal exploitation term definition in Excel environment

Parameters *a*, *b*, *n* та *A*, entered in range "E2:H2" manually. To facilitate parameter values input suggest using controls "Scroll Bar". These tools allow you to enter data in a spreadsheet cells without using the keyboard, moving the slider of the corresponding scroll bar up or down by mouse. Scroll bars can also be oriented horizontally.

Developing such control you can set not only the related cell's address, but its possible minimum and maximum values, large and small steps of this value changing etc.

The table, which contains calculated values of total cost function that is linked with providing the service of the kind of machines we consider, is presented in range "B2:C22". That table is designed for 20 years of operation and, if necessary, can be easily extended.

Table in cells "B2:C22" is the source of the data for the chart that illustrates the behavior of the cost function in a given range.

Formulas in the table are dynamically linked with the values of the parameters (cells "E2:H2"); data table is automatically recalculated and displayed on the chart by changing the value of any parameter. Through this user can immediately watch the effect of this change not just on the table, but also on the diagram.

Another significant feature of the information technology is possibility to find exact values of (a) machine exploitation term *t* at which the minimum value of cost is achieved and (b) the minimum value of cost itself. To get it in cells "C25:C27" are entered:

- value of the variable *t* (initially there shall be entered arbitrary value of its permitted range of values) – cell "C25";
- formula for calculating the cost function in a point *t* given in cell "C25" – cell "C26";
- formula for calculating the derivative of cost function in a point *t* given in cell "C25" – cell "C27".

We will use one of the features named "Goal Seek" to determine the value of *t*, that cause first derivative to zero; in Excel 2010 it's placed in group "Analysis "What-If" on the "Data" tab. That function has its own user dialog for entering:

a) cell where user wants to get desired value;
b) desired value itself;
c) cell which will be changing to achieve mentioned value.

Since this call of the window and setting parameter values are chores in nature (the same action are performed every time when user is performing this operation), let's automate its realization by creating a macro using VBA language.

Macro called "*Optimum*" is a program with a single command, which calls the method GoalSeek (Searching of desired value) of Range object, pointing on the cell "C27", where we need to obtain zero value:

```
Sub Optimum()
   Range("C27").GoalSeek Goal:=0, ChangingCell:=Range("C25")
End Sub
```

The call of this program is connected with event of clicking special user button with caption "Find optimum" (figure). Now each time, when user clicks this button by mouse, the value of the derivative will change to zero by choosing *t* (value in the cell "C25").

Thus, the use of created information technology of the tractors, agricultural machines and other equipment exploitation terms definition is:

1. Input of parameters values in cells "E2:H2" – manually or using of scroll bars;
2. Click "Find optimum" button to determine the exact coordinates of the point, which contains the optimal value of total cost function.

An improved version of information technology avoids the button "Find optimum" using. In this case program on VBA language (macro) will be much more complicated, and coordinates of the optimum point are found automatically with any change in value of each of the four parameters of the problem.

Conclusions. Optimization term replacement of machinery and equipment problem is appropriate to submit in Excel spreadsheet as a model, formed by

successive links in spreadsheet cells formulas. It's recommended to use wide range of inbuilt tools and VBA programming for developing the user interface of applied informational technology for solving this class of problems.

LIST OF LITERATURE

1. Bazhenov S.P. Osnovy ekspluatatsii i remonta avtomobiley i trktorov / S.P.Bazhenov, B.N.Kaz'min, S.V.Nosov. –M. : ACADEMIA, 2005. – 336 s.
2. Kovalev V.V. Vvedenie v finansovyi menedzhment / V.V.Kovalev. – M.: Finansy i statistika, 2004. – 768 s.
3. Organizatsiya i upravlenie proizvodstvom na sel'skohozyaystvennyh predpriyatiyah / Pod red. V.T.Vodyannikova. – M.: Izd-vo "KolosS", Izd-vo StGAU "AGRUS", 2006. – 506 s.
4. Karagodova O.O. Doslidzhennya operatsiy / O.O.Karagodova, V.R.Kigel', V.D.Rozhok. – K.: Tsentr uchbovoyi literatury, 2007. – 256 s.
5. Vagner G. Osnovy issledovaniya operatsiy / G.Vagner. – T.2. – M.: Mir, 1973. – 489 s.
6. Gus'kov V.Ya. Ispol'zovaniye elektronnyh tablits Excel v inzhenernyh raschetah / V.Ya.Gus'kov, R.L.Kochubievskaya, G.A.Ruyev, N.N.Fedorova. – Novosibirsk : NGASU, 1999. – 80 s.
7. VBA and Macros: Microsoft Excel 2010. – Indianapolis: Que, 2010. – 630 p.
8. Winston W. L. Microsoft Excel 2010 : Data Analysis and Business Modeling. – Redmond : Microsoft Press, 2011. – 700 p.