1. Introduction

Modern agricultural production processes are characterized by a high level of mechanization and automation and are aimed at creating favorable living conditions of plants and soil microorganisms. Technology used for mechanization of the process is knowledge-intensive, its cost is growing because there is a problem in the rational use of its mechanized processes that can reduce operating costs for agricultural production. The high level of technology in agricultural production, technical excellence and high cost of equipment requiring a high level of management of the technical resources, finding ways to reduce the share of material and energy costs in the cost of agricultural products.

Search for sustainable solutions in the composition and use of machine-tractor fleet of agricultural enterprises - one of the most difficult tasks, because when its decision should take into account a large number of factors, the overwhelming share are probabilistic in nature and ungovernability. Effective technical means on which it is advisable to complete machine-tractor fleet management, determined on the basis of technical and economic calculations [1-9, 11-14]. For their performance the scientists developed a number of methods and computer application software based on the methods of linear or dynamic programming [9]. For optimization criterion used straight or given operating costs.

2. Preconditions and means for resolving the problem

Modern trends in technology provide the technological operations in clearly defined terms of cultivation techniques, providing favorable conditions for plant growth and development and yield formation. This is especially true for spring sowing and harvesting, as each day deviation from the optimal timing of harvest shortfall increases [15, 18, 20].

To perform all the work in the shortest possible time necessary to provide differentiated approach to each transaction and prepare for their implementation tractor units, which provide high quality work, productivity and the lowest possible fuel consumption.

Characteristics of agricultural processes are probabilistic in nature. The scope of work and terms of their performance in the economic during the year variable. In certain periods there are so-called "peak load", the largest of which is calculated quantitative need for machines and power tools.

According to research authors [4, 5, 8, 11], timely and quality execution of all work positively affects the productivity of crops. From the level of the park and farm equipment with new equipment depend on production costs. Therefore, in determining the efficiency of the machine-tractor fleet should pay great attention to the requirements of agricultural technology, scope of work and terms of operation the machine-tractor units and their service provision.

Presence of modern computers, powerful operating systems, database management systems and applications has enabled scientists to develop algorithms and software economic and mathematical modeling of agricultural production processes, planning mechanized operations, determining the need agricultural enterprises in the engineering and assembly of the basis of rational structure of the machine-tractor fleet.

To solve the problem "Planning mechanized operations", basically use a mathematical model that solve linear programming method [8-11, 18 etc.]. Solving this problem to optimize machine-tractor fleet minimum criteria for direct exploitation or reduced costs. More and more in solving this problem, the method of dynamic programming [16, 17]. The essence of this method is that it does not require the linearity of the objective function and takes into account the cost of landscaping and expenses caused by the loss of production due to deviations from optimal deadlines.

These methods are focused on performance and average values do not include probabilistic nature of the factors of production processes, and therefore do not provide optimal solutions in terms that differ from those in the calculations.

There is also a method of optimizing machine - tractor fleet by the criterion of minimum energomachines [4]. This criterion, according to the authors provide minimum operational costs. This assumption focuses on the feasibility of acquisition machine - tractor park power means high power, use of which will increase the productivity of machine-tractor units and works fewer machines. However, this does not guarantee that the work will be done with the lowest possible operating cost. Also widely used method of statistical simulation modeling Agricultural productions justification for the need to implement them. [3] The use of these techniques requires appropriate specialist skills, inaccessible because the vast majority of farms.

3. Results and Discussion

When operating a machine-tractor fleet of agricultural enterprises for various types of work settings agree on technical means for the width, capacity and load factor that can increase the efficiency of their use. The parameters auxiliary machinery agree with the parameters of machines to perform the main technological operation.

To determine the parameters of the machine should consider the following factors [5]:

1) requirements for quality farming operations that set the terms of farming production of the type of product and are made of steel;
2) agronomic calendar and deadlines that have grown dependent on culture, state of the field, and weather conditions are variable;
3) the cost of technical tools that determine the value of the operating costs.

Selecting units to perform manufacturing operations carried out by the criterion according to performance requirements farming appointment to the quality of the work. The composition of the unit determined by the amount of work and permissible duration of their implementation.
The scope of work that must be done by one day \( R_i \) determined by the formula:

\[
R_i = \frac{\sum S_{ij}}{T},
\]

where \( S \) - the total amount of similar work in different cultures in the \( i \)-th period, ha or ton; \( T \) - agrotechnical permissible duration of the work, day.

If the unit is independent of the volume of work that can be performed by this unit per day, determined by the formula [4]:

\[
P_i = \frac{W_{zm} \cdot t \cdot k_o \cdot k_f}{R_i},
\]

where \( R_i \) - the amount of work that can be performed unit per day, at a certain kind of work, ha or ton; \( W_{zm} \) - performance unit for a certain kind of work an hour alternating time, ha/h; \( t \) - the duration of a given operation throughout the day, hours; \( k_o \) - factor for the simple organizational reasons; \( k_f \) - factor for the time spent to perform technical maintenance and repairs.

Various authors [5, 18, 19] suggested a number of criteria for pre-selection units:
- Minimum operating costs per unit of work;
- Maximum coefficient operation;
- Maximum performance machine - tractor aggregates;
- Maximum performance per unit of power;
- Minimum labor costs;
- Minimum energy vehicles.

Limited to one of the suggested criteria is inappropriate because they do not take into account the quality and timeliness of work and cost of ownership of technology. Therefore, the choice of machines should be carried out using the eligibility criteria indicators of quality of work and productivity requirements of agricultural technology, maximum use of machines in the production and minimum necessary cost of ownership of technology. The value of the costs to own this or that machines must not be greater than the cost of production lost due to untimely and poor quality of work performed in the household during field work cycle without machines.

In terms of quality machines selected in terms of their appointment with the terms of their compliance with agricultural technology to perform a technological operation:

\[
Q_m \geq Q_u,
\]

where \( Q_u \) - quality of work machine; \( Q_m \) - an indicator of quality requirements farming operations unit.

In terms of performance determined parameters such technical means by which the amount of work required to be done in optimal terms:

\[
W_q = \frac{\sum R_i}{P_i},
\]

Number of units required for each operation, determined by the formula [3]:

\[
x_{u} = \frac{R_i}{P_u},
\]

where \( x_u \) - number of units required for the performance of the total volume of similar works in optimal time; \( P_u \) - performance \( s \)-th unit in the \( i \)-th operation.

In terms of machine parameters selected from the conditions that the cost of car ownership was not greater than the value of proceeds from the sale of additional products produced with the use of a car, and a variable cost was less than the value of work performed under the contract of lease:

\[
C_c \leq S \cdot U \cdot C,
\]

where \( C_c \) - constant annual cost of the technique, UAH; \( S \) - the amount of work to be performed in the best technical means periods ha or ton; \( U \) - culture yield, t/ha; \( C \) - the price of additional products produced using machines due to the quality and timeliness of work, UAH/t.

To determine the performance of machines and technological complexes tractor fleet manned base on tractors with engine capacity of 130-140 kW and 44-60 kW has been calculated by the example of farm acreage 2700 hectares. To calculate the need for tractor fleet management adopted a 4-rotation of the fields sown areas structure (shown in Table 1) for intensive farming systems and selected tractor units to perform manufacturing operations plant production.

<table>
<thead>
<tr>
<th>Agricultural crops</th>
<th>Area crops</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter wheat</td>
<td>675</td>
<td>25,0</td>
</tr>
<tr>
<td>Corn for grain</td>
<td>1350</td>
<td>50,0</td>
</tr>
<tr>
<td>Sunflower</td>
<td>405</td>
<td>15,0</td>
</tr>
<tr>
<td>Soy</td>
<td>270</td>
<td>10,0</td>
</tr>
<tr>
<td>Total:</td>
<td>2700</td>
<td>100,0</td>
</tr>
</tbody>
</table>

After the appropriate calculations, it was determined the need for technological machinery for production system of intensive agriculture, namely the need for technical equipment (Fig. 1) and their annual download; Direct operating expenses technological complex machines and their structure by growing operations.

![Fig. 1. Estimated demand for technical means for completing future structure tractor fleet](image)

Established that the cultivation of crops for intensive technology park with a specific machine-tractor units direct operating costs in the structure of total expenses are 31% (Fig. 2).

![Fig. 2. Structure of the cost of crop production for intensive technology in short rotation rotation](image)

**4. Conclusions**

Using mathematical models proposed selection criteria and technical and operational parameters of means the specified volumes and crop production technologies provide choice.
complexes cars and manning rational structure of machine - tractor fleet management and improve the efficiency of crop production.

5. References


2. Адамчук В.В., Булгаков В.В. Підроботинення агротехнічними процесами в рослинництві/ Ф. С. Завалишин.


10. Удосконалилось детермінована модель планування механізованих робіт в аграрних підприємствах, що функціонують в різних природно-виробничих умовах України. Виконано перевірку детермінованої моделі планування механізованих робіт на етапі випробування. ДСТУ 4397:2005.


