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Mathematical Modeling Of The Technological System Of The Harvesting And Transport Process.

Valentin Nikolaevich Kurochkin[1]*, Anatoly Timofeevich Lebedev[2], Nikolay Efimovich Rudenko[2], Yury Ivanovich Zhevora[2], and Natalia Petrovna Doronina[2]

[1]Azov-Black Sea Engineering Institute, Don State Agrarian University, Lenina str. 21, Zernograd 347740, Russia.
[2]Stavropol State Agrarian University, Zootekhnicheskiy lane 12, Stavropol 355017, Russia.

ABSTRACT

Reduction of machine downtime in the production of agricultural work is possible due to the harmonization of the phases of the process in terms of productivity, reducing technological gaps during harvesting, which reduces the parametric and functional failures of the technological system in question. As a result, the cost of grain is reduced and the balanced result of the economic activities of the agricultural organization is improved. For the engineering and technical subsystem of the agricultural organization, the most urgent issue is ensuring the continuity of the operation of agricultural machinery. Topical issues of the effectiveness of technological processes for the production of agricultural crop production due to the consistency of the machine and tractor fleet performance, subject to maintenance of technical readiness at a regulated level. In connection with the increasing complexity of tractors, grain harvesters and other combines, agricultural machinery and machine-tractor units, the task of operating this technique can be solved more efficiently using information technologies based on mathematical modeling. The rational organization of the technological system of machine operation during the harvesting of grain crops on the basis of mathematical modeling will reduce the parametric and functional failures and increase the efficiency of the use of technical means. Based on the simulation system of discrete GPSS systems at the University of Michigan, it was planned to develop a formalized scheme, a mathematical model, and a simulation algorithm. A mathematical model of a system for the operation of combine harvesters, tractors and agricultural machines during the harvesting period of grain crops is proposed. The use of this method will make it possible to justify the economically expedient level of loading and productivity in the phases of the harvesting process. The mathematical model is the basis for improving the efficiency indicators of the use of technological processes for harvesting grain crops.

Keywords: modeling, operation, combine harvester, technological system, mathematical model.

Corresponding author

INTRODUCTION

At present, the main part of crop production is produced in agricultural organizations. Plant cultivation is dominated by the cultivation of cereal crops, for winter wheat, for example in the Rostov region, annually at least 1.5 million hectares, other cereal crops are planted about 400 thousand hectares, and in this entire area it is necessary to carry out harvesting- transport process. This requires a clear organization of operation of grain harvesters for harvesting grain crops, tractors and vehicles: the rational organization of harvesting and transport production on the basis of systemic research positively affects the results of the harvesting company and reduces grain losses during harvesting [1, p. 5]. This organization is an urgent issue for the modern period of improving existing agrarian technologies and technical means, the solution of which can ensure sustainable development of the grain economy and neutralize the consequences of the sanctions announced by the West. Rational organization allows for a stable and reliable operation of technological processes of operation of the machine and tractor fleet (EMSTP). Reduction of downtime of machines in the production of agricultural work is possible due to the harmonization of the phases of the process in terms of productivity, the reduction of technological discontinuities during harvesting, which reduces the parametric and functional failures of the technological system in question [2, p. 3]. As a result, the cost of grain is reduced, and the balanced result of the economic activities of the agricultural organization is improved. For the engineering and technical subsystem of the agricultural organization, topicality is the continuity of the issues of the effectiveness of technological processes for the production of agricultural crop production due to the consistency of the machine and tractor fleet in terms of productivity, provided that technical readiness is maintained at a regulated level [3, p. 454-455]. In connection with the increasing complexity of tractors, grain harvesters and other combines, agricultural machinery and machine-tractor units, the task of operating this technique can be solved more efficiently by using information technologies based on mathematical modeling, which is by now a fairly innovative direction for the modernization of harvesting and transport and harvesting processes when harvesting the entire biological crop of grain crops.

Therefore, it is necessary to investigate complex production processes occurring in the harvesting and transport process, to identify factors of efficiency and to develop measures that ensure the reduction of parametric and functional failures.

The scientific hypothesis is that the rational organization of the technological system of machine operation during the harvesting of grain crops on the basis of mathematical modeling will reduce the parametric and functional failures and increase the efficiency of the use of technical means.

The purpose of the work: development of the method of substantiation of the rational organization of the technological system for the operation of machines during the harvesting of grain crops on the basis of mathematical modeling.

The object of research is the functioning of the technological system of the harvesting and transport system.

The subject of the study is the dependencies and regularities arising in the implementation of harvesting and transport operations in an agricultural organization.

The system of harvesting and transporting and procuring works, the conditions and organization of the use of the machine and tractor fleet of agricultural organizations are examined in the works of academicians E.I. Lipkovich [1], M.S. Runchev, V.M. Kryazhkov [4], V.I. Chernoyivanova, A.I. Selivanova, A.E. Severnogo and others. The study of organization issues using the theory of Markov processes and its applications was carried out by N.I. Agafonov, Yu.A. Tsarev, A.I. Buriyanov and others.

MATERIAL AND METHODS

Research methods in this industry, according to the study of the state of the issue, are determined by the following factors. The system under consideration in accordance with the standard [2, p. 3-7] refers to technological ones that have several phases (mowing in rolls and subsequent threshing, harvesting directly, transporting grain and a non-grain part of the crop, peeling, plowing, cultivation) and consists of many probabilistic elements and the purpose of its work is stochastic. The system under consideration is characterized by the influence of random factors arising for reasons: unforeseen changes in prices for products and resources used in the production process due to fluctuations in market conditions; periodically arising crisis phenomena in economy and finance; natural and climatic factors of the zone of risky farming. In this regard, Academician RAS V.M. Kryazhkov recommended taking into account the operating conditions, the structure of the organizational systems, where it will work, etc., when solving problems of improving the use of agricultural machinery [4].

The method of mathematical modeling on the basis of representation of the process as Markov allows to optimize the organization of EMTP based on: identification of incoming trunktact flows, study of their service in various phases of the considered technological system, generation of indicators of parametric failures, incl. formation of the queue for maintenance [3, p. 260-276].

Mathematical modeling provided for the development of a formalized scheme, a mathematical model and an algorithm for modeling based on the simulation system of discrete GPSS systems at the University of Michigan [5, p. 24-27].

Formalized description of the technological system of the harvesting and transport system. Suppose: the state z of the harvesting system is described by a set of objects $z_1, z_2, \ldots z_n$, and besides $z_i \in Z_i$, *i*= 1, 2, .., *n*, where Zi — given sets. Usually researchers [6] consider a direct product

$$\hat{Z} = Z_1 \times Z_2 \times \ldots \times Z_n . \qquad (1)$$

In this case the set $\hat{Z}$ - is the state space of the harvesting process, which is the set of all ordered collections $z_1, z_2, \ldots, z_n$ including those not belonging to the state of the harvesting process under consideration, for which all states of the system are characterized by a set of points of the interval Z_1 — $(0, z_1^0)$ on the axis OZ_1, Z_2 — set of points of an interval $(0, z_2^0)$ on the axis $0Z_2$. etc. similarly. The input is tranactacts $x \in X$, where *X* — set of inputs of the system, and the transactum arriving at the system at the moment $t \in T$, is denoted by $x(t)$. Input and output signals in this case are tranacts serviced in the process phases. Let: for a period of time Δt_i, a part of the bread field dx enters the processing, then within a specified time, they make up a tranche

$$\rho = \int_{t_1}^{t_2} f(t, \eta_i) dt \qquad (2)$$

In this case, the input x of the system is described $x_i \in X_i = 1, 2, \ldots, m,$, where *Xi* — given sets. The set of transactions is determined by the set of inputs *x = L (t),* corresponding to the working conditions of the harvesting system. The latter also generates serviced tranquacts, which for $y \in Y$ at $t \in T$ designated as $y(t)$. Then the output space of the "served" tranactacts of the system will have the form [6]

$$\hat{Y} = Y_1 \times Y_2 \times \ldots \times Y_r \qquad (3)$$

Generalizing the concept of this system, following a number of researchers, we will assume that the state of the system z (t) for the instants of time $t \in T$ such that $t \geq t_0$ is determined by the system transition operator [6]

$$t \in Tz(t) = H\left\{t, t_0, z(t_0), (t, x_L]_{t_0}^{t}\right\} \qquad (4)$$

The role of the operator is fulfilled by the algorithm developed by us. In this case, the methodology for studying complex organizational systems began with its formalization, which requires identification of input parameters and control actions, and $g \in \tilde{A}$, $\hat{A} = \tilde{A}_1 \times \tilde{A}_2 \times \ldots \times \tilde{A}_m$).

Input and control actions were considered points of space $\bar{X} = X \times \tilde{A},$ generalized input parameters $\bar{x} = (x, g) = x_1, x_2, \ldots, x_n, g_1, g_2, \ldots g_m)$. When tranacts and control actions enter the system, its state, if it has a Metso Markov process, depends on $(t, x_L)_T$ and $(t, g_M)_T$. Taking this circumstance into account, the transition operator becomes $z(t) = H\{t, t_0, z(t_0), (t, x_L, g_M]_{t_0}^{t}\}$.

RESULTS AND DISCUSSION

An example of the implementation of the developed methodology. Modeling the functioning of the harvesting system on the basis of information support, obtained experimentally in efficiently operating enterprises, made it possible to obtain the following result (Fig. 1).

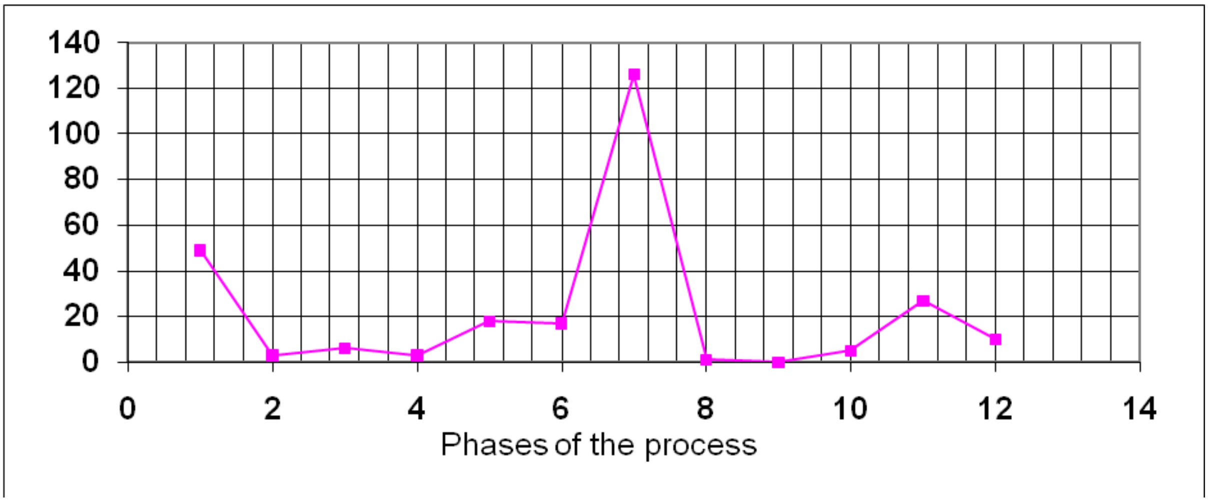

Figure 1: Changing the trunk queue length for the phases of the harvesting process

The graph shows "narrow" places, i.e. Phase in which tranquacts form queues. Increasing the productivity of these phases will reduce the queues, therefore, eliminate parametric failures, increase the capacity of the harvesting technological system and increase its efficiency.

CONCLUSION

The developed technique for justifying the rational organization of the operation of machines during the harvesting of grain crops on the basis of mathematical modeling makes it possible to reduce parametric and functional failures and increase the effectiveness of the technological system examined.

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