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ОБНОВЛЕНИЕ ТЕХНИЧЕСКИХ СРЕДСТВ ЗЕРНОУБОРОЧНОГО КОМПЛЕКСА

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В настоящее время разработано много вариантов реализации алгоритма по обновлению парка зерноуборочных средств. В соответствии с урожайностью и учетом других показателей предложены рекомендации по формированию и обновлению парка зерноуборочной техники дискретно в виде таблиц или диаграмм. Данная форма информации не всегда соответствует требованиям оперативного корректирования и не позволяет оценить технологические возможности уборочных агрегатов в зависимости от условий уборки. Предложен способ совершенствования формирования исходной информации для оперативного принятия решения по эффективному обновлению технических средств зерноуборочного комплекса с учетом зональных особенностей конкретного агропредприятия. Разработан графоаналитический метод определения основных параметров базовых уборочных средств в зависимости от прогнозируемого уровня урожайности и дана оценка влияния факторов, определяющих состав парка зерноуборочного комплекса. Данный метод позволяет выявить наиболее рациональные основные параметры альтернативных базовых уборочных средств конкретного агропредприятия. На первом этапе определяют основные параметры базовых технических средств, затем производят выбор соответствующих типоразмерных рядов самоходных молотилок комбайнов и жаток. Далее формируют альтернативные варианты различных моделей зерноуборочных агрегатов и комплексов. Для последующего выбора рациональных типажей уборочных средств и их критериальной оценки привлекают технико-технологические, экологические и другие показатели. Экспертно-логический анализ информационных ресурсов дает возможность выявить и дать оценку факторам, определяющим количественный состав технических средств зерноуборочного комплекса. Итоговым этапом формирования исходной информации для принятия решения по обновлению технических средств зерноуборочного комплекса должна стать их экономическая оценка, позволяющая прогнозировать конкурентоспособность намолачиваемого зерна.

Ключевые слова: уборка урожая, урожайность, зерноуборочный комплекс, обновление технических средств, агропредприятие

UPDATE OF TECHNICAL EQUIPMENT OF THE GRAIN HARVESTING COMPLEX

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Many options have been developed for the implementation of the algorithm for updating the fleet of grain harvesters to date. In accordance with the yield and other indicators, recommendations for the formation and renewal of the harvester fleet are proposed discretely in the form of tables or charts. This form of information does not always meet the requirements of operational correction and does not allow assessing the technological capabilities of the harvesting units, depending on the harvesting conditions. The method to improve the formation of the initial information for operational decision-making on the effective upgrading of technical means of grain harvesting complex taking into account the zonal features of a particular agricultural enterprise is proposed. A graph-analytical method for determining the main parameters of the basic harvesting tools depending on the predicted yield level is developed and the influence of the factors determining the composition of the grain harvesting fleet

is assessed. This method makes it possible to identify the most rational basic parameters of alternative basic harvesting tools for a specific agricultural enterprise. The first step is to determine the basic parameters of the basic equipment, then select the appropriate size series of self-propelled threshers for combine harvesters and reapers. Further, alternative versions of various models of grain harvesting units and complexes are formed. For the subsequent selection of rational types of cleaning agents and their criterion assessment, technical and technological, environmental and other indicators are used. The expert-logical analysis of information resources makes it possible to identify and assess the factors that determine the quantitative composition of the technical means of the grain harvesting complex. The final stage in the formation of the initial information for making a decision on updating the technical means of the grain harvesting complex should be their economic assessment, which makes it possible to predict the competitiveness of the threshed grain.

Keywords: harvest, crop yield, grain harvest complex, updating of technical means, agricultural enterprise

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INTRODUCTION

Timely effective renewal of technical means of grain harvesting complex of agricultural enterprise allows to obtain quality grain of different purposes in appropriate agrotechnical terms with minimal losses. At present, many variants of the formation of technical strategy for the renewal of grain harvesting facilities have been developed [1-5]. All variants take into account zonal conditions of harvesting, financial condition and other production and technological features of grain grower.

Grain yield is the most informative indicator that reflects the conditions of harvesting, since its level determines the value of technological loading of harvesting machine [2, 3, 5-7]. In this regard, in accordance with the level of this indicator recommendations for the formation and renewal of the fleet of grain harvesting equipment are given. The materials of the recommendations are presented mainly discretely in the form of tables or charts [2, 3, 5, 6]. This form of presentation of the original information does not always meet the requirements of its operational correction and does not allow to assess the trends in the technological capabilities of harvesting units.

At present, grain growers are presented with a very diverse market of technical means of harvesting complex with comparable technical and technological capabilities. In this regard, the decision to update the fleet of grain harvesting equipment is always associated with a comparative assessment of alternative technical means analogues. For its implementation it is necessary to choose certain criteria. Economic, technical and technological and other indicators may be involved in the criterial evaluation [1, 4, 7]. Multicriteria not only reflect the distinctive production features of a particular agricultural enterprise, but also indicate the lack of a single generally accepted approach to the selection of effective technical means and the multistage nature of its implementation [1, 7-9].

The dominant input data for the classical calculation of the need for grain harvesting equipment are the volume of work, productivity of technical means and agrotechnical terms of harvesting. These analytically interrelated

dominants, in turn, depend on different levels of production situational factors that significantly affect the final results of the calculation. It is necessary to identify and evaluate the factors determining the quantitative composition of the grain harvesting machinery fleet for the production of competitive basic crop production.

The purpose of the study is to improve the way of forming the initial information for operational decision-making on the effective renewal of technical means of grain harvesting complex, taking into account the zonal features of a particular agricultural enterprise.

Research objectives:

– using the graph-analytical method to determine the main parameters of basic harvesting tools depending on the projected yield level;

– identify and assess the factors determining the need for technical means of grain harvesting complex.

MATERIAL AND METHODS

Graphoanalytical method as the initial stage of forming the initial information for making decisions on updating the basic technical means of grain harvesting complex is implemented due to the fact that the main parameters of the latter have a formalized relationship with the yield as the main information indicator, reflecting the zonal harvesting conditions. The generally accepted analytical dependence, which is used to estimate both the required level of grain crop yield and its "boundary" value [3, 7], is as follows

$$Y = 360P^0 / (BV_{gr} (1 + \varphi)), \text{ c/ha}, \quad (1)$$

where P^0 is the nominal (nameplate) carrying capacity of threshing and separating working bodies of the combine harvester, kg/s; B – the width of the cutterbar, m; V gr – the maximum speed of combine harvester in specific conditions, km/h; φ - specific indicator of strawiness of threshed bread mass; 360 – the coefficient of agreement of measurement units.

Analytical dependence (1) after substitution of numerical values of its constituent values (Vgr = 7.2 km/h and φ = 1.5) is transformed into the following final equation:

$$Y = 20P^0 /B. \quad (2)$$

Graphical representation of this equation (2) and its inverse solution will allow us to estimate the main parameters of basic harvesting tools depending on the predicted level of yield of a particular agricultural enterprise.

The main method of identifying and evaluating the factors determining the quantitative composition of the grain harvesting machinery fleet is an expert-logical analysis of information resources concerning the machine use of technical means that implement resource-saving technologies of harvesting grain crops.

RESULTS AND DISCUSSION

Efficiency of the renewal of the grain harvesting complex fleet is determined by the rationality of the choice of the basic parameters of its basic technical means: self-propelled thresher combine and harvesters, designed to implement direct or separate harvesting. The main parameters of the basic technical means, which determine the productivity of the combine harvester are throughput and working width. Graphical representation of the resulting equation (2) in linear form, in contrast to the previously obtained result[1] allows us to predict the completeness of grain harvesting units with less error (see figure).

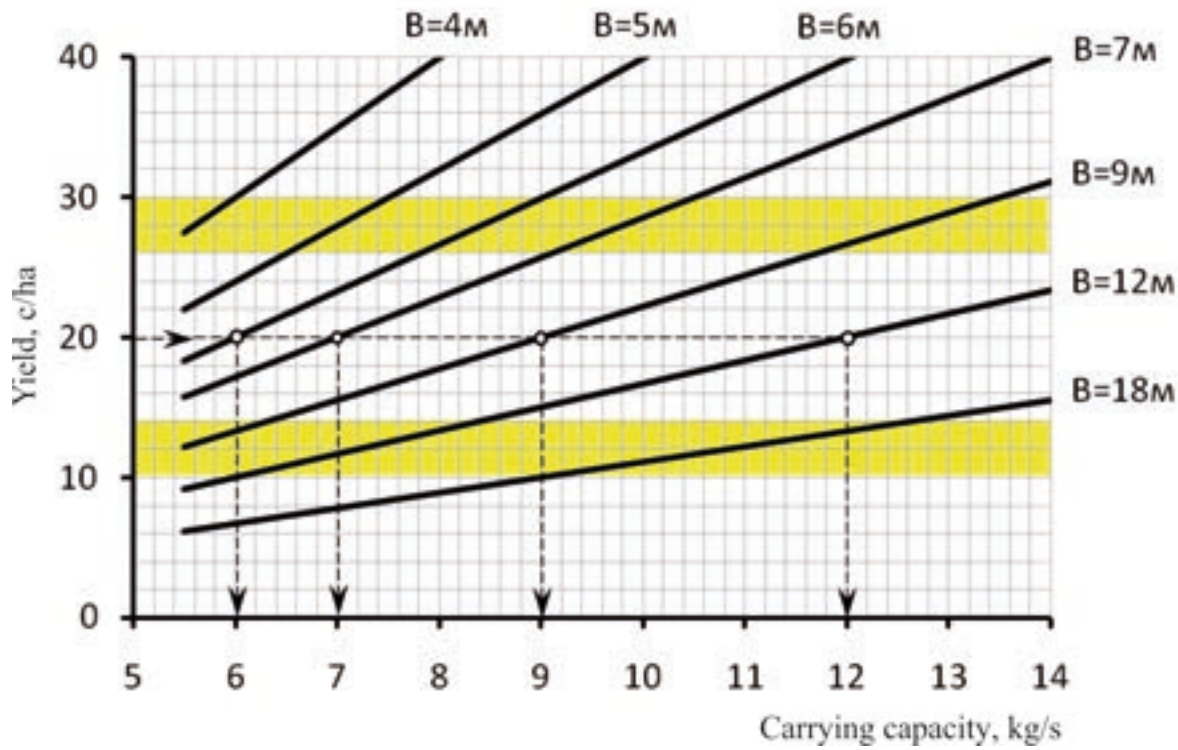
The figure shows that the inverse solution of the final equation makes it possible to determine the basic parameters of the basic harvesting tools needed for a particular agricultural enterprise with a given, predicted or established level of yield. Thus, for an agricultural enterprise with the yield of 20 c/ha the following dimension range of self-propelled threshers is the most effective: Grade 3 - 5-6 kg/s,

[1]Chemodanov S.I. Update of the grain harvesting equipment complex. Agrarian science to agriculture: materials: 15th International Scientific-Practical Conference in 2 parts. pp. 88-90.

Grade 4 - 7-8, Grade 5 - 9-10, Grade 6 - 11-12 kg/s. At the same time the nominal size range of cutterbars should be respectively 6, 7, 9 and 12 m regardless of the phase of harvesting. The design parameters of the working width shown in the figure apply to headers, universal cutterbars, as well as to windrower cutterbars, including those with the ability to form twin windrows.

At the first stage the basic parameters of the basic technical means are determined, then the choice of the appropriate size series of self-propelled threshers of combines and harvesters is made. Further, alternative variants of different models of grain harvester units and complexes are formed. For the subsequent selection of rational types of harvesters and their criterial evaluation technical, technological, environmental and other indicators are involved. These intermediate indicators, which take into account the production peculiarities of a particular grain producer, should be aimed at the rational use of the resource provision of the agricultural enterprise. Thus, the step-by-step identification of the most priority basic technical means makes it possible to choose the optimal variants of grain harvesting units and complexes.

The figure on the abscissa shows the capacity of the self-propelled threshing machine, which defines the passport (theoretical) capacity as an assessment of the potential capabilities of the grain harvester under normalized operating conditions. Real operating conditions reduce the realization of the potential capabilities of the grain harvester. Therefore, the required number of harvesting units is determined based on the real (operational) capacity, as well as taking into account the harvesting area in the peak period and the permissible agricultural terms of harvesting. The quantitative composition of the harvesting park depends on the technical level and efficiency of the use of technological



Графическая интерпретация взаимосвязи уровня урожайности и пропускной способности самоходных молотилок комбайна при различной ширине захвата жаток (B)

Graphical interpretation of the relationship between the yield level and the throughput of self-propelled combine threshers at different reaper capture widths (B)

machines, the structure and size of the sown areas, the harvesting technologies adopted, the technical equipment of post-harvest grain processing stations, the professional level of machine operators and specialists.

Operational performance of the grain harvesting complex is determined by the level of availability of technical means. It largely depends on the scheduled preventive maintenance and appropriate repair (preferably aggregate) in the inter-harvest period. Qualitative implementation of these measures allows maintaining the availability factor at a sufficiently high level throughout the life of the harvesting equipment, but at the same time direct operating costs will be increased.

From the economic point of view, for effective harvesting, it is necessary to maximize the potential of all technical means of the harvesting and transport complex. The priority object is a combine harvester as the most expensive basic technical means in technological process. Experimental studies have revealed that the maximum possible level of technological loading of the combine harvester also allows us to obtain the minimum indicators of grain injury and meet the environmental requirements for the content of harmful engine exhaust gases.

The implementation of different harvesting technologies must be interconnected with the previous and subsequent modules of grain production. This initial agrotechnical requirement assumes the presence of grain dryers and tedders of appropriate capacity in agricultural enterprises, as well as "engineering" crop rotations. Formation of "engineered" crop rotations as planning of sowing areas for crops with different periods of vegetation and terms of sowing is desirable to be carried out taking into account the routing of technical means. The implementation of the modular relationship of grain production will provide an opportunity to expand the calendar agricultural terms of harvesting, i.e. reduce the peak load on the harvesting equipment and, consequently, its need.

Increasing the harvesting period to the beginning of intensive shattering of grain in the phase of hard ripeness also contributes to the implementation of separate harvesting in the classical version (with drying of the bread mass in windrows). Extension of the boundaries of effective functioning of harvesting units is possible with the use of combing harvester in grain harvesting complex and introduction of technology of harvesting high-moisture grain (including threshing-free) for fodder purposes with subsequent conditioning and preservation [10]. It should be taken into account that the limitation in the use of combing working tools is the condition of the productive part of the crop, prone to self-drainage during the phase of firm ripeness.

The expediency of the quantitative composition of technical means of grain-harvesting complex is determined by the method of classical calculation of the need for grain-harvesting equipment, taking into account the actual and estimated dominant source data. The final stage of formation of the initial information for making decisions on the renewal of the structural and quantitative composition of the grain harvesting complex is their economic evaluation. The efficiency of renewal is estimated by "minimum direct operating costs" (GOST 34393-2018), because this indicator allows predicting the competitiveness of threshed grain.

CONCLUSIONS

1. The grapho-analytical method of determining the basic parameters of the basic harvesting tools for any agricultural enterprise with a given, predicted or established interval of grain yield. This makes it possible to obtain illustrative initial information at the initial stage for operative decision-making on the renewal of technical means of grain-harvesting complex.

2. Expert-logical analysis of information resources allows you to identify and evaluate the factors that determine the need for technical means of grain harvesting complex.

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