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Grain harvesting combiners' use in Poltava region. Analysis and forecasts

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The study aims to find technical, organizational, and economic mechanisms for improving the efficiency of grain harvesters by the example of the resource potential of agricultural harvesting equipment in the Poltava region. The study relied on statistical data, including both quantitative and qualitative characteristics of grain harvesters. The information was gathered from agricultural producers in the Poltava region, regardless of the form of ownership. The data was collected through automated records kept by the agricultural machinery registration department of the State Production and Consumer Service in Poltava. The information pertains to the end of the year 2023. The following indicators and characteristics have been studied in detail: the total number of combine harvesters registered in the Poltava region and their average age since the date of manufacture; absolute quantitative indicators regarding the duration of use of grain harvesters according to agricultural machinery manufacturers as of 2023; and relative indicators regarding the duration of use of grain harvesters according to agricultural machinery manufacturers as of 2023. After conducting the statistical analysis, it was found that machines from certain manufacturers have been used for over ten years in higher percentages: John Deere (66,23 %), Fortschritt (68,75 %), Claas (72,32 %), Case (81,42 %), combine harvesters manufactured in Ukraine and post-Soviet countries (88,60 %), Volvo (91,67 %), Massey Ferguson (94,12 %), Sampo (100 %), New Holland (28.1 %). In the specified category "combines older than 10 years prevail", the most commonly used combiners in the Poltava region are John Deere, Claas, Case combiners, and ones manufactured in Ukraine and post-Soviet countries. This makes up the majority of the combiner park in Poltava Region under current conditions. The national economy is currently facing the challenge of efficiently and effectively assessing the technical condition of grain harvesters, whether old or new. This has become an urgent issue that requires immediate attention. It is crucial to pay special attention to the quality of repair work done on the various units and components of these machines, ensuring that all necessary spare parts and accessories are provided.

Keywords: tractors, spare parts, engineering, registration, analysis, dynamics, forecasting, renovation, agriculture, provision strategy.

Використання зернозбиральних комбайнів в Полтавській області. Аналіз та прогнози

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Метою дослідження є пошук технічних, організаційних та економічних механізмів щодо удосконалення ефективності використання зернозбиральних комбайнів на прикладі ресурсного потенціалу сільськогосподарської збиральної техніки Полтавської області. Дослідження виконано на основі статистичної інформації: кількісних і якісних характеристик зернозбиральних комбайнів, що зареєстровані і використовуються аграрними виробниками Полтавщини різних форм власності відповідно до єдиного реєстру для ведення автоматизованого обліку комбайнів відділу реєстрації сільськогосподарської техніки головного управління Держпродспоживслужби в Полтавській області. Інформація подана станом на кінець 2023 рік. Основними досліджуваними показниками та характеристиками визначено: загальна кількість зернозбиральних комбайнів, зареєстрованих в Полтавській області, та їх середній вік з дати виробництва; абсолютні кількісні показники щодо терміну використання зернозбиральних комбайнів в розрізі фірм-виробників сільськогосподарської техніки станом на 2023 рік; відносні показники щодо терміну використання зернозбиральних комбайнів в розрізі фірм-виробників сільськогосподарської техніки станом на 2023 рік. За результатами статистичного аналізу, можливо зазначити, що у відсотковому відношенні більше десяти років використовуються машини наступних виробників: John Deere (66,23 %), Fortschritt (68,75 %), Claas (72,32 %), Case (81,42 %), комбайни виробництва України та пострадянських країн (88,60 %), Volvo (91,67 %), Massey Ferguson (94,12 %), Sampo (100 %), New Holland (28,1 %). Як бачимо, в зазначеній категорії «переважають комбайни старше 10 років» попали більш поширені в Полтавській області комбайни виробників John Deere, Claas, Case та комбайни виробництва України та пострадянських країн. Це становить основну частину комбайнового парку Полтавщини в умовах сьогодення. Тому постає актуальною народногосподарська проблема організації своєчасного та якісного проведення оцінки технічного стану зернозбиральних комбайнів як відносно нових, так і тих, що вже відпрацювали свій розрахунковий амортизаційний термін експлуатації. При цьому, можливо запропонувати звернути особливу увагу на показники якісного виконання ремонтних робіт з відновлення вузлів і агрегатів таких сільськогосподарських машин, забезпечення необхідними запасними частинами та комплектуючими.

Ключові слова: трактори, запчастини, засоби механізації, реєстрація, аналіз, динаміка, прогнозування, оновлення, сільське господарство, стратегія забезпечення.

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Introduction

Since Ukraine gained independence, the issue of providing modern grain-harvesting equipment to farmers in Poltava Oblast, considering their agrarian focus, has remained relevant. In this publication, we will not discuss the current state of domestic combine-harvester construction. Instead, we will analyze the extent to which agricultural producers in the Poltava region are equipped with harvesting machines. We will take into account the impact of our country's integration into the global economy, which has resulted in the presence of a significant number of both domestic and foreign agricultural techniques in agricultural enterprises.

The technical equipment level of Poltava Oblast's agricultural producers can be evaluated through statistical data from the single register for automated agricultural machinery records. According to the agricultural machinery registration department of the head office of the State Production and Consumer Service in Poltava Region [1], this analysis will cover the period from 2018 to 2023. This evaluation will help determine the availability of complex agricultural machinery such as grain harvesters.

After analyzing the report of Oleg Palii [2], the deputy director of the regional department of agro-industrial development, it was found that in 2023, the farmers of the region harvested approximately 1 700 000 tons of early grain crops, which is an increase of 317 000 tons compared to the previous year (2022). Despite the ongoing war in Ukraine and the challenges faced by the agricultural production such as the increase in fuel and lubricant prices, fertilizers, plant protection products, spare parts for agricultural machinery, as well as a decrease in the purchase price of agricultural products, the agricultural sector of the economy in both the Poltava region and Ukraine as a whole is not only adapting to the new conditions but also showing signs of confident stabilization and further development.

The purpose of the study

The study aims to find technical, organizational, and economic mechanisms for improving the efficiency of grain harvesters by the example of the resource potential of agricultural harvesting equipment in the Poltava region.

Materials and methods

The laws of Ukraine [3, 4] reflect the state's policy on providing agricultural production. The issue of equipping Ukraine's agricultural sector with modern, high-performance equipment has remained relevant since the country gained independence. Scientific studies [5] have analyzed the mechanical engineering sector of agricultural machinery. The article [6] discusses the investment model for renewing fixed means of production using Ukraine as an example. Another study [7] explores the socio-economic factors that affect the implementation of agricultural machinery. Paper [8] presents an analysis of the current state of material and technical resources provision of agricultural enterprises in the Kharkiv region. The article [9] deals with improving the energy sector of the national economy, with a focus on the agricultural sector. Lastly, [10] introduces the components of modern investment models for renewing the primary means of production in the agro-industrial complex.

Studies [11, 12] examine technical service issues related to grain-harvesting equipment, particularly in preparation for the harvesting season. In [13], high-performance combine harvesters from leading global manufacturers are analyzed, focusing on increasing grain productivity up to 100 tons per hour during working time. However, the study also highlights the negative impact of over-compaction of the surface layer of the soil and offers an overview of alternative designs for combine harvesters. Meanwhile, [14–16] delve into crucial questions concerning the reliability and efficiency of grain harvesting machines, their impact on work quality, as well as their durability.

Publications [17–19] focus on the pressing issue of identifying and classifying malfunctions in grain harvesting equipment, as well as enhancing the mechanisms and processes involved in repairing combiner parts and assemblies.

Scientific papers [20–22] cover topics such as the elements of operational evaluation, standardizing the reliability level of newly manufactured Ukrainian grain harvesters, and exploring ways to increase the productivity of harvesting machines.

Publications [23, 24] delve into determining the trends and patterns of agricultural machinery failures, as well as finding ways to improve the technical service of combiners.

The study in [25] found that the design features of the harvester and the speed of movement significantly affect the quality of harvesting soybeans. Article [26] describes how the separation modes impact the quality of threshed grain. [27] provides methodological aspects and results of experimental studies on the operation of grain harvesters. The technical aspects of improving the transport systems of threshers of grain harvesters are discussed in the works [28, 29].

It is possible to observe that scientific research on modern grain-harvesting equipment has a multi-vector nature which can be directed towards several areas. These include the improvement and development of mechanisms for technical support of agricultural production, enhancing productivity, improving technical reliability, enhancing the quality of grain separation, and finding effective systems for the technical maintenance of combine harvesters.

The purpose of this publication is to explore technical, organizational, and economic methods for enhancing the effectiveness of grain harvesters, using the resource potential of agricultural harvesting equipment in the Poltava region as an example.

Results and discussion

Despite the challenges posed by climate change, Poltava farmers were able to collect a significant portion of their grain harvest on time, thanks to the overall productivity of their grain harvesters. This was achieved despite the intense precipitation and difficult weather conditions in 2023 during the threshing of early

grain crops. In this regard, we would like to investigate the number and types of combine harvesters available to farmers in Poltava Region.

The bar charts depicted in ***Figure 1*** are based on statistical data obtained from the unified register for automated accounting of agricultural machinery in the Poltava region, as of 2023. The data includes the total number of grain harvesters and their average age.

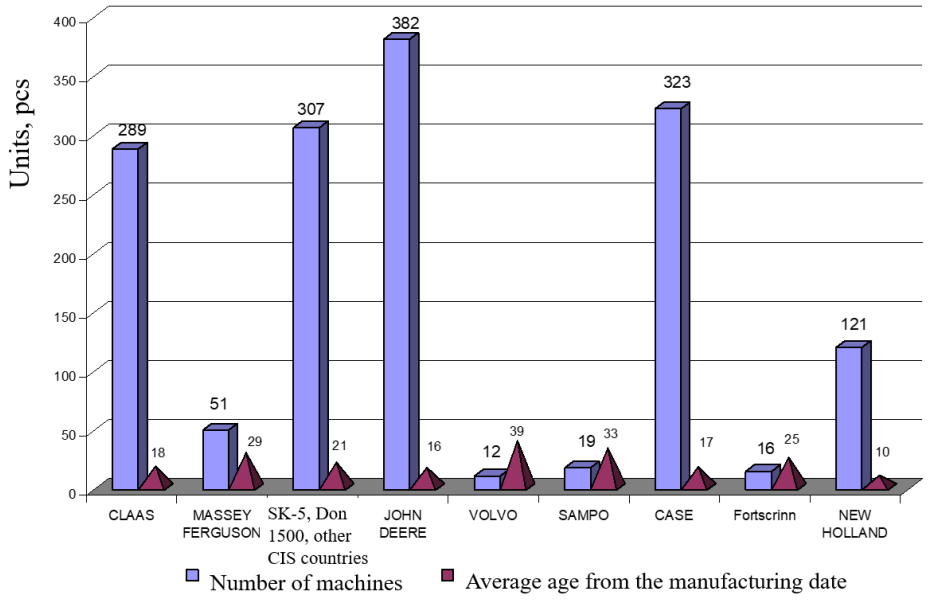

Figure 1. The total number of combine harvesters registered in the Poltava region and their average age from the date of manufacture

Based on data from a single register for automated records of the Agricultural Machinery Registration Department of the Main Department of the State Production and Consumer Service in Poltava region, the authors developed this source

According to the results of the statistical analysis, it is possible to determine that the largest number of grain harvesters owned by agricultural owners of the Poltava region are combiners of the John Deere brand (382 units) and Case (323 units), after that, we have 307 units of combine harvesters produced in Ukraine and post-Soviet countries (Slavutich, Lan, Don, Niva), Claas (289 units), and closes the dominant position in terms of combiners' manufacturers - the number of New Holland machines – 121 units respectively. Less common, relative to the Poltava region, are combine harvesters manufactured by Massey Ferguson (51 units), Sampo (19 units), Fortschritt (16 units), and Volvo (12 units).

At the same time, an interesting point is the average age of registered harvesting equipment. The oldest samples include Volvo harvesters (average age is 39 years), Sampo combines (38 years), Massey Ferguson (29 years), Fortschritt (25 years). While grain-harvesting machines made for small farms are not commonly available, they are still in use. However, as agricultural machinery ages, maintenance costs tend to increase while efficiency decreases. Thus, these machines are only used when there is no better alternative.

We believe that the fleet of combine harvesters produced in Ukraine and the CIS countries is a cause for concern as they are quite old, averaging 21 years. There are a significant number of these machines still in use by farmers (307 units), even if we hypothetically reduce the recommended annual workload to 100 hectares, there is still a lot of harvesting work to be done. The Poltava region is facing increasing challenges in restoring units and assemblies of farming machines and acquiring spare parts. As a result, the majority of technical support for harvesting grain crops is dependent on agricultural machinery from foreign manufacturers such as Claas (with an average harvester age of 18 years), Case (with an average age of 17 years) and John Deere (with an average combine age of 16 years). According to our observations and cooperation with stakeholders, such machines have a fairly high level of technical service, in particular, those models that at one time were purchased new from representatives of the above-mentioned brands.

The analysis of absolute indicators regarding the age distribution of grain-harvesting equipment in the Poltava region is presented in ***Fig. 2***. Based on the statistical analysis presented in the bar charts of Figure 2, it can be concluded that as of 2023, farmers in Poltava Oblast have a total of 68 new grain harvesters that have been used for up to three years. Among these harvesters, 40 are from John Deere, 9 are from New Holland, and 13 are from Claas. We also have a limited number of grain harvesting equipment from Massey Ferguson, Case, combiners manufactured in Ukraine and post-Soviet countries – respectively three units of such machines. Combine harvesters, which are also relevant by age category: from three to ten years old, are distributed in our research as follows: John Deere (89 units), New Holland (78 units), Claas (67 units), Case (57 units), harvesters manufactured

in Ukraine and post-Soviet countries (32 units). In the agrarian Poltava region, we have 391 combine harvesters that are relatively old, up to 10 years. There are also around 1.113 older machines that have been in use for more than 10 years. While the situation isn't entirely positive, there is some encouraging news: a significant portion of both early and late grain crops are being harvested with these old combine harvesters. Practical experience shows that these machines are outdated, with insufficient productivity and quality for harvesting work, and suffer both physical and moral wear and tear.

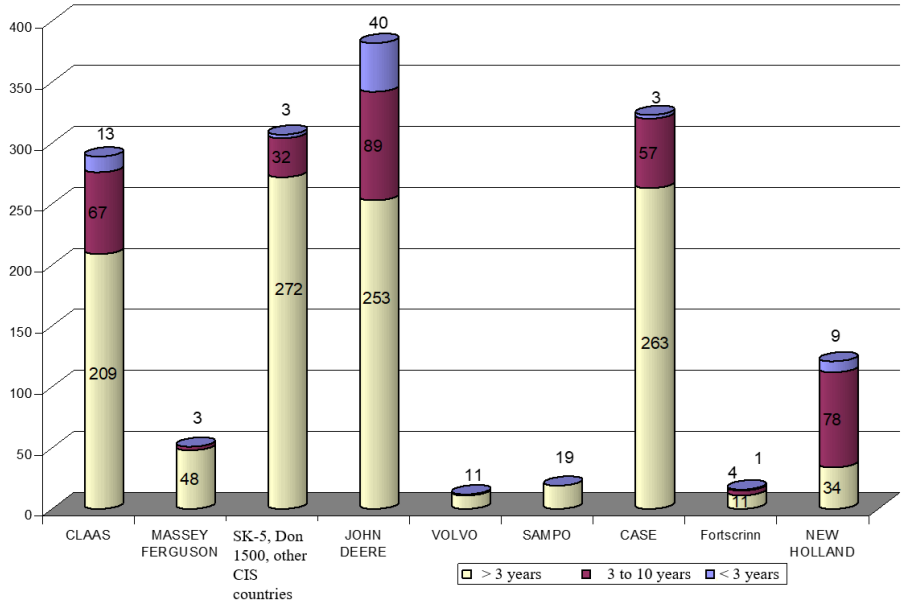

Figure 2. Agricultural machinery manufacturers' absolute quantitative indicators for grain harvester usage period as of 2023
Source: developed by the authors based on the data of a single register for keeping automated records of the agricultural machinery registration department of the Main Department of the State Production and Consumer Service in Poltava Region

Upon examining the data on the usage term of grain harvesters (as shown in ***Figure 3***), we find that the situation is not entirely favorable. If we look at a small percentage of New Holland machines (only 28.10 % of New Holland grain harvesters have been used for more than 10 years), we see that other well-known manufacturers have a significant percentage of grain-harvesting equipment that is older than 10 years. This ranges from 66.23 % for John Deere to 100 % for Sampo.

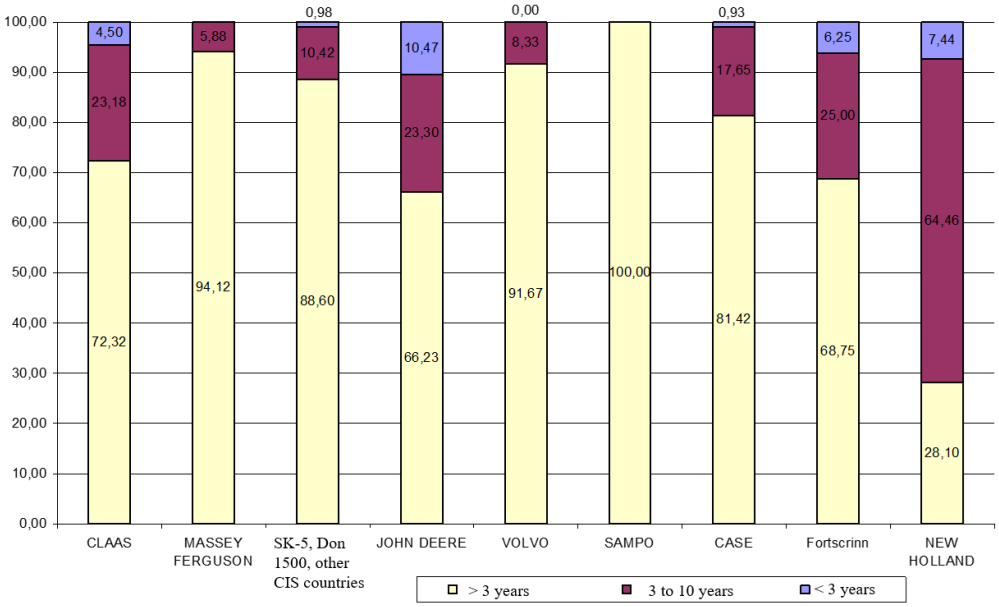

Figure 3. Relative indicators regarding the usage term of grain harvesters by agricultural machinery manufacturers as of 2023
Source: developed by the authors based on the data of a single register for keeping automated records of the agricultural machinery registration department of the Main Department of the State Production and Consumer Service in Poltava Region

In this case, the majority of the combine harvesters used are more than 10 years old. The most commonly used machines, listed in order of age, are John Deere (66.23 %), Fortschritt (68.75 %), Claas (72.32 %), Case (81.42 %), harvesters manufactured in Ukraine and post-Soviet countries (88.60 %), Volvo (91.67 %), Massey Ferguson (94.12 %), Sampo (100 %), and New Holland (28.1 %). As you can see, the most common combine harvesters in the Poltava region are John Deere, Claas, Case, and those manufactured in Ukraine and post-Soviet countries. These machines constitute the main part of the combine harvester fleet in the Poltava region in current conditions.

Undoubtedly, the best way to improve grain production in Poltava Oblast would be to upgrade the current fleet of grain-harvesting equipment. However, the current situation is such that farmers cannot afford to purchase new, high-performance combines, which can cost between 400 000 and 1 000 000 USD. It has been proven that even with such a park of agricultural grain harvesters, it is possible to carry out a significant amount of harvesting work. Therefore, it is important to focus on assessing the technical condition of both new and old grain harvesters. Additionally, there should be a focus on improving the quality of repair work to restore the units and aggregates of these agricultural machines. This is especially important in today's realities.

Conclusions

1. The agrarians of the Poltava region have managed to increase the gross harvest of early grain crops by 317.000 tons in comparison to the year of 2023. However, the harvesting process was not without its challenges, including unstable weather conditions, high fuel and lubricant prices, and relatively low grain purchase prices. Another difficulty was the limited number of grain harvesters available, and the significant physical and moral wear and tear of the majority of machines used by farmers in the region.

2. Based on the results of statistical analysis, it has been determined that the majority of grain harvesters owned by agricultural owners in the Poltava region are combiners of the John Deere brand (382 units) and Case (323 units). Following these, there are 307 units of combine harvesters manufactured in Ukraine and post-Soviet countries (Slavutich, Lan, Don, Niva), Claas (289 units), and finally, New Holland machines with 121 units, which has the least number of machines in the field of combine-harvester manufacturers.

3. Machines used for more than ten years (in order of increase in age): John Deere (66.23 %), Fortschritt (68.75 %), Claas (72.32 %), Case (81.42 %), combiners manufactured in Ukraine and post-Soviet countries (88.60 %), Volvo (91.67 %), Massey Ferguson (94.12 %), Sampo (100 %), New Holland (28.1 %). In the Poltava region, the most common combine harvesters for the category of "combiners older than 10 years" are John Deere, Claas, Case, as well as those manufactured in Ukraine and post-Soviet countries. These machines make up the majority of the combine harvester fleet in Poltava Region currently.

4. In today's world, it is crucial to focus on assessing the technical condition of grain harvesters, both new and old. It's also important to address the issue of poor quality repair work done to restore units and components of these agricultural machines.

Conflict of interest

The authors declare no conflict of interest.

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