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Assessment of selection and use of combine harvesters

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Abstract: *Assessment of selection and use of combine harvesters.* The objective of this study was a comparative analysis of combine harvesters, conducted on the basis of the criterion of modernity and the set of operating and technical parameters of machines offered on the market. In the comparative analysis of modernity, two harvesters were taken into account, manufactured by the same factory in different time periods. The study participants were users of equipment, who assessed selected features of harvesters, assigning specific scores to them in a survey. The respondents assessed positively the engine power, comfort of use, size of the grain container and performance of the newer combine harvester, at the same time indicating the negative features, that is, high cost of purchase and rapid depreciation of the machine.

Key words: farm, maintenance, storage, farming equipment

INTRODUCTION

In modern farming, a combine harvester is as essential as a tractor. As a multi--tasking machine, the harvester makes grain collection much faster, which allows the farmer to take advantage of the optimum weather conditions, which are often of short duration. A combine harvester makes it possible to reduce grain losses and manual labor expenditures, associated with harvesting of cereals and plants with similar technological characteristics [Przybył and Sęk 2010].

A combine harvester is used not only for harvesting of such cereals as wheat, rye, barley, triticale or oats. A properly modified and reconfigured harvester can also be used for harvesting of corn, oilseed rape, agrimonia, sunflower or legumes (lupine, peas etc.). A modern combine harvester, apart from high performance, should provide for [Dreszer et al. 1998]:

- The possibility of harvesting of dry and moist cereals, standing and lodged plants, as well as weedy cereals;
- Losses reduced to a minimum;
- Purity of the grains harvested;
- Proper operation within fields with inclines up to 10%, possibility to work on surfaces with inclines up to 18%;
- Ability to adapt the machine easily to harvesting of various plants;
- Simple and easy management and adjustment, consistent with the requirements of ergonomics;
- High operational reliability, easiness of repair and replacement of damaged parts.

Such great number of functional factors, in combination with technical factors, is decisive for complexity of the decision-making process aimed at selection of the optimum strategy of equipping a farm with harvesters [Izdebski 2003]. It is even more visible, if it is necessary to take into account variability of yields of the plants harvested, which is reflected by model research encompassing methods of estimation of the harvest index in grain crops [Kemanian et al. 2007].

In the context of the broad spectrum of issues associated with use of combine harvesters, the objective of the study was to conduct a comparative analysis of combine harvesters, conducted on the basis of the criterion of modernity and a set of operating and technical parameters of machines offered on the market.

MATERIAL AND METHODS

Within the framework of detailed research, two combine harvesters offered by the same manufacturer were compared. The comparison was conducted on the basis of results of the survey, conducted among the users of these specialist machines.

In detailed research, the following combine harvesters were taken into account: Bizon Rekord Z 058 and New Holland TC 5070. Both models are designated for harvesting of crops from the area of 150 to 200 ha per season.

Bizon harvester is relatively older, designed in the 1980s and no longer produced. Harvester control is fully mechanical.

New Holland TC 5070 is the successor of Bizon. Technical characteristics of the two machines have been presented in Table 1. Harvester New Holland is distinguished by the fact that it is controlled using a multi-function joystick – thanks to this, the machine is controlled by a single hand. This increases the comfort of work, performance and precision of control of the machine. In order to increase performance, an optional rotational separator has been introduced, which increases the harvester performance substantially.

TABLE 1. Technical and operating parameters of Bizon Rekord Z 058 and New Holland TC 5070

Specification	Bizon Rekord Z 058	New Holland TC 5070
Cutting width [m]	4.2	3.9/4.5/5.1
Threshing drum length [cm]	125	130
Threshing drum diameter [m]	0.60	0.61
Threshing floor area [m^2]	0.75	0.79
Sieve area [m^2]	2.92	4.13
Walker area [m^2]	5	5
Grain container capacity [l]	3 500	5 200
Engine power [kW]	88.2	125
Drive unit	mechanical	hydrostatic

Source: Corporation materials.

The methodological approach in the second part of the study encompassed a breakdown of technological and operating parameters of the modern combine harvesters, which were used to identify links between the working parameters

of the analyzed group of machines. Research of this type, in particular, conducted over various time periods [Górski and Klimkiewicz 1992] and using the example of various harvesting machines [Waszkiewicz et al. 2007] constitute a valuable example of an approach towards assessment of trends in development of technological potential in the plant harvesting technology [Pawlak 2011], which is subject to progressing modernization [Olszewski 2009, Gaworski 2013].

RESULTS AND DISCUSSION

For the purpose of a comparative assessment of two combine harvesters, differing in terms of production period, a survey was conducted among the users of Bizon Rekord Z 058 and New Holland TC 5070 machines. Individual features of the combine harvesters in the survey were assessed using the scale from 1 to 10; the score of 1 was treated as the lowest score for a given feature, while 10 was the highest possible score.

The criterion of selection of the survey participants was the previous ownership of Bizon Rekord harvesters, which were then replaced with New Holland series TC, which is the successor of the Bizon harvester. The newer machine is equipped with similar technical solutions, which have been modernized in terms of such aspects as outer appearance, comfort in the driver's cabin etc. The survey respondents included agricultural producers – owners of their own farms and working with the machines personally. The farmers assessed the following features of the combine harvesters:

- technical (engine power, fuel consumption);
- durability;
- running costs;
- performance in tons and hectares per hour;
- comfort of use, ergonomic design of the cabin, tiredness after an entire day of work;
- size of the grain container;
- access to everyday machine handling points.

The survey conducted with harvester users indicates that the successor of Bizon – New Holland – is assessed highly by the users mostly with regard to engine power, comfort of use, size of the grain container, performance and access to everyday handling points. The main advantage of the new combine harvester is the possibility of controlling the machine using a multi-functional lever and a hydrostatic drive. The users pointed out that the latter increased greatly work performance and mitigated tiredness of the operator. In the new combine harvester model, the advantages seem to outweigh the disadvantages greatly. However, the machine is not perfect – it has been reported that fuel consumption increases along with engine power. The running costs are also higher. All farmers complained about the high cost of purchase and rapid depreciation of the machine (Table 2).

TABLE 2. Results of the survey, in 10-point scale, on Bizon (B) and New Holland (NH) combine harvesters

Parameter	Number of a farm											
	1		2		3		4		5		6	
	B	NH	B	NH	B	NH	B	NH	B	NH	B	NH
Engine power	4	7	5	9	6	10	7	9	5	8	4	9
Fuel consumption	8	6	7	7	8	7	8	7	7	6	7	5
Running costs	9	5	8	6	8	6	9	6	8	5	7	5
Comfort of use	4	8	5	9	6	10	6	9	5	8	4	9
Durability	6	6	7	7	7	8	7	7	7	8	6	8
Grain container size	4	8	5	9	6	9	6	10	5	9	4	8
Performance	4	7	5	9	6	8	5	9	4	8	5	10
Everyday handling	5	7	6	8	7	9	6	9	5	8	4	9

Source: Own elaboration.

The second part of the study was aimed at searching for links between the selected technical and operating parameters of combine harvesters of four manufacturers, offering their products on the domestic market.

Figure 1 presents the links between the operating width of a combine harvester and the theoretical performance suggested by manufacturers during harvest. As the operating width increases, so does the theoretical performance of a combine harvester. Using the example of a set of data coming from four companies manufacturing combine harvesters, it can be indicated that the correlation

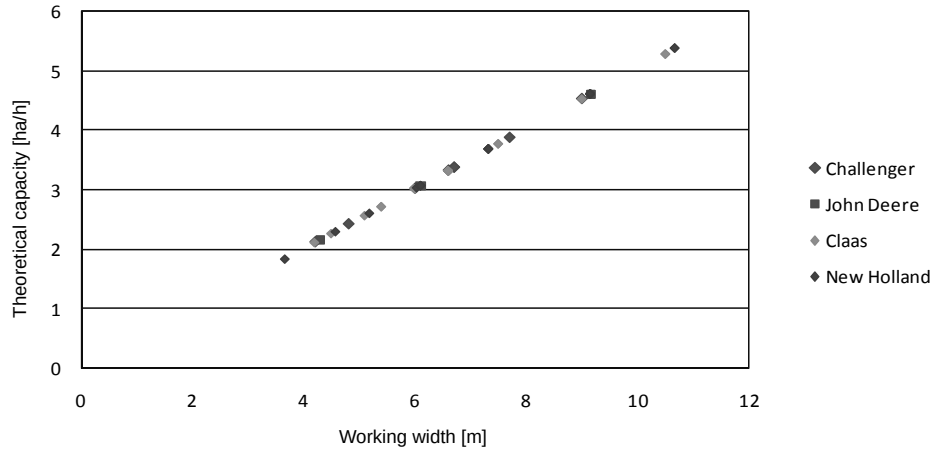

FIGURE 1. A link between the working width of a set of combine harvesters and their theoretical performance
Source: Own elaboration.

model is in form of a straight line. The most comprehensive range of varying widths of combine harvesters has been presented by New Holland, and the poorest – by John Deere. Combine harvesters working at the width of 3.66 m achieve the theoretical performance of about 1.84 ha/h, while machines of width of 10.67 m are able to work at a theoretical capacity of 5.38 ha/h.

Figure 2 presents the correlation between the theoretical performance and the nominal power of the combine harvester engine.

An increase in the engine nominal power is associated with increasing of the theoretical performance of the combine harvester. The quickest increase in terms of this correlation can be observed among Claas harvesters, and the lowest – among John Deere machines. For harvesters with nominal power equal to about 300 KM, the highest theoretical performance has been recorded for New Holland harvesters; it reaches about 3.7 ha/h. A similar level of performance in this power class has been recorded for Claas harvesters. Among the companies examined, New Holland has a machine with the highest nominal engine power of 544 KM, able to reach theoretical performance of 5.38 ha/h. As for nominal power up to 250 KM, Claas harvesters achieve the highest theoretical performance.

Figure 3 presents the correlation between the engine nominal power and the grain container size of a combine harvester. On the basis of the course of changes in Figure 3, it is possible to indicate that as the nominal engine power increases, the manufacturers use grain containers of larger sizes. The fastest growth in this regard can be observed in harvesters made by John Deere, and the

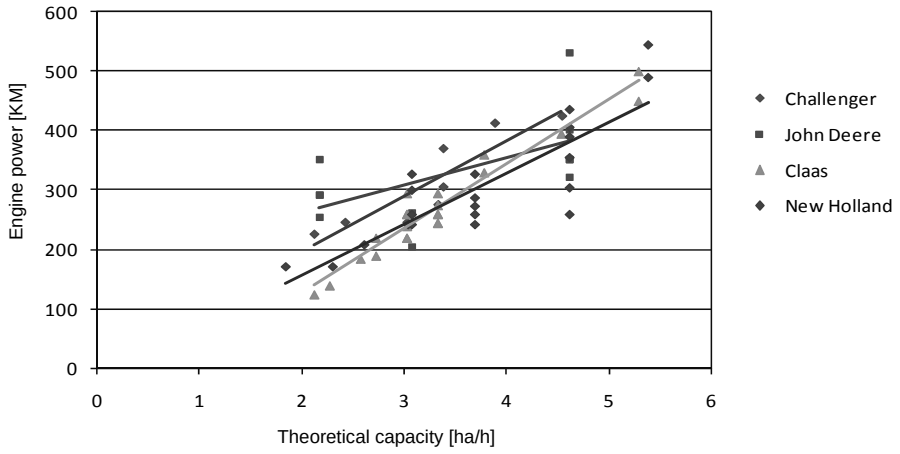

FIGURE 2. Links between theoretical performance of combine harvesters and their nominal engine power
Source: Own elaboration.

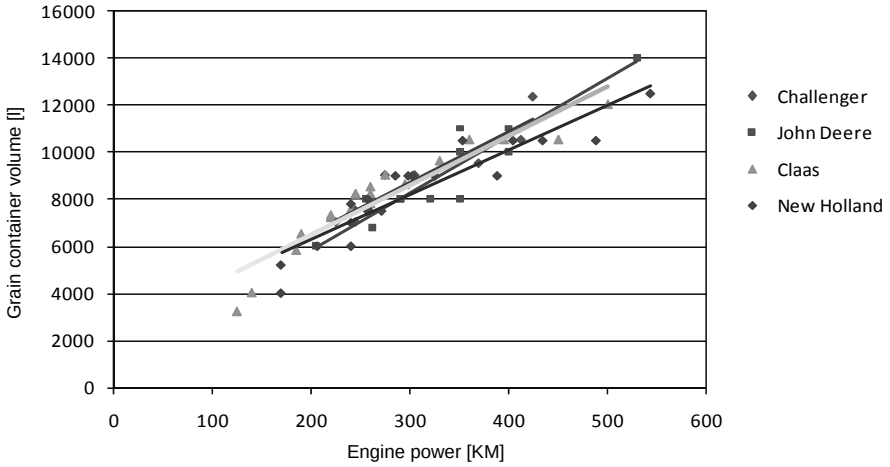

FIGURE 3. Links between the engine nominal power and the grain container capacity in a combine harvester
Source: Own elaboration.

slowest – in New Holland harvesters. Challenger, Claas and New Holland harvesters display intermediate, comparable increase trends in this regard. Among the analyzed harvester models, John Deere has the largest grain container of capacity of 14,000 l, while the smallest grain container is found in a Claas combine harvester – its capacity is 3,200 l.

Figure 4 presents links between the engine nominal power and the threshing drum width. On the basis of data present-

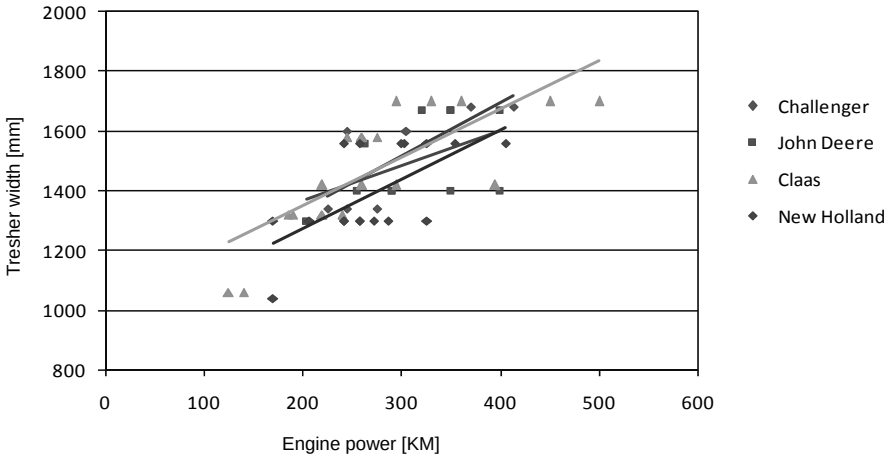

FIGURE 4. Links between the engine nominal power and the combine harvester threshing drum width
Source: Own elaboration.

ed in Figure 4, it can be stated that as the harvester engine nominal power increases, so does the width of the threshing drum. The highest increase in the ratio is recorded for Challenger combine harvesters, and the lowest – for John Deere harvesters. Challenger, Claas and New Holland harvesters display intermediate, comparable increase trends in this regard. In the examined combine harvester models, at varying nominal power, the length of the machine threshing drum is the same for several models of the same manufacturer. The smallest length of the threshing drum has been recorded for the New Holland combine harvester, and the largest – for Claas harvesters. The works undertaken to improve the threshing systems [Zagajski and Dreszer 2006] confirm the need for continuous improvement of effectiveness of harvesters and the quality of their work [Tanaś and Zagajski 2010], as well as safety of operation [Gaworski 2012].

CONCLUSIONS

1. The survey conducted with harvester operators, who have purchased a new generation model, indicated the great importance attached by machine users and operators to such features as comfort, performance and easy handling of harvesters. The market of combine harvesters is very diversified, and many producers propose their own systems and solutions, which encourages comparisons.
2. The companies analyzed offer a comprehensive range of combine harvesters, designated for harvesting of cereals, as well as corn, oilseed rape and other plants.
3. The structural solutions of combine harvester units often vary, but they always perform the defined functions.
4. Claas, John Deere and New Holland companies offer their own corn harvesting tools, cooperating with harvesters.
5. Claas company offers the most developed threshing and separating unit, consisting of a traditional threshing drum with the APS system and a rotor-based separation system.

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Streszczenie: *Ocena doboru i użytkowania kombajnów zbożowych*. W pracy przedstawiono porównawczą ocenę kombajnów zbożowych, przeprowadzoną na bazie kryterium nowoczesności i zbioru parametrów eksploatacyjno-technicznych maszyn oferowanych na rynku. W porównawczej ocenie nowoczesności uwzględniono dwa kombajny produkowane przez tą samą fabrykę, lecz w różnym okresie. W badaniach wzięli udział użytkownicy sprzętu, którzy w ankiecie oceniali w skali punktowej wybrane cechy kombajnów. Respondenci pozytywnie ocenili moc silnika, komfort użytkowania, wielkość zbiornika na ziarno i wydajność nowszego kombajnu, wskazując równocześnie na cechy negatywne, tj. duży koszt zakupu i szybki spadek wartości maszyny.

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