WORKING PARAMETERS OF ROSTSELMASH TORUM COMBINES

Vlad Nicolae ARSENOAIA[1], Anca CALISTRU[1], Tudor AOSTĂCIOAEI[1], Roxana Nicoleta RAȚU[1], Ionuț VELEȘCU[1], Ioan ȚENU[1]

e-mail: vnarsenoaia@uaiasi.ro

Abstract

Agriculture and plant cultivation have been and will continue to be important areas of human endeavor; they have always been a part of everyday life for people. Instead, man sought out techniques, devices, and technologies to streamline labor and make the most of the biological potential of cultivated plants. As a result, there has been a continuing need for improvement and knowledge in this subject, which is a science in and of itself. This technological development represents a true revolution of contemporary technologies, integrated in the most significant activity sector of humanity, agriculture, as a result of the transition from manual tools to modern, self-guiding machines and from manual grain harvesting to the creation of true mobile processing factories known as generic combine harvesters.

Key words: harvester, cereals, TORUM

Since the first grain harvesters had stationary modes of operation and the only tasks they performed were threshing and cleaning of seeds, systems have been followed and developed through which the quality and energy indices of this mobile processing station fulfill as many tasks as possible, be readily adaptable for various types of agricultural crops, and carry out grain threshing works in the quickest amount of time. As a result, we are now developing high-capacity grain harvesters that have a number of integrated technologies for enhancing the quality of the harvested goods (Cazacu D., Roșca R., 2020).

The harvesting equipment currently on the market needs to adhere to a number of standards and guidelines set out by both farmers and the technology systems used to cultivate plants under intensive or mixed systems.

Therefore, the harvesters must satisfy the following requirements: to be suitable for multiple types of culture, and the harvesting machine must be able to adapt to different types of work equipment; to present a simple operative character; and to make the transition from one culture to another relatively simple to achieve; presenting integrated processing methods for the crops that will be harvested, including cutting the plants, threshing the ears, separating the seeds from the plant, ensuring the storage of the grains for a brief period of time, and simultaneously performing shredding or chopping of the vegetable remains that were left unthreshed; being able to perform the threshing and harvesting of the seeds of various crops with the highest level of precision, achieving the lowest level of crop losses. As a result of these specific characteristics of the agricultural machines for harvesting cereals and not only, we understand that the permanent development of the technologies applied in agriculture is absolutely necessary, in order to carry out efficient works with a minimum of losses, but also for the efficiency of agricultural technologies by recording the quantities of harvest threshed from a certain area (Petcu G., 2018; Zhalnin *et al,* 2018).

The integration of automatic adjustment and piloting systems offers greater ease in operating these machines that perform the last but also the most important work in the technological flow, more precisely the harvesting of grain crops. Cutting the plants, threshing the plant (represents the action of separating the seeds from the vegetative part of the plants), collecting and transporting the finished product in after harvesting are the well-established technological operations in the technological flow to be harvested that make up the complex process of harvesting cereals.

Because the harvest decades are well established as being as brief as possible to prevent grain losses, even the smallest delays can result in losses that are significant, making this process one of the most significant works within the technological flow of growing agricultural crops. Cutting the plants, threshing the plant (represents the action of separating the seeds from the

[1] Iasi University of Life Sciences, Romania

vegetative part of the plants), collecting and transporting the finished product in after harvesting are the well-established technological operations that make up the complex process of harvesting cereals (Cazacu D., 2021).

This process is one of the most important works in the technological flow of growing agricultural crops since the harvest decades are widely accepted as being as quick as feasible so that there are no grain losses. Significant losses can be caused by even the smallest delays (Zhalnin E.V., 2013; Zherdev M.N., Golovkov A.N. 2016).

As a result, harvesting is carried out as quickly as possible while adhering to the ideal harvesting stage for each crop, limiting grain losses, and causing them as little damage as possible (Huzum N., 2013).

The grain harvesters were originally designed as fixed machines that only carried out the beating, shaking, and cleaning of the seeds, cutting, and transorting the plants to be harvested to the threshing machine, which was done manually by humans (Leontescu M., 2016; Izmailov A. Yu., Moskovsky M.N.,2018). However, through their use, they have gradually expanded, being able to be equipped with different equipment that enables the harvesting of several agricultural crops.

Currently, harvesters make it possible to harvest a variety of agricultural crops, including grains and others, such as wheat, corn, sunflower, soybean, pea, oilseeds, and grasses, by simply altering the parts of the working organs and the operating procedure (Ibanescu A., 2015).

As a result, this field, which is a science in and of itself, has had a constant need for advancement and knowledge. The transition from manual tools to modern, self-guiding machines and from manual grain harvesting to the creation of true mobile processing factories known as generic combine harvesters makes this technological advancement represent a true revolution of modern technologies, integrated in the most important activity sector of humanity, agriculture.

MATERIAL AND METHOD

TORUM is a powerful rotor combine harvester, one of the most efficient in the world. TORUM can harvest over 2000 hectares of different crops, obtaining 40 tons of grain per hour and 300 tons per shift (Zhalnin E.V., 2013).

The harvester is based on a unique ARS (Advance Rotor System) threshing system. Additionally, in the semi-tracked version, thanks to the increased area of the support area, this combine harvester is one of the most acceptable solutions for submerged fields for soybean and rice crops.

The new generation of feeding chambers significantly increases the functionality of the harvester and operational comfort for different crops. The basic configuration benefits from a hydraulic coupling, adjustable angle for better performance and easy harvesting of any crops without making changes, with quick adapter connections (modules weighing 4500 kg).

The TORUM uses the L6 engine, Cummins QSG 12 (520 HP, Stage IV). The powerful and compact engine has a good specific consumption rate for fuel and a torque reserve of up to 20%.

The air cleaning system uses a forced rotation air intake mesh (from the hydraulic motor), which significantly reduces the complexity of maintenance (Lobachevsky YP, 2016).

The proper front equipment is necessary for such a highly efficient combine. Everyone knows that the harvest begins with the reaper. Therefore, making the right decision is the most important aspect when selecting a combine harvester.

Thanks to it, the mass is threshed three times with a single rotation of the rotor, unlike the single threshing in the case of conventional rotors. The same principle allows the configuration of larger threshing distances as shown in *figure 1.*

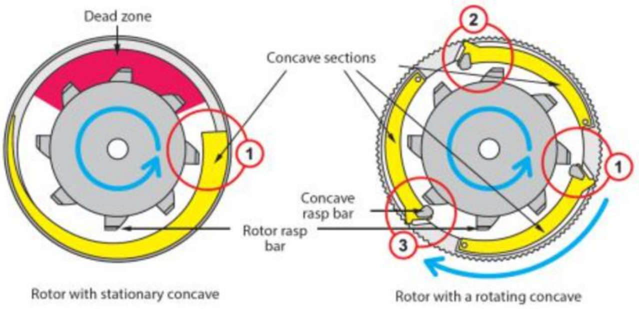

Figure 1 **Advanced rotor system with rotary concave profile**

In the case of a rotary harvester with a stationary concave profile, the concave area is not fully used, therefore the possible performance indicators are reduced. Except for the incomplete use of the concave zone, when harvesting wet rice crops, the upper part of the concave zone is coagulated (the so-called dead zone). The rotating concave profile allows 360° use of the concave surface, prevents the formation of dead zones and prevents rotor braking. In addition, the concave area has three threshing sections that allow a threshing gap to be established in one of the sections.

No additional adjustment of the concave profile is required depending on the harvesting conditions of the crop: for crops from barley to wheat the threshing distance is configured in the range of 16-20 mm.

The clean grains reach the tank with a capacity of 12300 liters. this capability increases performance efficiency by reducing download cycles. the discharge rate is 120 l/sec, the entire tank is discharged in 2 minutes. The length of the unloading auger is increased and reaches 7.5 m, the unloading height - 5.4 m, the opening angle - 105 degrees.

Grain can be easily unloaded into any truck or trailer using a harvesting module up to 14m wide, when harvesting rice unloading can be done without leaving the ramp. for efficient consumption, the threshing mechanism can be deactivated.

The rotor is driven by the cvt system of the planetary gear with hydraulic control - a unique hydro-mechanical device, which combines the advantages of both types of mechanisms: smooth and precise speed control, high bearing capacity and reliable transmission without a belt.

For heavy conditions the harvester allows the installation of the AWD system, for extreme conditions the modification with the semi-track unit and the AWD system is provided.

In addition, in the basic configuration the power from the hydraulic transmission mechanism increases so that the combine can easily climb hills with a full grain tank.

RESULTS AND DISCUSSIONS

Due to these unique qualities of agricultural machinery used for harvesting cereals and other crops, we have come to realize how crucial it is for agricultural technologies to continue to advance. This is true both for the efficiency of agricultural technologies by tracking the amounts of harvest threshed from a specific area as well as for the efficiency of agricultural technologies in general.

The incorporation of automatic adjustment and piloting systems makes it easier to operate these equipment, which more precisely harvest grain crops, the final but most crucial task in the technological cycle.

With a feed rate of between 23 and 25 kg/s for corn crops and a loss coefficient of less than 1.5% at speeds between 4.5 and 5 km/h, this combination offers the potential to harvest 3.8 to 4 hectares of maize every hour.

Because the plant residue chopping system has an adjustable minimum rotation speed that is too high, the corn stems are quickly chopped and the cobs with grains are fragmented or discharged on the ground, which significantly increases the percentage of grain losses at the level of the front attachment used for the corn crop, or the header.

It was established that the feed rate for the sunflower crop when the harvester combination was monitored was 19–21 kg/s with a loss coefficient under 3%.

The grain damage was more severe due to the plants' elevated humidity at harvest, which measured 6–6,3 percent.

In sunflower cultivation, the operating capacity per hour ranged between 3.4 and 3.8 ha/h, producing 3700 kg of seeds per hectare on average.

The study combine does not have the option of mounting a copying system on the slope; instead, it provides support through systems integrated regulation and directing of sieves, seeds, and air, to achieve the best cleaning with a minimum of grain losses.

The auxiliary systems for a better cleaning of the seeds in slope conditions have facilitated the good operation of the combine and the quality of the work performed.

As a key metric for judging the effectiveness of the grain harvester, the precise fuel consumption stated in liters/ton is particularly significant.

The average fuel consumption for one ton of harvested product did not exceed the value of 3.2 liters/ton, which in the current economic conditions renders this combination has an added advantage for low consumption and maximum performance.

Thus, taking into account the high working capacity but also the high energy performance of up to 530 horsepower.

CONCLUSIONS

It must be mentioned that foreign firms do not supply to evaluate the quality of their manufactured harvesters' performance under the conditions of harvesting our country, although providing them in big quantities and at a comparatively high buy price.

The concave area on the rotary combines with a fixed concave is not used to its full extent, reducing the potential performance. In addition, when harvesting damp crops or rice, the top of concave becomes plugged (the so-called dead zone).

The rotating concave allows using 360° of the concave surface and avoiding dead zones and the rotor plugging. The rotor, 3200 mm long and 762 mm in diameter, provides a threshing and separation area of 360 degrees — as much as 5.4

sq.m. The concave forms three threshing sections, allowing to set the clearance in one cross section. So, in one rotor revolution the heap is threshed not once, but three times. In addition, the concave design allows setting increased clearances.

No additional adjustment of concave is required depending on crop harvesting conditions: for crops from barley to wheat, the threshing clearance is set between 16 and 25 mm.

TORUM 750 comes with inline 6-cylinder Cummins engines. Powerful and compact, these engines have good fuel consumption and torque reserve. The air cleaning system uses an air intake screen with forced rotation (by a hydraulic motor), which significantly reduces the maintenance effort. A special rotating vane between the coolers provides their self-cleaning, increasing the useful operating time.

TORUM 750 combines are equipped with Comfort Cab II. Climate control, cab noise insulation and suspension system, air-suspended operator's seat, additional assistant’s seat, beverage cooler, Adviser IV voice information system, and Agrotronic Agromanagement platform come in basic configuration.

Adviser IV voice information system continuously monitors the threshing process and the functioning of combine mechanisms, allows to monitor the process stability and prevent the failure of units.

The feeder house beaters spread and accelerate the compressed crop material before it enters the rotor. The implemented Feed & Boost principle ensures the process stability and low energy consumption of the unit. The advantages of the feeder house are especially clear when working with uneven windrows, or moist and weedy crops. Experience shows that unlike conventional slat conveyors, such a scheme increases the feeder house throughput by 20%, while the power consumption is reduced by 15%.

For TORUM 750, a combine version with improved chain slat type feeder house (with for/aft tilt) is available as well. This function is of particular help when harvesting soybeans and corn.

The clean grain goes into a 10,500 l grain tank. This capacity increases the performance by reducing the unloading cycles.

The unload rate is 105 l/s, the full grain tank is discharged within 2 minutes. The unloading auger length is now increased to 5.7 m, the unload height is 5.2 m, the reach angle is 105 degrees. This allows an easy unloading of grain into any truck or trailer, even when a 11 m header is used. When harvesting rice, unloading can be done without leaving the bay. An unloading and rear view video monitoring system is available as an option (e.g., for unloading on the move).

The rotor is driven by a hydraulically controlled planetary CVT (continuously variable transmission) — a unique hydromechanical device that combines the advantages of both types of drives: smooth and accurate speed control, high bearing force, and reliable beltless transmission.

ACKNOWLEGMENTS

The realization of the study is part of the Activity of type D collaborative activities - Industrial research and/or experimental development activities carried out by the research organization in effective collaboration with the enterprise, Subactivity D. 2 - Research on cost analysis in vegetable farms and how in which they influence farmers' decisions - Contract 3.D.119611/ 25.01.2021.

REFERENCES

Cazacu D., 2021 – *The research method to determine the work quality, energy and exploitation indices of grain harvesters, Iași*.

Cazacu D., Roșca R., 2020, – *Exploitation of agricultural aggregates, Iași*.

Huzum N., 2013 – *Industrial machines and equipment, Bucuresti*.

Ibanescu A., 2015 – *Exploitation of agricultural machines, Craiova*.

Izmailov A. Yu., Moskovsky M.N.,2018 - *Podlesnyi D.S. Development of a set of working units from polymeric materials for the design of combine harvesters*, International Conference on Modern Trends in Manufacturing Technologies and Equipment (ICMTMTE 2018) electronic edition. Cep "MATEC Web of Conferences" 2018. q. 05010.

Leontescu M., 2016 – *Assembly of machines and industrial installations, Timisoara*.

Lobachevsky YP, 2016 - *Methodical recommendations on the implementation of monitoring systems and management of harvest-transport complexes* / co-authors: FSBI FNATS VIM. M., 2016.107 p.

Petcu G., 2018 – *Technology guide for wheat, corn and sunflower, Cluj-Napoca*.

Zhalnin E.V., Cench Yu.S., Pyanov V.S. 2018 - *Technique for analyzing the technical level of combine harvesters by functional and design parameters* // Agricultural Machines and Technologies. V. 12. No. 2. p. 4-8.

Zhalnin E.V., 2013 - Security of Russian farms with grain harvesting equipment // Rural mechanicizer. No. 3. P. 4-6.

Zhalnin E.V., **2013** - Optimization of the machine use of a powerful reserve for increasing the efficiency of agricultural production // Science in Central Russia. No. 1. P. 4-15

Zherdev M.N., Golovkov A.N. 2016 - *Scientific and analytical review of test results at the Central Chernozem MIS of self-propelled combine harvesters* // Federal State Budgetary Institution “Central Chernozem State Zonal Machine-Building Testing Station”. Pos. Reeds. No.2.128p