# STUDIES ON THE CLEANING SYSTEM OF SELF-PROPELLED CEREAL HARVESTER COMBINES

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***Abstract.*** *The aim of the paper is a better organization of mechanical work in agriculture, taking into account the following aspects: selection and using the methods and the optimal work procedures which ensures obtaining the production quantities with minimal expenses. The second aspect, is the assembly of all works and operations within the cycle of agricultural production in such succession and correlation to be able to ensure optimization of the production processes. Due to the appearance of agricultural machines with superior technology the possibility of increasing agricultural production was created and reducing its cost. A primary objective of modern agriculture is the intensive development of agricultural production, as an essential condition for obtaining the highest possible productions per surface unit and with the lowest possible expenses per product unit. Experimental studies on grain harvesting combines were carried out under working conditions, during wheat harvesting, on a number of 3 self-propelled combines, from a harvested formation on the territory of Moșnița. The three types of combines harvester for which measurements and determinations were made, was: 1. CLAAS-98SL MAXI combine: engine-160 CP/2100 rot/min, working width –5 meters; 2. MDW-525 STS combine: engine-268 CP/2170 rot/min, working width –7 meters; 3. John Deere-Hydro 4-1174 S combine : engine–150 CP/2100 rot/min, working width – 7 meters. The three combines harvested in the same formation under identical working conditions, having identical technological settings. The mechanism operation of the connecting rod-crank type sieves gives them a plane-parallel motion.*

***Keywords****: self-propelled combines, cleaning system, technological settings, optimal work*

## INTRODUCTION

Equipping agriculture with self-propelled grain harvesters combine was a consequence of necessity to harvest larger and larger agricultural areas in the shortest possible time and with the minimum possible human labor force. [ANIȘOARA DUMA COPCEA, si colab.2022, DUMA COPCEA, A., si colab.., 2018]. Considering that the technique in the mechanization of grain harvesting works has advanced a lot recently, worldwide, the most important aspect that must be addressed refers to the choice of optimal operating regimes that allow increasing productivity and quality and also reducing costs for mechanized harvesting works. [ DAVID, SAIDA FEIER, 2020, LATO A.M., V, si colab., 2016]. For this reason, a main aspect studied refers to the current state of agricultural machinery for grain harvesting. [ CASIANA MIHUȚ, si colab., si colab.,2022, LATO, K. I.., si colab., 2019].

The self-propelled combines intended for the complete harvesting in the form of grains of grassy cereals, simultaneously performs reaping, threshing, grain cleaning and their collection in its own bunker. [STEF, RAMONA, și colab., 2022]. For the harvesting of other crops, equipment is installed on the combine that ensures their adaptation to specific conditions: the equipment intended for harvesting the sunflower; the cob picker intended for harvesting corn in the form of grains; the equipment intended for harvesting the soybean crop. [DUMA COPCEA, A., și colab., 2021]. Harvesting combines, provided with the equipment mentioned above and with a series of simple adaptations and adjustments, can harvest in optimal conditions. From the point of view of the threshing process, worldwide, two variants of self-propelled combines for grain harvesting can

be distinguished: - combine with tangential threshing device (conventional combine); - combine with axial threshing device (combine with axial flow). [MIHUȚ, CASIANA, și colab , 2014, MIHUȚ C. , 2014].

As a result of the threshing process, two material fractions result: the fraction that does not pass through the contra-beater and the fraction that passes through the contra-beater. For combines with a tangential threshing machine, the threshing process is carried out as follows: - the first fraction, which does not pass through the counter beater, is directed by the post beater to the separation system (belt shaker). This fraction consists of: straw, un-threshed ears of wheat and loose grains in the straw. [NITA L., și colab ., 2019, NIȚĂ L., și colab, 2018 ]

For the right functioning of self-propelled combines during work and to reduce grain losses, it is necessary to perform a series of technological adjustments. These adjustments are made before starting work and during work, both at the header and at the batose. [OKROS A., 2015, OKROS A., și colab, 2018]

Adjusting the cutting height. This adjustment is carried out by raising and lowering the cutting platform with the help of the two hydraulic lifting cylinders, controlled from the hydraulic distributor by a lever. [OKROS A., și colab., 2014]

The adjustment of the chain splitters is done as follows: For normal crops, the splitters mounted in the extension of the platform shields are adjusted only as the height of the spikes, with the help of the adjustment screws.

For crops lying down and with a long length of plants, the platform will be equipped with special wire splitters that have the additional possibility to adjust their shield vertically and laterally, and the two bars, inner and outer, to adjust their proximity or distance from the splitter . For fallen crops it is mounted on the plant lifting cutting platform.

Cutter settings

Harvesting plants with minimal grain loss requires a good sharpening of the knife as well as a correct adjustment of the cutting device.

The cutting of plants is done by shearing by two distinct elements: the cutting blades of the knife and the counter-cutting blades of the fingers.

Feed screw conveyor adjustments

At the feeding helical conveyor, the following can be adjusted: the approach and distance of the conveyor from the bottom of the platform, the horizontal movement of the conveyor, the adjustment of the scraper and the adjustment of the retractable fingers.

The flapper settings. [ANIȘOARA DUMA COPCEA, si colab.2022].

When adjusting the thresher, it must be taken into account that it works without producing losses of plants and grains. Since the condition of the chain is different, it is necessary that the harvester is constantly adjusted during work. [DUMA COPCEA, A., si colab.., 2018]

The following adjustments are made to the harvester:

- adjusting the speed of the thresher;
-adjusting the position of the flapper in the vertical plane;
-adjusting the position of the flapper in the horizontal plane.

## MATERIAL AND METHODS

The three types of combines harvester for which measurements and determinations were made, was:

1. CLAAS-98SL MAXI combine: engine-160 CP/2100 rot/min, working width –5 meters;

2. MDW-525 STS combine: engine-268 CP/2170 rot/min, working width –7 meters;

3. John Deere-Hydro 4-1174 S combine : engine–150 CP/2100 rot/min, working width – 7 meters.

The three combines harvested in the same formation under identical working conditions, having identical technological settings. The mechanism operation of the connecting rod-crank type sieves gives them a plane-parallel motion. [DUMA COPCEA, A.,si colab., 2018]

At each combine, the parameters of the cleaning system were measured, namely:

- the speed rotation of the drive shaft of the cleaning system,
- radius of the crank;
- connecting rod length;
- the length of the oscillating system;
- the sieves dimensions;
- the angle of inclination of the sieves;
- the angle of the direction of oscillation of the sieves;
- the angle of the airstream direction.

To determine the hourly working capacity (t/h) was taken into account of the effective time for filling the bunker with seeds, by the bunker volume and the hectoliter weight of the harvested wheat (780 kg/m3). At each combine, a number of four timings of the actual time of filling the seed bunker were made and the arithmetic average of these timings was taken into account to determine the hourly work capacity.

**RESULTS AND DISCUSSIONS**

The cleaning system of the CLAAS-98 SL combine facilitates the harvesting of grain on sloping land. This CLAAS-3D dynamic slope leveling cleaning system enables harvesting with the same productivity on land with a slope of up to 20% as on flat land.

Slope gradients can cause high losses in the clearing area. At an inclined position of the combine, the harvested product slides down the sieve, the air currents look for the most accessible path and blow through the free spaces, without keeping the chaff and short straw in suspension. As a result, a thick layer of material is formed, and the grains can no longer be separated from the chaff.

Combine MDW-525 STS equipped with a cleaning system that keeps the sieves horizontal regardless of the slope of the land. The clinometer cleaning system keeps the screens in a horizontal position regardless of the slope of the land and ensures constant productivity.

The sites are equipped with a "Self-Levelling" horizontalization sensor that works automatically. It makes the sieves work in a horizontal position regardless of the inclination of the combine and the slope of the land, ensuring a constant productivity. The efficiency of the system is increased by achieving a constant flow of material, with the help of self-adjusting dividers. In addition to the fact that the sieves have relative movements in the opposite direction, the upper sieve has a longer stroke thus ensuring a more efficient transport of the material.

The self-propelled combine John Deere - 1174 S has a dynamic cleaning system that is characterized by a high cleaning capacity, in different working conditions and for different crops.

The cleaning system of the STS series combines is characterized by pre-separation with the help of inclined air currents. The high-capacity helical conveyors ensure the feeding of the sieves with a constant and uniform flow of material, even when harvesting on sloping land.

The Dual-Flo centrifugal fan is equipped with 12 blades and ensures a high flow of air, constant and evenly distributed on the separation surface of the screens.

A percentage of about 20% of the air discharged by the fan is sent to the pre-separation screens in front. The chaff is removed from the combine even before it reaches the rear cleaning sieves. Taking into account that in many cases the material waste contains up to 40% chaff, with

this cleaning system the separation productivity increases without the need to increase the surface of the sieves. The previous pre-cleaning screen separates about 1/3 of the material debris thus reducing the volume of grain and chaff that reaches the screen.

The screens of the cleaning system are divided longitudinally. The adjustment of the opening of the sieves is carried out by electric control from the cabin of the combine.

Adjusting the speed of the beater, which consists in changing the speed with the help of the variator during operation. This adjustment is made from the control station, several times during the day, depending on the condition of the field, so that the percentage of broken grains or unthreshed ears is minimal. Adjusting the distance between the beater and counter-beater.

The distance between the beater and counter-beater varies depending on the nature of the crop, the diameter of the seeds, the humidity of the harvested material and the degree of detachment of the seeds from the ear. The rear opening between the beater and counter beater must always be smaller than the front opening to ensure the beating of the harvested crop by the friction effect.

Adjusting the cleaning system consists of adjusting the opening of the screens with the blinds, adjusting the inclination of the screens, adjusting the intensity and direction of the fan's air current.

The cleaning system of grain harvesters is a working organ inside which a complex process of separating the seeds from the debris resulting from the threshing machine and the shaking system by removing impurities, with direct implications on the performance of the combine and the quality of the harvested material.

In the cleaning process, two distinct fractions are retained from the crop, seeds and unthreshed ears, which are further subjected to the action of the working and transport organs of the combine, the rest of the components of the crop being discharged on the ground.

The adjustment of the opening of the upper sieve and the extension of the upper sieve is carried out depending on the type, humidity and degree of maturity of the harvested crop. In general, a large opening of the blades is recommended to benefit from the cleaning effect in the air current produced by the fan. The lower sieve is interchangeable and is chosen (as hole sizes) according to the size of the harvested crop seeds. Grain harvesters are delivered with a sieve set for harvested crops. In the overall cleaning system, an essential role belongs to the fan, which through the characteristics of the air current must ensure certain distributions of the speed field along the length and width of the sieves, so that seed recovery is more efficient and seed losses are as low as possible. Adjusting the volume of air produced by the fan is performed by changing the speed of the fan. The lower sieve is interchangeable and is chosen (as hole sizes) according to the size of the harvested crop seeds. Grain harvesters are delivered with a sieve set for harvested crops.

In the overall cleaning system, an essential role belongs to the fan, which through the characteristics of the air current must ensure certain distributions of the speed field along the length and width of the sieves, so that seed recovery is more efficient and seed losses are as low as possible. Adjusting the volume of air produced by the fan is performed by changing the speed of the fan.

## CONCLUSIONS

Based on the centralized data, following the measurements and experimental determinations carried out on the three self-propelled combines, the following conclusions were established:

-The average hourly productivity is proportional to the separation surface, to the power of the drive motor, respectively to the supply flow.

-Fuel consumption per ton of grain decreases with increasing hourly productivity.

However, important differences appear between the three combines in terms of hourly productivity related to the separation surface of the mechanical sieves. The threshing machines of the MDW-525 STS, CLAAS-98SL and John Deere-1174S combines are of the forced loading type, their work process directly influencing the process of separation-cleaning as well as the dynamics of the separation-cleaning activity. Due the fact that the feed flow rate of the threshing machines and the percentage of grains separated from the ears is higher in these combines compared to classic combines, the percentage of un threshed ears decreases, respectively the percentage of grains that reaches the sieve, increases. Another characteristic that explains the increase in the productivity of these combines consists in the pre-separation of chaff and light particles by the air current of the ventilator before the waste reaches the upper sieve of the cleaning system. By increasing the percentage of grains on the same surface of the sieves, the hourly sieving productivity increases compared to that found in classic systems.

From the analysis of the technical characteristics of the threshing machines studied, it is found that worldwide, grain harvesting combines tend to use double threshing machines with tangential flow and threshing machines with axial flow.

The harvesting of straw grains in optimal conditions, on time, without losses and with high purity is conditioned to the greatest extent by the technical condition of the self-propelled combine that participates in the harvesting process. Maintaining the combines in the appropriate technical condition, which ensure their normal functioning, constitutes an essential condition for the for good performance of the harvesting campaign. In the event that the maintenance technical rules are not respected, in sense that they are not performed at the established deadlines and according to the indicated technology, accidental malfunctions occur. For remediation, the combines are stopped from working and as a result the harvest period is extended, losses occur and production costs are exceeded. To avoid these unwanted phenomena it is necessary to perform daily and periodic technical maintenance.

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