RESEARCH REGARDING THE DETERMINATION OF THE WORKING INDEXES FOR THE GRAIN COMBINES HARVESTERS IN WHEAT AND BARLEY HARVESTING

CERCETĂRI PRIVIND DETERMINAREA INDICILOR DE LUCRU AI COMBINELOR DE RECOLTAT CEREALE PĂIOASE LA RECOLTAREA CULTURILOR DE GRÂU ŞI ORZ

***PAHONI C.*[1], *ȚENU I.*[1], *BĂETU M. M.*[1]**
e-mail: pahoni_corneliu @yahoo.com

Abstract. *This work presents the results of laboratory experiments and field studies in harvesting wheat and barley by two combine harvesters: Claas Lexion 560 and Claas Lexion 750, both made in Germany. There are differences between this two combines at both constructive level and the degree of automation. This work has tracked the impact of the existing automation elements in the construction of the combines on the growth of their performance, by determining the work quality indexes and the energetic and operating indexes of the combines studied. The major difference has been done by both the values of the working capacities and the values of the operating coefficients, which were higher for the Claas Lexion 750 combine, to the values obtained by the Claas Lexion 560 combine. Overall, the Claas Lexion 750 combine has proven better performance, due to the higher level of automation.*
Keywords: grain combine harvesters, work quality indexes, the energetic and operating indexes.

Rezumat. *În această lucrare sunt prezentate rezultatele experiențelor de laborator şi în câmp, efectuate la recoltarea culturilor de grâu şi orz, cu două combine de recoltat cereale: Claas Lexion 560 şi Claas Lexion 750, ambele fabricate în Germania. Între cele două combine există diferențe atât la nivel constructiv cât şi la gradul lor de automatizare. Lucrarea de față a urmărit influența elementelor de automatizare existente în costrucția combinelor asupra creşterii performanțelor lor prin determinarea indicilor calitativi de lucru şi a indicilor energetici şi de exploatare ale combinelor. În ansamblu, combina Claas Lexion 750, a înregistrat performanțe mai bune, diferența majoră facând-o valorile capacităților de lucru şi valorile coeficienților de exploatare, care au fost superiori celor obținuți de combina Claas Lexion 560, nivelul de automatizare mai ridicat al combinei Claas Lexion 750 făcând diferența de performanță.*
Cuvinte cheie: combine de recoltat cereale, indici calitativi de lucru, indici energetici şi de exploatare.

INTRODUCTION

Since the straw cereal harvest period is relatively short, it is important that all harvesting operations run on time to avoid significant grain losses. In order to use straw cereals combine harvesters effectively, the combines need to satisfy certain parameters such as: providing the plants cut at a 70 - 260

[1] University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

mm height, cutting the plants without shaking off their spikes, ensuring at least 98% purity percentage of the grains collected (Neculăiasa, 2002). Moreover, it is necesary that the grain losses from the remaining unthreshed spikes does not exceed 1.5%, the shaken grains on the top of the the ground to be less than 1 g/m^2 and the percentage of broken grains to be below 2% (Toma and Sin, 1987).

MATERIAL ŞI METHODS

The experimental research were conducted in 2011 at " SA Zimbrul SA", in the farm no. 3 of the "Ialomita Pond" (Făcăeni - Ialomita) in winter wheat crops, respectively winter barley crops with the biological characteristics presented in table 1, both crops being located on the level ground.

In order to dertmine the combines' technical and functional performance in field laboratory and in the operating conditions, we studied the behavior in exploatation of two combines harvesters: CLAAS LEXION 560 and CLAAS LEXION 750, both manufactured by CLAAS in Germany. The main technical characteristics of the combines tested are listed in table 2.

Table 1

The crops' biological characteristics

Specification	The measurement unit	The average value of the biological characteristics	
		Wheat	Barley
Variety	-	Alex	Cristalia
Grain moisture	%	14.6	14.8
Plants' density	buc/m^2	374	365
Plants' average height	cm	74.5	77.6
Total mass of the plants:	g/m^2	989.45	896.09
- grain mass	g/m^2	437.62	405.86
- straw mass	g/m^2	469.58	450.45
- weed mass	g/m^2	82.25	39.78
Recumbent plants percentage	%	0.67	0.52
Grain production per hectare	kg/ha	4376.2	4058.6
Average straw production per hectare	kg/ha	4695.8	4504.55
Grain-straw ratio	-	0.93	0.90
The 1000 seeds mass	g	46.65	42.4
Mass per storage volume	kg/hl	78.4	63.4

The measurement and the calculation of the work quality indexes, the energetic and operating indexes of the Claas Lexion 560 and the Claas Lexion 750 combines have been done according to the specifications. The measurements were taken in three variants, represented by the three feeding flows of each combine. For each variant a total of three repetitions were performed. The working capacity indexes have been measured and calculated on a 8 hours shift, at a normal working combines' speed, which provided an optimal feeding flow, specific to each combine.

Table 2

The main technical and functional characteristics of the combines tested

The characteristics' name	M. U.	Combine	
		CLAAS LEXION 750	CLAAS LEXION 560
Header – working width	m	7.5	7.5
Beater	-		
- width	mm	1680	1680
- diameter	mm	600	600
- number of rails	-	8	8
- rotation speed	rot/min	395-1150	395-1150
concave	-		
- number of rails		10	10
- wrapping angle	degrees	90	90
Rotary separator		yes	no
First ceaning			
- upper sieve	-	yes	yes
- bottom sieves kit	-	yes	yes
- cleaning area	m^2	5.80	5.80
Second cleaning	-	yes	yes
- number of shackers		2 rotory separators	6
- separation area	m^2	3.00	9.85
Chopping equipment	-	yes	yes
Bunker - capacity	l	10500	10500
Engine - model	-	Caterpillar C-13	Caterpillar C-10
- cylinders' capacity	l	12.5	10.3
- Fuel tank capacity	l	800	800
Transmission - number of speeds	-	3x2	3x2
-rear tires' size		600/55 - 26.5	16.5/85 - 24 IMP
-front tires' size	-	800/65 R 32	650/75 R32 R1
-length with header	m	11.42	11.42
- length without header	m	9.2	9.2
-width	m	3.5	3.5
- maximum height	m	4.85	4.85
Combine's mass	kg	17320	15655

Operating measurements were conducted under normal poduction conditions. The experiments took place in plots with shapes and sizes that could ensure the mechanized harvesting.

Grain moisture was within acceptable limits of 14-16% during the harvest (Toma and Bianu, 1987).

The combines' working proces stages were photographed daily and the daily worksheets were prepared. In these records were recorded: the experiments' location, the crop, the time when the work started, the operations and the period of each operation, the time when the work has ended, the plot's drawing and harvested area, the quantity of the grains harvested, the cutting height, the fuel consumption and the grain moisture.

In the experimental research were also used: metric frame, electronic scale, moisture meter, sheet to collect grains, straws and chaff, plastic bags to collect the grain samples, stopwatch, daily monitoring sheets.

RESULTS AND DISCUSSIONS

The working quality indexes were calculated based on the feeding flows of the combines. The working quality indexes obtained by the combines in wheat and barley harvesting are grouped in table 3.

For the feeding flows on which the combines were tested, the losses value did not exceed the maximum allowable limit of 2.5%. There were, however, significant losses on both combines for the biggest feeding flows in the experiments. Yet, although both combine reported losses to bigger feeding flows, losses percentage were higher in Claas Lexion 560 case, for both crops.

Table 3

The work quality indexes obtained by the Claas Lexion 560 and the Claas Lexion 750 combines in wheat and barley harvesting

Specification	M.U.	Average values											
Crop	-	Wheat						Barley					
Combine	-	Lexion 560			Lexion 750			Lexion 560			Lexion 750		
Average speed	Km/h	3.22	4.33	5.52	3.98	6.00	7.64	3.00	4.04	5.16	3.70	5.57	7.09
Moisture	%	14.6	14.6	14.6	14.6	14.6	14.6	14.8	14.8	14.8	14.8	14.8	14.8
Feeding flow	kg/s	3.32	5.00	6.37	4.23	5.70	7.27	3.08	4.64	5.91	3.95	5.32	6.79
Header losses	%	0.31	0.75	1.00	0.28	0.45	0.77	0.44	1.04	1.33	0.42	0.60	1.19
- on the soil-free grains	%	0.14	0.24	0.24	0.13	0.11	0.31	0.12	0.35	0.32	0.26	0.39	0.59
- grains in the cut-off fallen spikes	%	0.17	0.51	0.63	0.15	0.19	0.33	0.22	0.69	0.79	0.16	0.20	0.30
- grains in the uncut spikes on the soil	%	-	-	0.13	-	0.15	0.13	0.10	-	0.22	-	0.01	0.30
Thresher loss	%	0.43	0.59	1.13	0.16	0.32	0.72	0.60	0.75	1.14	0.31	0.58	1.00
- free grains in chaff and straws	%	0.43	0.48	0.98	0.16	0.32	0.56	0.60	0.75	0.90	0.31	0.58	0.79
- grains in unthreshed spikes	%	-	0.11	0.15	-	-	0.15	-	-	0.24	-	-	0.21
Total losses	%	0.74	1.34	2.13	0.44	0.77	1.49	1.04	1.79	2.47	0.73	1.18	2.19
Purity	%	99.01	98.83	98.09	99.14	98.91	97.94	99.1	98.97	98.00	99.1	98.9	97.4
Broken grains	%	3.39	2.99	2.49	3.48	2.69	2.27	3.72	2.90	2.98	3.45	2.83	2.57

To be metioned the fact that for a feeding flow of 7.27 kg/s achieved by the Claas Lexion 750 combine in winter wheat harvesting and for a feediing flow of 6.79 kg/s performed by the same combine in winter barley harvesting, the grain purity value fell below the minimum allowable limit of 98%.

The operating indexes of the combines tested were calculated based on the timing sheets prepared during the operating experiments.

The average values of the operating coefficients of the combines studied

are shown in table 4.

Table 4

The operating coefficients of the Claas Lexion 560 and the Claas Lexion 750 combines in wheat and barley harvesting

Specification	Symbol	Combine			
Combine	-	Lexion 560		Lexion 750	
Crop	-	Wheat	Barley	Wheat	Barley
Operational time usage coefficient	K02	0.87	0.86	0.87	0.87
Production time usage coefficient	K04	0.80	0.78	0.82	0.80
Shift time usage coefficient	K07	0.71	0.68	0.73	0.71
Turns coefficient	K21	0.94	0.93	0.95	0.94
Technological service coefficient	K23	0.91	0.89	0.92	0.90
Technical care coefficient	K31	0.92	0.95	0.95	0.95
Technological safety coefficient	K41	0.98	0.96	0.98	0.97
Technical safety coefficient	K42	0.98	0.94	0.98	0.93
Operational safety coefficient	K4	0.97	0.90	0.96	0.93

As seen on table 4, the Claas Lexion 750 combine recorded higher values at almost all of the coefficients copared to the Claas Lexion 560 combine. The Claas Lexion 750 combine registered lower values for the operational safety coefficient in winter wheat harvesting and for the technical safety coefficient in winter barley harvesting, but the differences were insignificant.

The work capacities and the fuel consumption average values of the both combines can be found in table 5.

Table 5

The work capacities and the fuel consumption of the Claas Lexion 560 and the Claas Lexion 750 combines in wheat and barley harvesting

Specification	Symbol	M.U.	Specification			
Combine	-	-	Combine		Combine	
Crop	-	-	Wheat	Barley	Wheat	Barley
Hourly work capacity on effective time	Wef	t/h	10.15	9.42	16.72	15.61
Hourly work capacity on operative time	W02	t/h	8.92	8.28	14.73	13.75
Hourly work capacity on production time	W04	t/h	8.01	7.44	13.31	12.42
Hourly work capacity on shift time	W07	t/h	7.07	6.56	11.62	10.85
Work capacity on a 8 hours shift	Wsch	t/sch	56.56	52.48	92.96	86.80
Fuel consumption per reference unit	Gc	l/ha	8.85	8.22	9.82	9.17

The Claas Lexion 750 combine had registered better values on the work capacity indexes, compared to the values recorded by the Claas Lexion 560 combine in both winter wheat and winter barley harvesting. (tab. 5).

The fuel consumption per reference unit was higher on the Claas Lexion 750 combine, then the one registered on Claas Lexion 560 combine, mainly due to the bigger quantity of material threshed and to the bigger cylinders' capacity of the Claas Lexion 750 combine's engine.

CONCLUSIONS

1. From experimental research results can be observed a directly proportional relationship between the feeding flow and the total grains losses of the combines, and a reverse relationship between the feeding flow and the percentage of broken grains.

2. The grains losses did not exceed the maximum allowable limit of 2.5%, this fact proving a quality and a reliability of both combines' construction, especially on threshing and cleaning systems' performance.

3. The Claas Lexion 750 combine, had performed better than the Claas Lexion 560 combine, the major difference being made by the working capacity indexes and the operating coefficients values. Higher values of those indexes registered in operation by the Claas Lexion 750 combine were due to the existence in its construction of the separating rotors that have replaced the classic walkers and the existence of the automation elements, namely: the combine's automatic routing by the chain's edge, the automatic control system of the working speed according to the chain's characteristics and the automatic control of grains losses.

REFERENCES

1. **Neculăiasa V., 2002 -** *Operations and work processes of the agricultural harvesters*. Editura Gh. Asachi, Iaşi.
2. **Toma D., Bianu L., 1987** - *Machinery systems and their efficiency in the plant exploitation.* Editura Ceres, Bucureşti.
3. **Toma D., Sin Gh., 1987** – *The quality of the agricultural work performed mechanized in the field crops*. Editura Ceres, Bucureşti.