

PERSPECTIVES ON THE CONSTRUCTION OF COMBINE HARVESTERS, IN THE LAST YEARS

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Abstract: *Following the change of areas held by owners of large constructors harvesters have adapted their production to meet these requirements, meeting with large and medium-capacity combines, threshing systems leading to improved productivity obtaining large losses as low. This paper presents a brief summary of the development combinations of technology flows in recent years, the main world producers: John Deere, Case New Holland, Claas, AGCO Group (Laverda, Massey Ferguson, Fendt), SAME DEUTZ-FAHR Group etc.*

Key words: *combine, technological flow, threshing, development*

INTRODUCTION

In the last years appeared on the market that combines used for the operation of threshing and separation, combined, a striking tangentially classic and one or two axial rotors, thus leading to the achievement of high productivity, combined flow can reach work contained between 12 and 15 kg/s.

From analysis of the major achievements in the field can highlight the current research worldwide, while pulling out that in recent years have made great technological breakthroughs in this area but were upgraded technological schemes.

After the technological flows, combine harvesters are divided into two categories:

- *combine with tangential threshing apparatus*, where the threshing apparatus is placed transversely, immediately after the central conveyor, the flow of material entering perpendicular to it, the material is taken from the conveyor screw conveyor and placed in the center where it is threshing machine hit the bars (rails) approximately tangentially beater;
- *combine axial threshing apparatus*, where the threshing apparatus is located axially on the longitudinal axis of the thresher and in some cases transverse flow of material moving through the threshing machine as a helical path, the material separates mainly due to friction and forces centrifuges and to a lesser extent collision.

Major production companies combine are:

❖ DEERE & COMPANY

JOHN DEERE U.S. company is the largest agricultural machinery manufacturer in the world with experience in this field for over 140 years in the field. The first plants were built since 1927, since then the company producing over 1,100,000 pieces. Over time the company has spearheaded the development of new times of agricultural machinery and combine harvesters, the company with many factories in the U.S. and Canada, Europe, Asia and Latin America. Currently the company produces branded JOHN DEERE.

❖ CNH - CASE NEW HOLLAND

CASE NEW HOLLAND company was formed in 1999 through the merger of the two largest manufacturers of agricultural machinery and construction equipment: CASE IH and New Holland, becoming one of the world's largest manufacturers of such equipment, along with the American company JOHN DEERE, far away from other competitors: group AGCO, CLAAS, SAME DEUTZ FAHR, etc.

The group has about 100 years experience in producing combine harvesters classical (with tangential threshing machine) - axial flow and NEW HOLLAND - CASE IH, currently farmers can meet all the requirements are produced to combine the capabilities small, medium, large and very large, from 175 ÷ 523 HP, the screening device tangential, axial, or combination thereof.

❖ **AGCO GROUP**

It contains large manufacturers and combines classical tradition in production in recent years developing and range of axial flow combine.

- **LAVERDA:** Breganze based company - part of Italy and AGCO is a multinational group of over 130 years experience in producing specialized equipment for agriculture. Experience gained in more than 100 years in the field to make one of Laverda combine harvesters recognized manufacturers in the world, which is demonstrated by the new models of developed in recent years, incorporating innovative solutions that combine increased performance combines and farm work easier.
- **MASSEY FERGUSON:** multinational company is part of the AGCO and has over 50 years experience in producing equipment for harvesting and threshing grain. The company currently manufactures over 20 models of the factories in Brazil, Italy, Denmark and the U.S., small-medium class, average, high and very high, with power ranging between 175 and 459 hp. Combines innovative solutions leverage multiple discovered in recent years have led to increasing their performance and easing farmers' labor.
- **FENDT:** with the company and LAVERDA MASSEY FERGUSON, FENDT AGCO part of the multinational group and has over 75 years experience in producing tractors, diesel engines and agricultural equipment. In recent years, FENDT began to produce and combine harvesters, so that the company currently manufactures over 18 models, grouped into six series.

❖ **CLAAS GROUP**

The German company CLAAS Group is today one of the major manufacturers of agricultural machinery including combine harvesters, with experience in the field for nearly 100 years. First models of development began in 1930, first built in Europe combining can be done in 1936 and in 1946 he appeared on the market the first self-propelled harvester CLAAS. Over time the company produced threshing machine combines classical tangential, small capacity, medium and large and to increase the working capacity of the combine has introduced two additional traps placed longitudinal rotary threshing device as possible to achieve productivity high.

❖ **SAME DEUTZ FAHR GROUP**

SAME DEUTZ-FAHR Group has over 120 years experience in producing agricultural machinery harvesting self-propelled combines were first built in 1955 KODEL & Bohm GmbH company over the years has built more models by the year 1969 when the DEUTZ-FAHR was acquired from the moment all machines bearing Deutz-Fahr. In 1995 the group formed by the merger SAME DEUTZ-FAHR company with the SAME DEUTZ-FAHR. Combine harvesters Production continued in Germany until 2002 when the factory was moved to Randers in Denmark.

- **VASSALI FABRIL:** Argentine company acquired by Same Deutz-Fahr group in 2008, VASS Fabril produces branded DON ROQUE more classic models of tangential threshing machine: RV 125, RV 125 Electro, RV 150, RV 150 Electro, RV 170; I 1300 and I, 1550, 7500 and the AX model with axial threshing machine.

RESULTS AND DISCUSSIONS

❖ **Deere & Company**

▪ **JOHN DEERE series CWS**

JOHN DEERE series combines CWS (Cylinder Walker System) - Figure 1, combines medium capacity are high, made in two models: 1450 and 1550 CWS CWS, with power being provided with engines of 204 / 262 HP.



Fig. 1 - JOHN DEERE Combine harvesters 1550 CWS [1]

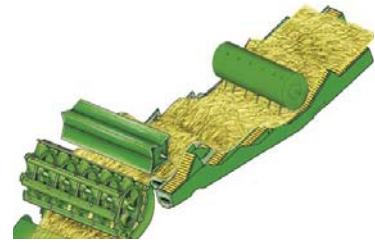


Fig. 2 - Power Divider System [1]

▪ **JOHN DEERE series WTS and W**

WTS combines series were made in 6 models, combining high capacity that is used in the process of threshing and separation system Tine Separation Walker - fingers shake separation. These were engines combine power from 215÷355 HP, but after 2000, to achieve greater work capacity were replaced with more powerful engines in the 9000 series models WTS: WTS 9540 / 9560 WTS / WTS 9580 / 9640 WTS / 9660i WTS / WTS 9680 (Figure 3), thus leading to power between 235 ÷ 373 HP.



Fig. 3 - Combine harvesters JOHN DEERE 9680i WTS [1]

W series combines came on the market a few years after WTS models and are made in four models: W 540 / W 550 / W 650 / W 660, for both field crops and for slopes, being fitted with more powerful engines than WTS Series, 255÷350 HP respectively. W series in recent years appeared on the market with improved models: W 540i / 550i W / W 650i / 660i W (Figure 4).



Fig. 4 - Combine harvesters JOHN DEERE W 660i [1]

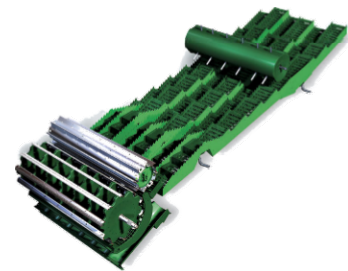


Fig. 5 - Threshing and separation system [1]

Threshing machine combines the WTS and W series is comprised of a beater bar 10 (with a variable speed adjustable), a bar wrapped beater 13 at an angle of 116 ° and postbeater whose barbecue is operated manually.

The shaker is provided to enhance the process with a separator (Power Separator) comprising a cylinder 15-18 fingers, retractable, prepared in line.

Cleaning System "Quadra-FLO" with pre and four fans (blades spirals) with double-flow and speed adjustable. Separate seed husks are transported in a bunker with a capacity of 11.000

liters. WTS combines, and W series incorporates the latest technology to their construction: a platform for cutting and harvesting equipment with HEADERTRAK control system (control and automatic cutting height), cleaning system "Quadra-FLO" with system precurățire and four double-flow fan speed control, slope compensation scheme HILMASTER II separation system - Power Divider with WTS (shake-off fingers), cabin new, improved ergonomic, fitted with passenger seat, automatic control Temperature (ClimaTrak), etc.

• **JOHN DEERE, series CTS**

CTS Series combines high capacity for work are being equipped with power over 300 Hp tangential threshing machine and system CTS (Cylinder Tine Separation) consists of two axial rotors placed lengthwise, which replaced walkers. Longitudinal direction of rotation rotors are different from each other (inwards), their speed and distance of separation screens and rotors automatically adjusts the cabin, the system is assisted by a computer board (Vision Trak Monitor) located in the combine cab. Beater threshing the material is taken from a uniform bitters it moves to the two rotors. By replacing walkers, threshing and separation area greatly increases, which allows processing of larger amounts of material, realizing the separation in excess of 99%, with low losses and injuries.



Fig. 6 - Combine harvesters JOHN DEERE 9780 CTS [1]

• **JOHN DEERE, series STS**

Represents currently combines work with the largest capacity (over 15 kg/s) at this maximum power rivaling a motor over 400 HP, a header whose width exceeds 9 m, but especially the threshing machine represents a true revolution in the field. Threshing machine series of STS (*Single Tine Separation - separation in a single step*) incorporates a number of very valuable ideas:

- to reduce the impact of beater rails / runner on the ears (pods, cobs, etc.) transporter was fitted between the central power and the threshing machine, an accelerator to power - which obviously speeds up the material and reduces the relative velocity between the material and items threshing (rails) rotor;
- unlike other types of thrust combined with sound device when STS - introducing material into the threshing machine is on three streams, which avoids clogging in case of some very large flows of material wet or incomplete maturity;
- to enhance the seed threshing and separation rotor was mounted off center which provides an intense pulsed motion of the material, facilitating the separation of seed;



Fig. 7 - Combine harvesters JOHN DEERE 9880 STS and threshing machine [1]

- by making a 3-tier housing and drive the material elements (fingers) with different lengths to ensure a progressive increase in the intensity of the threshing and separation process, high peripheral speed of the drive that features a bunch the last section of the device ensures threshing ensure an increase in centrifugal forces associated with the pulsating movement, much easier to separate the seeds and reduce losses and threshing machine.

❖ CASE NEW HOLLAND

▪ New Holland series CS

CS Series combines the four models are made for the field and a model - the slope, being fitted with engines that develops a maximum power of 242÷272 HP, this ability to combine work is high because of the width of the cutting device between 4.57÷7.32 m. threshing and separation process is performed using a threshing machine with eight classic bar being adjustable speed, a speed synchronized to the bitters with beater, namely a rotary separator, which enhances shake off the system (the system which controls multi-Tresh™ change of distance between the separator and grate it).



Fig. 8 - Combine harvesters NEW HOLLAND CS540 system and threshing / separation [2]

▪ NEW HOLLAND series CSX

CSX combines series (Fig. 9) are combining high capacity, made in five models for field gradient of 3 models with power ranging between 242÷333 HP and working widths from 7.32 to 4.57 m. The system combines threshing and separation of CSX series consists of a threshing machine, a bitters and a rotary separator (multi-Tresh™) improves the separation shaker system (Flow™ Beater Straw).



Fig. 9 - Combine harvesters NEW HOLLAND CSX 7080 system and threshing / separation [2]

▪ NEW HOLLAND series CX

CX Series combines (Figure 10) are high capacity combines with the header being provided with working widths up to 9.15 m, engines with power ranging from 272 ÷ 455 HP threshing machines with widths of 1300 / 1560 mm (diameter 750 mm), bitters and a rotary separator which contains multi-Tresh™ (which controls the change of distance between the separator and its concave). Opti-Thresh™ system fitted to the threshing machine

control automatically adjust the distance between the beater and againstbeater depending on the operating mode to achieve maximum product quality threshers. rotary separator.



Fig. 10 - Combine harvesters NEW HOLLAND CX 880 [2]

▪ **CASE - IH, series 2300 X-CLUSIVE**

The latest generation of Case IH Axial Flow combine - 2300 Series X-clusive benefit of the latest technological breakthroughs in the field, including three models, each offering exceptional performance: more power, higher productivity, comfort, etc. To the novelty introduced by the 2100 series, 2300 series combines farmers meet the new features: header type 2015 "pick up" X-clusive rotor, AFS (*Systems Farming Advances*) to the satellite via a GPS antenna receives satellite information about the material and control of the machine operating mode, the computer processes the board, the operator can receive basic information and transmits the information; cabin with panoramic views, easy access to commands by simplifying them (multi-hand console straight), control and monitoring all work through automation appliance bodies, powerful spotlights and floodlights for night harvesting, the engine more powerful, economical and reliable, system cleansing "CROS FLOW™" multistoried, higher-capacity hopper, etc.



Fig. 11 - Combine harvesters CASE IH 2388 [3]

❖ **AGCO Group**

▪ **LAVERDA series LCS**

The new series combines LCS (Laverda Crop System) - Figure 12, are of medium to combine high capacity, made in two models and two models for the field gradient.

Combines are equipped with the electronic GSAX (Ground Self Alignment Extra) allowing for adjustment of the cutting device on the ground, both longitudinal and transverse PFR system (Prepare and Feeding Roller), which is intended to prepare the material before entering threshing device - a uniform layer of material and homogenize it, MCS Plus system (Multi Crop Separator Plus), which substantially improves seed threshing and separation system, HCD (High Capacity Design) for setting screens enabling a good separation of seed straw and chaff.



Fig. 12 - Combine harvesters Laverda LCS [4]

▪ **LAVERDA series M**

M Series combines (Laverda Special Power) - Figure 13, are of medium to combine high capacity, made in five models and three models for the field gradient, all models are equipped with the electronic GSAX (Ground Self Alignment Extra), the PFR (Prepare and Feeding Roller), the MCS Plus (Multi Crop Separator Plus) and HCD system (High Capacity Design) for setting screens enabling a good separation of straw and seed husks.



Fig. 13 - Combine harvesters Laverda M 304 [4]

▪ **MASSEY FERGUSON series ACTIVA**

Series combines medium capacity combine assets are made in four models for the field (Figure 14a) and three models for slope (Figure 14b). Main features of the combinations are striking 1.340/1.600 mm wide (600 mm), surface separation walkers: 6,72÷7,99 m² (to combine field) and 5,73÷6,81 m² (to combine slope), surface separation ERM system: 1.89÷2,25 m² (only to combine slope), surface site: 4.67÷5,58 m², hopper capacity: 5.200÷8.800 liters, with power provided by an engine 176÷275 CP.

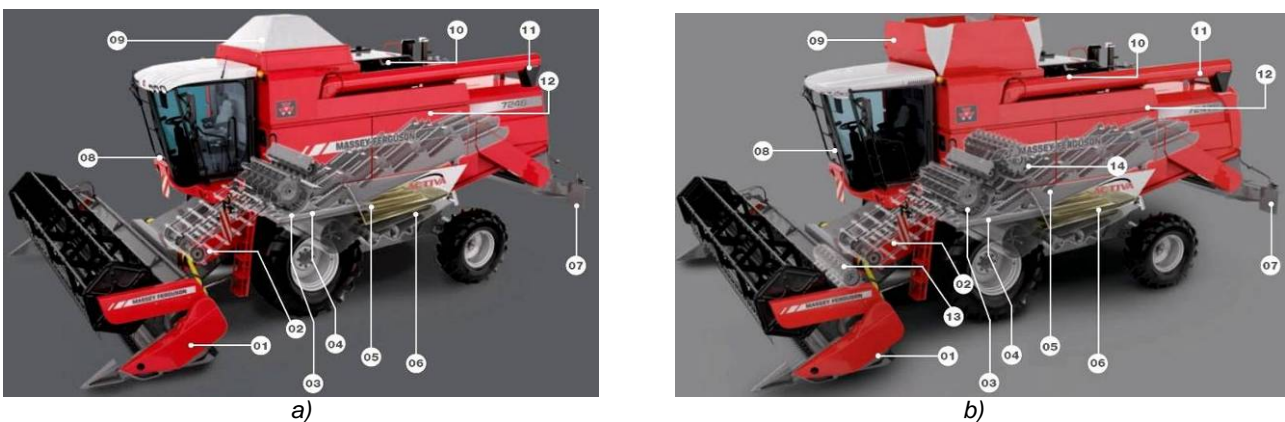


Fig. 14 - Combine harvesters MASSEY FERGUSON [5]

▪ **MASSEY FERGUSON series BETA**

Series combines BETA (figure 15) are medium-high capacity combine made in 4 models: 2 for the field and 2 for the slope.



Fig. 15 - Combine harvesters MASSEY FERGUSON BETA 7270 [5]

▪ **MASSEY FERGUSON series CENTORA**

Series combines CENTORA (Figure 16) are combining high and very high capacity, made 4 models: 2 for the field and 2 for slope. Combines are equipped with Power Flow system to ensure a smooth and efficient cutting of the ears, ERM system to increase the separation of seed, 100 Grain Histria system (elevator discharge seeds) that can provide a download of 100t / h, Auto Level system (adjustment longitudinal: 12%, to combine the slope) of powered screens, shaker system with 8 elements that lead to increased segregation by about 6-cell system to system, VISION DATA, control, monitoring and achieving maximum efficiency combined.



Fig. 16 - Combine harvesters MASSEY FERGUSON CENTORA 7282 [5]

▪ **FENDT series E and L**

E-series combines (Figure 17) and L (Figure 18) are small and medium-capacity combines with power ranging from 176÷275 CP, additional L-series combines are equipped with a central drum which stood before the carrier takes over and smooth out the material from the header screw conveyor before it reaches the central transporter and the MCS Plus system, located after the threshing machine that is designed to enhance the separation of seed heads before they reach shake the device.



Fig. 17 - Combine harvesters FENDT 6250 E [6]



Fig. 18 - Combine harvesters FENDT 6270 L [6]

- **FENDT series C**

C-Series combines (Figure 19) are medium-high capacity combines with power ranging from 277÷300 HP, beater, rotary separator MCS Plus extra to enhance separation before it reaches the shaker system and cleaning system. Also referred to combine cutting bar and drum Power flow Power feeder allowing cutting tracking defects of ground to plant as uniform.



Fig. 19 - Combine Fendt 5270 C (seria C) [6]

- ❖ **CLAAS Group**

- **CLAAS series LEXION**

LEXION combines are series combines high capacity and very high, made in 23 models and four models for the field gradient, with power ranging between 235 and 586 HP, working widths between 5.16÷10,56 m and threshing machine with the APS system and the system further stirring or shaking the threshing machine and supporting APS PLUS ROTO system, which uses two rotors placed longitudinal separation. Hopper capacity is between 7,300 and 12,000 liters.



Fig. 20 - Combine harvesters CLAAS LEXION 540C / 570 [7]

- **CLAAS series LEXION R**

560R_595R LEXION combines series (Figure 21) are combining high capacity and very high, seven models made for the field, with power ranging between 336÷516 CP, working widths between 7.6÷12.2 threshing machine with the APS system, separation is accomplished using two rotors placed lengthwise - PLUS ROTO. The system combines

the cleaning jet is STREAM™, assisted by a ventilator 6 / 8 turbines, hopper capacity is up to 12,500 liters.

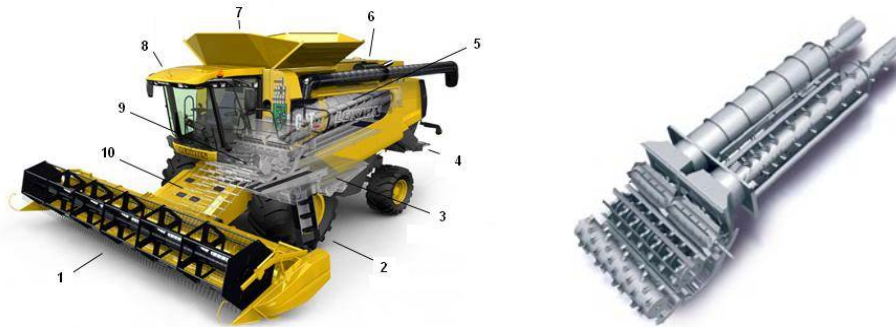


Fig. 21 - Combine harvesters CLAAS LEXION 560R_595R [7]

CONCLUSIONS AND FUTURE WORK

Analyzing the latest models combine made by major manufacturers in the world is their tendency to increase the working capacity and diversity of models, all major building and or combined axial-flow models: the operation of threshing and separation rotor beater classic axial arranged longitudinally.

In this way it succeeded in increasing capacity, without increasing the overall size of the appliance and hence its mass, modernizing and improving the other systems: cleaning, cutting, monitoring, etc.

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