

Böttinger, Stefan and Wacker, Peter

Combine harvesters – state-of-the-art and further developments for the improvement of machine settings

The manufacturers of combine harvesters are expanding their product offers to provide solutions for the various demands of the European market. Most of the brands offer now several threshing and separation systems. The manufacturers strengthen their position and increase the production numbers of single factories by cooperation and joint ventures. At the VDI-MEG Conference Landtechnik AgEng 2009 and at the Agritechnica 2009 new solutions were presented to improve machine utilization and to facilitate machine settings.

Keywords

Combine harvester, information systems, control systems, electronic, harvest conditions

Abstract

Landtechnik 65 (2010), no. 2, pp. 102-105, 4 figures, 8 references

system was presented on the fair Agritechnica 2009 as Fendt 9460 X / MF Delta 9280. Based on the platform of the 8 walker machine, a threshing system with 3 drums (threshing drum with 600 mm diameter, beater and rotor feeder) and two separation rotors with 4.2 m length are integrated, **figure 3 bottom**. The cleaning unit was adapted to higher sieve loads. For example the fan got an additional suction opening in the middle of its housing. The maximal engine power will be 367 kW. During 2010 the production site in Randers/Denmark will be closed and the production of the new hybrid combine and the 8 walker machines will be transferred to Breganze/Italy. By this the site of the joint venture between Agco and Laverda, a subsidiary of the Argo group, will be fostered.

Claas is extending his market offer in the medium and smaller segments. The Tucano series combines already proven techniques from medium sized machines and the bigger Lexion series. The threshing drum has a diameter of 450 mm and is combined in the bigger models with an additional pre-separation drum. For separation conventional 5 or 6 walkers are used. Since Agritechnica 2009 this series is extended by a hybrid model. The pre-separation drum and the threshing drum have a width of 1580 mm. As separation system a rotor with 4.2 m length and a diameter of 570 mm is used. The combine has a rated engine power of 261 kW. The introduction of the new model Averro with a rated power of 146 kW complements and upgrades the smaller range of machines. The threshing system consists of a pre-separation and a threshing drum with 1060 mm width and the grain separation is done by 4 straw walkers. According to the price class the information and control systems are kept simple, but their look and feel is designed in the style of the bigger series of this manufacturer.

Deutz-Fahr already presented in November 2008 at the fair EIMA in Bologna/Italy and in February 2009 at the SIMA in

■ In 2008/09 the combine market dropped in Germany about 2 % to 2 324 units [1]. With that the decrease in the market was not as strong as expected. In North America the sales volume increased further by 15 % and reached 12 306 units [2], **figure 1**. In addition to the development of sold units the increase of the average size of sold combines has also to be taken into account. The company Claas published the development of the average performance index of their sold machines [3]. Over the whole considered time range of 17 years a continuous growth of approximately 3.2 % per annum or of totally 70 % can be seen, **figure 2**.

Agco improved their activities in the area of harvesting techniques. The market offer of axial combine harvesters in Europe is based on the 9000 series of Massey Ferguson in the USA. Three different combines in the range of rated power from 224 to 316 kW are now offered under the brands Fendt and MF. Their axial rotors have diameters of 700 and 800 mm. The pre-announced combine with hybrid threshing and separating

Fig. 1

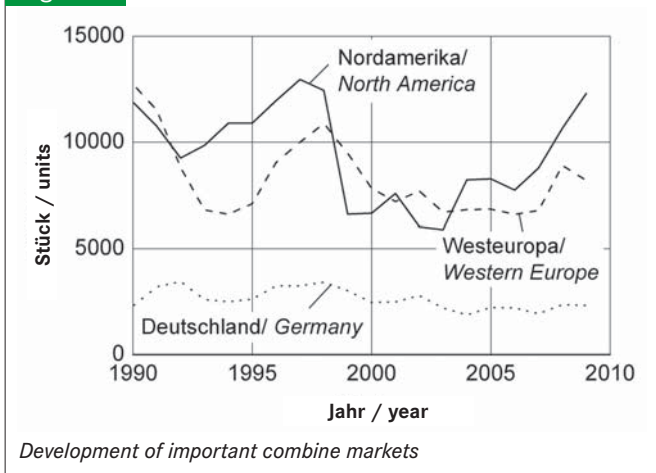


Fig. 2

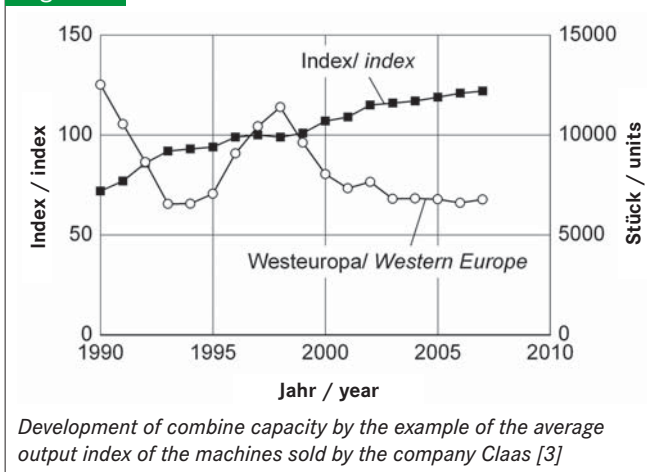
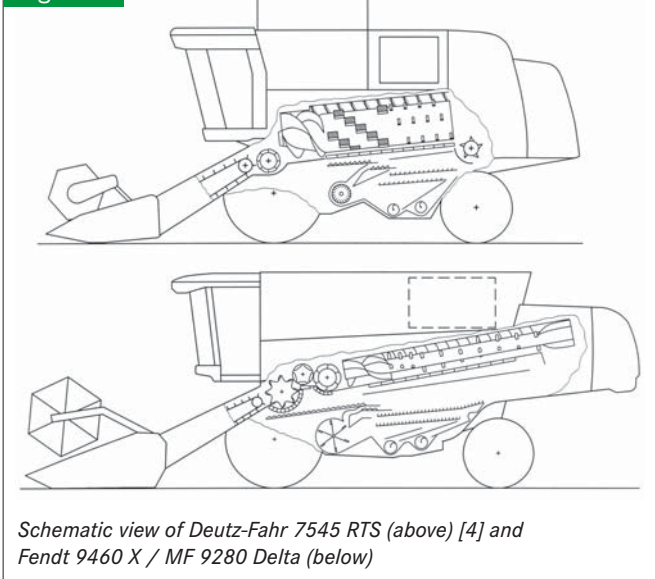


Fig. 3



Paris/France a new axial flow combine harvester with a Deutz engine. The combine is developed by the company Vassalli in Argentina and is offered there as AC 7500. In Europe it will be offered as 7545 RTS with 331 kW. The production is in the plant of

the company Same Deutz-Fahr in Zupanja/Croatia. The rotor has a diameter of 750 mm, a length of 3150 mm and is hydrostatic driven. The cleaning unit has two ventilated steps, **figure 3 top**. A shiftable all-wheel drive is standard for this combine.

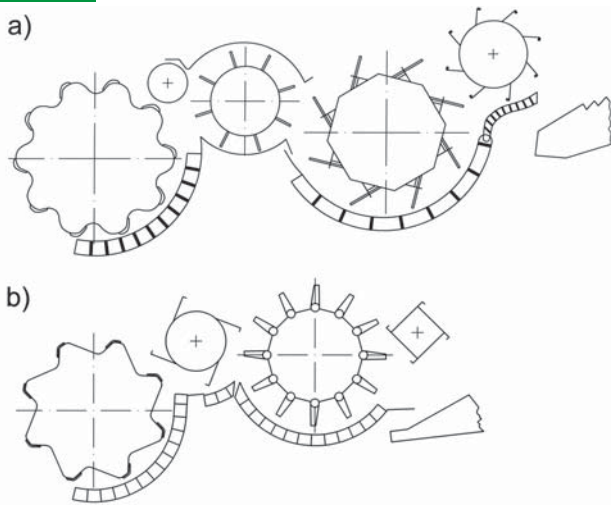
John Deere introduced with their T-series a new developed threshing and separation concept. From the C-series the threshing, the wiping and the feeding drums are used and complemented by a separation drum and a beater. 5 or 6 straw walkers with reduced length are used for grain separation, **figure 4a**. The separation drum with 660 mm has the same diameter as the threshing drum and runs like the beater with two different speeds. This threshing and separation concept shall bring together smooth straw handling and high throughputs. In comparison with a pure walker combine harvester a throughput of plus 15 % shall be possible in combination with a less steeper grain loss characteristic.

New Holland's threshing and separation system of the CSX series also consists of four drums, **figure 4b**. For smoother straw handling the far end of the concave can be swivelled away and the clearance of the concave of the separation drum can be increased. The optical sensor at the grain elevator for the sensing of grain breakage and uncleanliness is available for the CR series. New Holland offers optional undercarriages for up- and downhill combines. For the side hill compensation they offer three different systems. For the CR and the CX series the whole cleaning shoe can be levelled up to an inclination of 17 %. As option for the TC series levelled parts of the upper sieve up to 23 % and moveable baffle plates on the grain pan are available. An additional lateral oscillation of the pre-separation sieve and the upper sieve levels inclinations up to 25 % for the CSX series. The strength of this additional oscillation depends also from the actual fan speed. On the Agritechnica 2009 New Holland presented now an automatic adjustment of the fan speed in dependence of the up- and downhill inclination of the combine harvester and of the type of crop.

Driver assistance

The installed capacities of combine harvesters have to be utilized as far as possible during the most different harvest conditions. Therefore the operation of the machines is developed further and they are connected to remote maintenance systems. Multifunction levers and LC displays are available as standard from the medium segment upwards by all manufacturers for the Western European market. Today the machines have up to 50 parameters adjustable by the operator. Most of them can be controlled directly from the cab. Automatic steering systems relieve the operator during the harvest and enable better control and more optimisation of the working performance of the machine by adapting the machine settings. For the automatic control of the threshing and separation processes in combine harvesters there is still a lack of appropriate sensors for the working quality of the machine. Therefore the operator is still responsible for its adjustment. For his training courses are offered by the manufacturers. Bigger farms and contractors are

Fig. 4



Newer threshing and separation systems:
a) John Deere T-series, b) New Holland CSX series [5]

using also the internal transfer of knowledge from experienced to less experienced operators. By the aid of remote service systems the setting and the performance of the machine can be monitored. But without information about the actual local and the changing harvest conditions valid recommendations can hardly be derived.

An expert system for the settings of combine harvesters is presented by New Holland as further possibility for the support of the operator [6]. The five most important parameters for the function of the machine are monitored. These parameters are separation losses, cleaning losses, amount of return, and if available on the machine, the breakage and the uncleanness of the harvested grain. Limits for these parameters are set by the operator. If they are exceeded the operator can retrieve recommendations for the optimisation of the machine settings by a keystroke. For this the actual settings of the threshing system and of the cleaning unit are compared with stored recommended settings for different types of grain. The bigger the deviation the higher is the priority for a recommended change of the setting of the machine. If the limits of several parameters are exceeded and if several settings differ strongly from the recommended ones then several changes are recommended at the same time. If the operator confirms the recommendation then the settings are corrected automatically. If the operator requests support by the system though the settings are similar to the stored ones then advices are made for manual changes at the machine. These can be for example the activation of deawning plates or the check of the tension of belts.

Claas also presented an expert system for the optimisation of the machine setting [7]. This system was honoured on the Agritechnica 2009 with a gold medal. The optimisation is started by the operator independent from presetting of limits. He chooses one of five optimisation goals and gets recommendations for a different machine setting. These are based on measured or on keyed assessments of the actual machine per-

formance. If the operator accepts them then they are adjusted automatically if possible. Again the machine performance with the new setting is assessed. The setting will be reversed if the expected improvement doesn't occur. An alternative optimisation will then be chosen. The expert system recommends independently opportunities for improvement. The optimisation goals of this system are beside the grain losses, the amount of return and the grain quality in the grain bin also the throughput and the crop flow.

The expert system from Claas was tested over two harvest seasons [8]. The success of the particular optimisation goals could be clearly verified by the hand of measured values. The financial benefit by reduced grain damage, improved cleanliness and higher throughputs were in the range of 13.- to 28.- €/ha. It could be observed during the examinations that operators are optimising more often the machine setting by the aid of the expert system. This led to an overall better adaptation of the settings to changing harvest conditions. It was also reported that experienced drivers were surprised by the success of sometimes unusual machine settings.

Conclusions

During the VDI-MEG conference Landtechnik AgEng 2009 and the fair Agritechnica 2009 a lot of new developments and improvements for grain harvesting were presented. New machines in different ranges of performance are offered. The manufacturers support more and more the operator by the optimisation of the machine setting during difficult harvesting conditions. Examinations could verify in practice the advantages of new expert systems for the machine settings.

Literature

- [1] Wiesendorfer, G.: Erfolgreicher Abschluss der Mähdescher-Saison in Deutschland. http://www.vdma.org/wps/portal/Home/de/Branchen/L/LT/Wirtschaft_und_Recht?WCM_GLOBAL_CONTEXT=/vdma/Home/de/Branchen/L/LT/Wirtschaft_und_Recht. Zugriff am 05.02.2010
- [2] n. n.: AEM Flash Reports. <http://www.aem.org/Trends/>. Zugriff am 05.02.2010
- [3] Kutschenreiter, W.: Transparenz – das Gebot der Stunde, Teil 1. Agrartechnik business 3 (2009), H. 12, S. 1–5
- [4] Böttinger, S. und P. Wacker: Mähdescher. In: Jahrbuch Agrartechnik 22 (2010) S. 137-145
- [5] Böttinger, S. und P. Wacker: Mähdescher. In: Jahrbuch Agrartechnik 21 (2009) S. 145-154
- [6] Hindrycks, K.: Intelligent User Interface. VDI-MEG Tagung Landtechnik AgEng 2009. 06./07.11.2009 Hannover. In: VDI-Berichte Nr. 2060. VDI-Verlag, Düsseldorf, 2009, S. 357-362
- [7] Baumgarten, J., S. Neu und B. Kettelhoit: An assistance system for the optimization of the harvesting process in combine harvesters. VDI-MEG Tagung Landtechnik AgEng 2009. 6./7.11.2009 Hannover. In: VDI-Berichte Nr. 2060. VDI-Verlag, Düsseldorf, 2009, S. 363-368
- [8] Rademacher, T.: The increase of efficiency of combines through optimisation of the machine's settings. VDI-MEG Tagung Landtechnik AgEng 2009. 6./7.11.2009 Hannover. In: VDI-Berichte Nr. 2060. VDI-Verlag, Düsseldorf, 2009, S. 369-374

Authors

Prof. Dr.-Ing. Stefan Böttinger is head of the chair Fundamentals of Agricultural Engineering at the Department of Agricultural Engineering of the University of Hohenheim, **Dr. Peter Wacker** is research associate at this chair.