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Trends in threshing crop harvesting process technology

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(DLG). At Agritechnica 2019, the manufacturers of technologies for threshing crop harvesting will present an unusually large number of innovations in the hardware and software segment. Focus here is on information and threshing technologies. For the first time, the sensor technology of combine harvesters anticipates the respective harvest conditions. Despite the restrictions in the construction volume, innovative further developments of threshing and separating techniques are resulting in a further increase in threshing capacity. More and more detailed developments in harvesting headers, which are increasingly playing a key role, serve as the basis for higher harvesting yields with minor pick-up losses.

Trend to belt cutting systems and special solutions

More diverse crop rotations and cultivation of plants which are otherwise cultivated in more southern regions present additional challenges for designers of harvesting headers for combine harvesters. Belt cutting systems are achieving ever increasing market shares. They are characterised by a uniform crop flow and can be outstandingly combined with flexible cutter bars. In addition, they enable ground adjustment within the working width perpendicular to the driving direction, which is not possible with screw cutting systems. As fewer and fewer large linear rape varieties are being cultivated and the designs are being increasingly adapted, these cutting systems are becoming increasingly suitable for harvesting rape.

Due to the system, pick-up losses with belt cutting systems are slightly higher than with screw cutting systems depending on the threshing crop because grains can roll counter to the direction of travel during lateral transport. The manufacturers are counteracting this with different designs. These range from simple retaining edges and specially profiled conveyor belts to air slit systems behind the cutter bar. The air volume flow, which can be adjusted
depending on crop, blows rollable kernels with various weights uphill onto the lateral conveyor belt.

Swathers are used for swath threshing, which may be of greater interest for some regions and crops in the future due to the reduced use of herbicides; these can be used in tractor driven form and for harvesting on combine harvesters. This combination of uses reduces costs, as no swather vehicle is required. On the other hand, it increases the harvest losses compared to special swathers due to turning manoeuvres with the tractor at the headlands.

An increasing number of manufacturers are splitting the frames of the draper headers for lateral adjustment to uneven ground. The three-piece drapers are being equipped with increasingly complex hydraulic control arm linkages with control technology for precise ground adjustment. Furthermore, the inclination of the cutting system in the driving direction is passively adjusted. These technologies reduce pick-up losses.

Residual plants should be used as little as possible as intermediate hosts for pests, and are therefore already intensively chopped up with the harvesting header before a chassis presses the stubble into the ground. Different variants of chopping technologies on maize pickers up to and including sunflower harvesting headers will be presented for this.

Detailed improvements to the cutting system are required because the inert mass of all components increases along with the working width. Acceleration and braking are required twice within one revolution of the blade drive shaft. Lightweight designs and the development of sensor systems are resulting from this. Drives with sensor technology form the basis for wear prediction and for protection of the blade drive in order to reduce repair costs and for load-dependent control of the blade drive train and/or the throughput regulator of the combine harvester.

New electrohydraulic locking technologies for the intake duct hydraulic cylinders are helping to increase work safety when working on the harvesting header or intake duct. If the driver leaves his seat, the hydraulic cylinders are automatically locked. The safety flaps which are otherwise usually found on the hydraulic cylinders are replaced. These can occasionally be forgotten during maintenance, repair and cleaning, or can damage the piston rod when actuated roughly.

**Trends in threshing and separation**

On combine harvesters of the highest performance classes, the construction volume limits a further increase in technical threshing performance. As a result, designers are increasingly optimising the threshing and separating techniques of these combine harvesters in order to nevertheless trim them to higher threshing capacities. This naturally includes further increases in engine outputs. These now reach nearly 800 hp on the top models. Speed-reduced engines and the automatic adjustment of the engine output to the respective performance requirements of the combine harvester result in reduced fuel
consumption per tonne of threshed crops. The new top models of the four largest manufacturers promise many exciting work performance and work quality comparisons for the 2020 harvest.

The designs required for this range from an increased threshing basket area and larger distances between the rotor housing and the rotors in the upper area up to and including improvements to the discharge drum and the last separating basket for increased straw throughput with axial rotor combine harvesters. Newly designed systems for increased performance stability will also be presented.

Further developments in tangential threshing and separating technologies, which combine the advantages of the previous accelerator threshing unit and the centrifugal threshing unit are increasing the threshing performance of walker combine harvesters. With a harvested crop flow that is more linear on the whole, this design is gentler on the grain and straw, and diesel consumption is reduced. Nor has user friendliness been overlooked: the rear areas of the threshing and separating baskets remain in the combine harvester, while the front areas can be removed and installed from the left-hand side of the machine for the first time.

After many decades with virtually identical threshing drums, the design engineers have finally decided to implement major changes. The threshing outputs of the open drums are quartered and offset to each other by a half distance in each case. This increases threshed crop intake from the angled conveyor with reduced pick-up noises and the suction effect for reducing the dust load in front of the cab. At the same time, grain separation at the threshing basket is increased, and with it the threshing output. To reduce grain cracking, steel material has actually been forgone elsewhere.

**Trends in information systems and sensor technologies**

The information technologies for threshing crop harvesting are becoming increasingly complex. They are primarily used to maximise performance and work quality and to reduce the strain on the driver. More and more, digitalisation is finding its way into threshing crop harvesting via networked information systems. Manufacturers are increasingly basing their developments on different technologies and modular systems: machine-supported intelligence from adjustment assistants to fully automated threshing and separating processes also function without networking information technologies. Teleservice-supported systems link the combine harvester to the server and permit the flow of information from and to the combine harvester. The possible combinations of both methods are very diverse, as a result of which option lists will become longer in the future.

The first combine harvester without a steering wheel will be presented at Agritechnica 2019. In place of the steering column with a steering wheel, a joystick is located in the left-hand armrest on the driver’s seat. All controls for road traffic are integrated in the joystick.
As on construction machines, this technology provides for a better overview towards the front and is intended to increase the threshing output.

New control technology shows the operator of combine harvesters with an automatic adjustment system which assemblies are limiting performance under the given harvesting conditions. It helps the operator to determine his agronomic goals. Even the straw chopper settings have been automated for the first time. Depending on the specified strategy - from 'highest chopping quality' to 'maximum efficiency', the automatic system optimises the settings depending on the crop. The system saves energy because it avoids unnecessarily excessive straw chopping.

The first foresighted combine harvester is an interesting development. The technology includes the usual throughput controller, which is supported by cameras and plant growth models. The camera technology recognises the crop situation in the same manner as a foresighted, experienced combine harvester driver. Consequently, the system looks ahead to see how much biomass the threshing crop stock contains and what its characteristics are, i.e. whether it is standing, lying or partially lying. This new recognition technology is combined not only with the throughput controller but also with the adjustment control technology. The foresighted combine harvester harvests almost autonomously.

Sensor technologies for determining the contents of threshing crops will also be on show. The technology is not new; however, it shows that especially farmers who produce protein plants are interested in ingredients yield maps. These maps serve as an additional information source for 'precision farming'.

Trends in drive technologies and straw-chaff management

As in the automotive sector, alternative drive technologies are also being researched in agricultural technology. In the harvesting machine segment the diesel engine has been indispensable up until now due to the high energy density of diesel. However, focus is increasingly shifting to gas engines against the background of reduced emissions. This concept is certainly of interest in case of major price differences between diesel fuel and natural gas. Due to increasing daily production rates, the diesel tank volumes of large combine harvesters are usually more than one cubic meter. As filling with a fuel pump takes a great deal of time, fast refuelling technologies are to reduce waiting times. Work safety is additionally increased if fast refuelling is carried out while standing on the ground.

Trends for all aspects of combine harvesters

With increasing combine harvester outputs, setting optimisation and sensor technology adjustment are playing an ever more important role, as incorrect settings on large machines cause proportionately higher economic losses than on small machines. As a result, a growing number of large combine harvesters are being equipped with adjustment control technology. And because the harvesting conditions push even the best sensor technology
to its limits, control always better than trust. This monitoring is usually carried out by looking at the ground behind the combine harvester, but with insufficient accuracy. Therefore, checking is increasingly carried out with a grain loss bowl. There are even attempts to recycle the grain losses. The lost grain contained in the chaff is to be separated again and returned to the grain flow in the combine harvester.

Economically acceptable grain loss levels are often discussed. Usually a grain loss range between one and three percent is suggested – 1 % of 9 t/ha = 3 % of 3 t/ha. Therefore, these discussions are pointless. The agronomically acceptable grain loss level is crucial, because the subsequent agronomic costs of high grain losses are usually higher than the cost savings through an increased loss level, and with it a higher threshing output. This primarily applies against the background of growing restrictions for herbicide applications.

**Summary:** The manufacturers of technologies for threshing crop harvesting will present an especially large number of innovations in the threshing crop harvesting segment at AGRITECHNICA 2019. The worldwide trend towards belt cutting systems and techniques for the adaptation of harvesting headers to a broad range of conditions is continuing. The belt cutting systems of manufacturers present on international markets are becoming increasingly Europeanised, therefore increasing their suitability for rape harvesting. With growing working widths, belt cutting systems are becoming more advantageous, as their ground adjustment perpendicular to the driving direction is better than that of screw cutting systems. Sensor technology in the blade drive not only enables early detection of damage on the cutter bar, but also load-dependent control of the cutting frequency for the first time.

Despite the restriction of the construction volumes, threshing outputs are on the rise. The threshing and separating elements are designed so that a linear flow of harvested crops is possible in tangential threshing units, and is therefore gentle on materials and saves power. Not only increased threshing drum diameters, but rather appropriate suitable threshing drum, feed and separating drum configurations contribute to this increased performance. Threshing and separating baskets can now be removed and installed from the side for the first time. On axial rotor combine harvesters, performance stability is increased with high straw yields and water contents through new rotor/housing configurations and modified spreading cylinder/separating basket combinations. The top rotary combine harvester models are equipped with engine outputs of around 800 hp. This clearly confirms the trend towards an increasing combine harvester power density.

The first ‘seeing’ combine harvester will be on exhibit at AGRITECHNICA 2019. The stereo cameras on the cab detect the threshing crop stock like a driver and the information system calculates the plant mass and condition from it, which the combine harvester must foreseeably process. In addition, the data from satellite maps on the grown organic mass are integrated, enabling the combine harvester to ‘recognise’ what it must process with the help of the combined information from all sensors. The trend towards increased sensor and
control technology is continuing. In addition to the threshing and separating elements, the assemblies of the straw chopper are now also adjusted with characteristic control technology in order to increase the efficiency of combine harvesters by adapting to the respective situation. And even the steering wheel with the steering column is being eliminated for reasons of increased efficiency.

AGRITECHNICA 2019 will clearly show the long-term trends with a large number of innovations in the threshing crop harvesting segment; the machines are becoming more powerful, more efficient and more intelligent. Of course, purchase prices for end customers will also rise as the level of innovation increases. Based on the current market and price situation, a reserved willingness to invest can be anticipated from farmers and contractors in 2020.