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Combine Straw Choppers

A Newly Developed Unit with Large Throwing Width and Lost Grain Destruction

At large working widths in particular, current combine straw choppers do not meet the requirements of plant cultivation and the demands of agricultural practice. Therefore, a new chopper principle based on vertical chopping rotors working according to the principle of the helical chopper was studied in Göttingen. Pre-trials show that this design allows very large distribution widths to be reached even at large working widths while achieving good straw comminution. An appropriate design of the conditioning path even enables lost grains and weed seeds to be destroyed.

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Keywords

Combine straw chopper, straw distribution, straw comminution, lost grain, weed seeds

The working width of the combines used in agriculture today is continuing to grow. The Agritechnica in Hanover, which ended just recently, impressively confirmed this statement. The ever larger cutter bars, however, lead to more and more problems with regard to the distribution of material other than grain, such as straw and chaff. The problems which result in particular from insufficient straw distribution, along with inadequate straw comminution in some cases, range from inaccurate seed insertion during mulch- and zero tillage to insufficient straw rotting and phytosanitary problems.

In the future, even the destruction of the separated lost grains and potential weed seeds during the chopping process will be considered in order to reduce the necessity to control weeds and weed grass in successive crops. At the same time, even the purity of variety of a lot must possibly be guaranteed with regard to growing quality requirements according to EU directive number 178 from 28 January 2002. For this reason, increasing importance must be attached to the destruction of lost grains in order to avoid self-sown cereals. Hence, combine straw choppers must meet the following work quality requirements (altered, according to Kämmerer 2003 [1]):

- uniform and complete comminution of grains
- even straw- and chaff distribution in the lateral and longitudinal direction over the entire working width;
- comminution of self-sown cereals and weed seeds and
- reduced susceptibility to crosswinds.

Practical observations show that these requirements are not sufficiently fulfilled by conventional mounted choppers with a horizontal chopping shaft, in particular at working widths of more than 6 m. This especially applies to the insufficient distribution of straw at large working widths. In conventional chopping technology, one is well aware of the problem of sufficient comminution for good straw rotting and the necessity of improved straw distribution. The Agritechnica showed that additional chopping knives, increased circumferential velocities, and the installation of opposite knives or friction ledges are employed to meet these demands. For straw distribution, active distributors are meanwhile available which widely distribute the straw chopped in a conventional unit with the aid of a throwing plate. According to information provided by the manufacturer, this allows good straw comminution at working widths of up to 7.50 m to be achieved [2].

Prototype of a New Chopper System

With regard to the comminution of straw, one must take into account that fast straw rotting is only possible after adequate conditioning and quick incorporation into the soil [3]. It was shown that helical choppers with an appropriately designed gathering unit are very well able to take in various kinds of organic materials (stems, branches, grass, leaves, and seeds), to destroy them efficiently and to distribute them evenly. Based on these experiences, the helical chopper principle was applied to straw chopping. In addition to good comminution and conditioning of the straw- and chaff particles, large throwing widths and even lateral distribution are intended to be realized. Moreover, the helical chopper principle in combination with other conditioning systems enables lost grains and weed seeds to be comminuted in the combine and problems caused by chemical weed control in cereal production to be reduced.

In order to meet these demands, the prototype of a novel combine straw chopper (*figure 1*) was designed and tested in pre-trials. For trial purposes, the implement was mounted in a three-point frame in order to allow it to be driven by a tractor. The straw is fed into the chopper from a hopper and free-falls onto the helix, which is driven by the tractor PTO via an angle transmission. This helix sits on a conically designed rotating body surrounded by four flights. The straw is taken in by the flights and moved downwards by the rotational movement while being compressed by an opposite cutting edge in the perimeter of the casing. At the same time, it is ground and crushed by the rotating helix and comminuted by its shear forces. Due to the shape of the opposite cutting edge, straw

transport is intensified and the straw is force-fed into the discharge area of the chopper. The opposite cutting edge is of crucial importance for the function of the chopper. The discharge area is designed as a combined throwing and radial fan. The discharge units not only fulfill their actual throwing function, but their appropriate design also allows them to comminute the straw further in particular by interacting with the friction ledges in the perimeter and the bottom of the casing. Pre-trials showed that straw intake by the helix depended on both the design of the gathering area and the presence of a not insignificant air flow. In the experiments carried out so far, throwing widths of more than 10 m with good lateral distribution of the material were able to be realized, which corresponds to a working width of 20 m if two rotors are used.

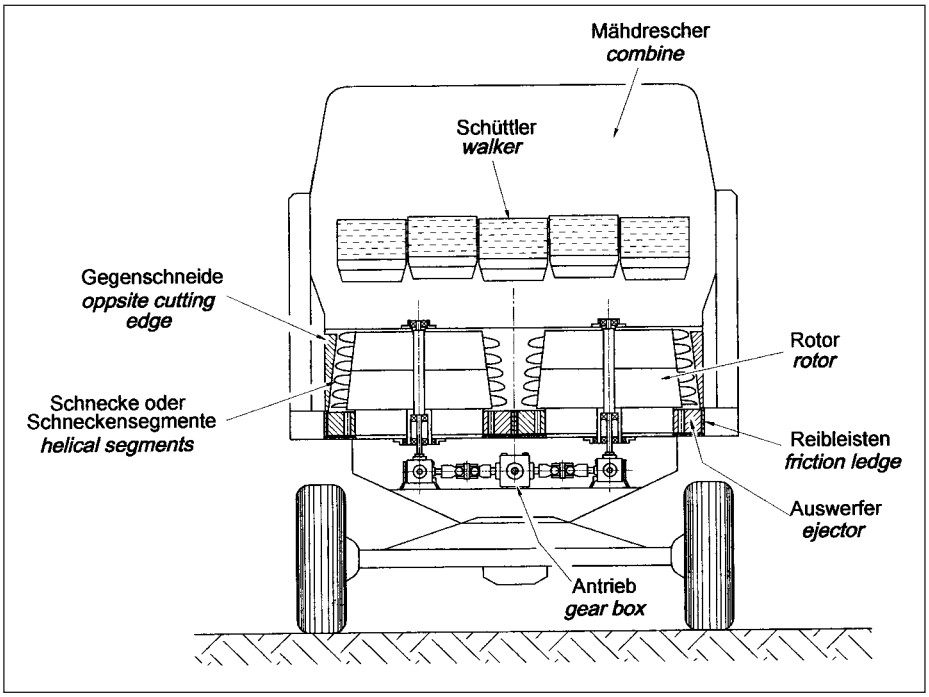

Fig. 2: Integration of the straw chopper into a combine harvester

Mounting of the Chopper on the Combine

The integration of the new chopper principle is shown in *Figure 2* using the example of a conventional combine. As can be seen, two vertical rotors are arranged underneath the walkers. The rotors can be arranged such that they are situated underneath instead of behind the walker level if fed from the rear. This requires a very short chopper design and allows the chopper to be situated closer to the sieve shoe, which considerably facilitates the transition of the material from the sieve to the distributor. Due to the counter-rotation of the two rotors, the straw is discharged on both sides. The vertical conditioning path of the chopper enables the straw to be discharged closely above the stubble, which results in reduced crosswind influence. At the same time, different rotational speeds of the rotors allow lateral distribution to be influenced. This could also be achieved by inclining the individual rotors or the entire chopper. In addition, a hollow shaft enables the drive of the discharge unit to be decoupled from the helix so that the chopper, the helix, and the discharge unit can be run at different rotational speeds. The integration of the new chopper principle into existing combine designs seems unproblematical.

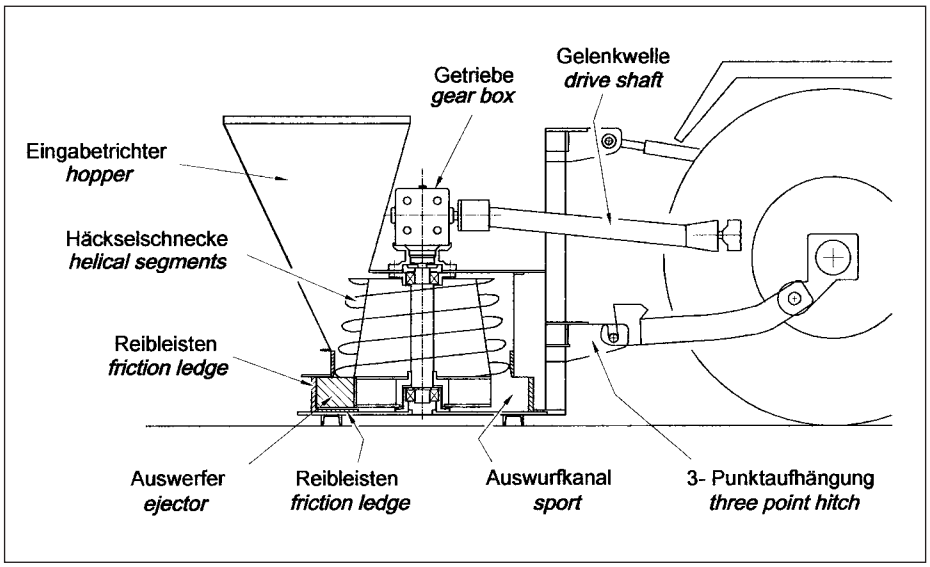

Fig. 1: Prototype of a novel combine straw chopper with large throwing widths (experimental equipment)

Literature

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