Arno Wiedermann, Brunswick

Test Rig for Precision-Chopping of Straw

Due to increasing throughput and to increasing demands on straw chopping quality, the requirements for the chopping aggregate of modern combines are rising. Today's choppers work mostly with flail knives, allowing for a simple mechanical design and are relatively practical against contact with a foreign object. However, the cutting length is not adjustable and no homogeneous and complete cutting of the straw are guaranteed. The Institute of Farm Machinery and Fluid Technology is developing a chopping aggregate with precision-chopping and this is supposed to produce a more homogeneous material and adjustable cutting length with a low power requirement as possible.

Dipl.-Ing. Arno Wiedermann is a scientist working at the Institute of Agricultural Machinery and Fluid Power (director: Prof. Dr.-Ing. Dr. h.c. H.-H. Harms) of the Technical University of Braunschweig, Langer Kamp 19a, D-38106 Braunschweig; e-mail: a.wiedermann@tu-bs.de

Keywords

Combine harvester, straw chopper, cutting principles

The improvement of chopping quality, which is necessary in particular for mulch and direct seeding in order to provide good straw rotting, is reflected by a reduction of the long straw fraction. This long straw fraction can impede seed placing during drilling and hamper the growth of following crops.

Another aspect of the straw chopper use is the cost of energy, which accounts for a growing percentage of the entire operating costs due to increasing fuel prices. In order to keep the costs low, the unit must use the available power efficiently. In addition, the most uniform chopping length possible must be striven for, in order to avoid unnecessary cuts at overly small straw lengths.

In addition to the development of a chopping unit at the ILF, the unit is studied primarily with regard to different cutting parameters, in order to systematically determine the influence of these parameters on chopping quality and power requirements.

Cutting Principle

The development of the novel chopping unit is based on the examination of the effects, which the replacement of the free cut (*Fig. 1*, top) and the adoption of a new principle for straw comminution in the combine has on chopping quality and on power requirements. During the free cut, the blade must overcome only the inertial force of the straw and its flexural strength. Straw-blade contact also accelerates the straw. The resulting characteristics of motion determine how often the individual straw pieces are cut. This behaviour can be influenced by means of counterblades or a braking ridge. However, the chopping length cannot be adjusted. This results in very uneven straw length.

In the newly developed unit, cutting with a counterblade and a counterholder, which is also termed precise cutting, is intended to be applied (*Fig. 1*, bottom). The feeder takes the

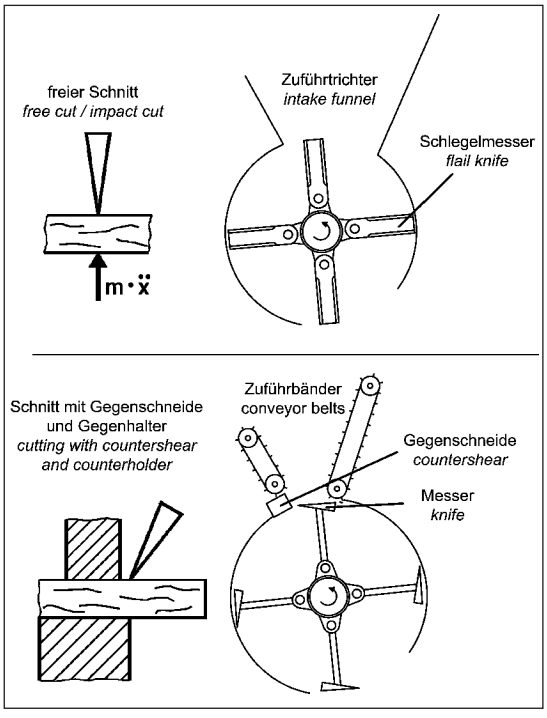

Fig. 1: Cutting principles

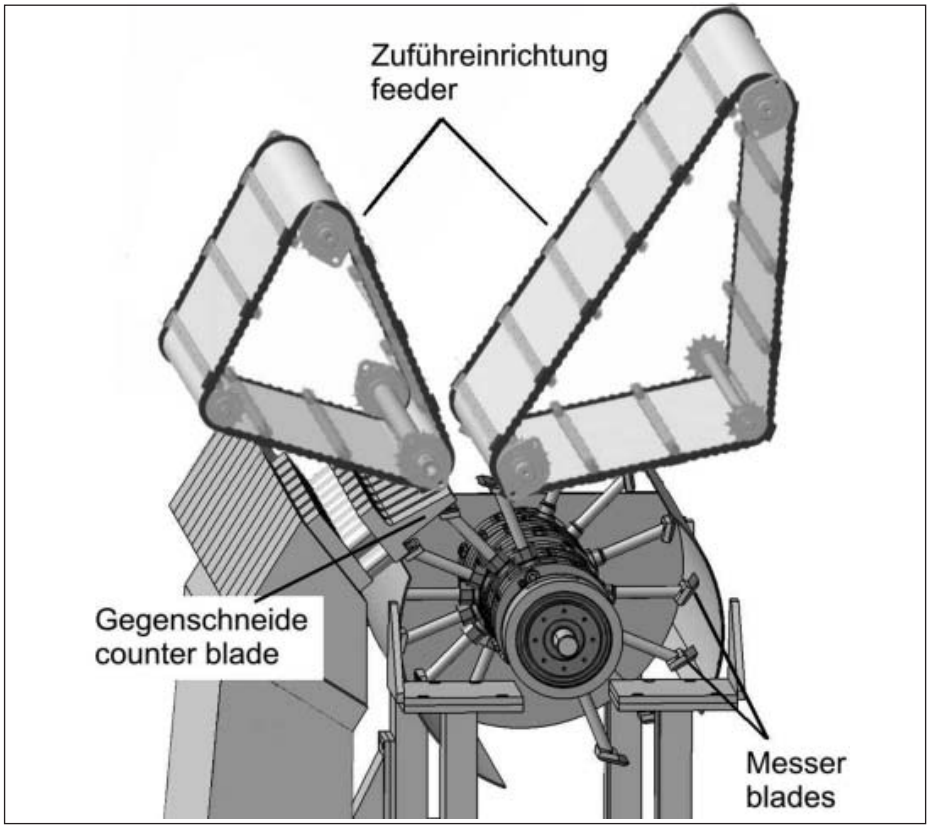

Fig. 2: Concept for a straw chopper with countershear and counterholder

straw in and compresses it. When the straw passes from the feeder to the chopping unit, the conveyor belts also serve to fix the straw. From the counterblade, the straw is fed into the chopper and then cut between the rotating blades and the counterblade. The theoretical cutting length results from the ratio of the conveying speed to the cutting frequency.

As compared with a flail chopper, the rotational speed of the chopper can be reduced significantly because the mass inertia of the straw no longer plays a role. The reduced rotational speed is intended to limit cutting to the counterblade, while the remaining course through the chopper only serves as a transport and acceleration phase.

Design of the Test Rig

In contrast to a conventional drum chopper (e.g. in a forage harvester), the blades feature pendulum suspension so that they can yield when they enter into contact with a foreign body and thus avoid damage to the chopping unit. In addition, they are segmented and arranged in an offset position on the shaft so that force transmission to the drive is more uniform (*Fig. 2*). The unit is designed in such a way that not only the cutting angles (pulling cut, wedge angle, free angle, rake angle), but also clearance, circumferential and conveying speed, as well as counterblade offset can be varied.

Figure 3 shows the integration of a chopper concept specially designed for the requirements of combining on a test rig.

The storage belt allows a straw flow up to 20 m in length and of variable thickness to be fed into the chopper in order to provide reference throughputs of up to 70 t/h. A walker feeds the straw into the feeding system, while conditioning it at the same time in order to make the structure of the straw as realistic as possible. After the straw has passed the feeding system and has left the chopping unit, it is collected in a container, from which samples can be taken in order to determine chopping quality.

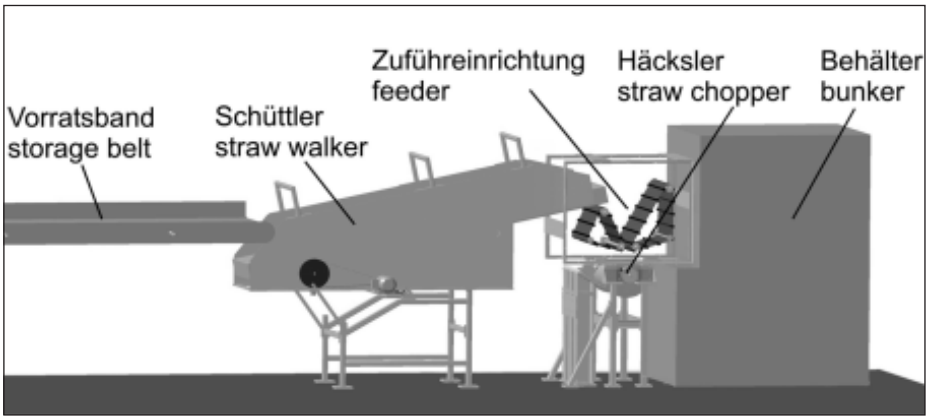

Fig. 3: Test rig

Measuring Instruments

For the determination of chopping length distribution, the ILF has a cascade sieve with different sieve hole sizes allowing a straw sample to be sorted into fractions having different chopping lengths. By weighing the fractions, the chopping length distribution / chopping quality can be evaluated objectively.

The second important criterion for the assessment of the chopper is total drive power, which can be measured with the aid of a torque sensor and a rotational speed sensor at the drive shaft. Additional measurements of counterblade forces, casing friction and idling power enable the power fractions in different chopper configurations to be evaluated and compared.

The measured power of the feeding system must also be considered in the overall power balance in order to allow the chopper to be compared with the flail chopper, which does not need a driven feeder.

Summary

The research project described in this contribution addresses the question of whether exact cutting in straw comminution in the combine can meet the mentioned goals. At the same time, the influence of individual parameters on this cutting concept is examined systematically and documented.