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A Feeding Device for the Combine Straw Chopper

Lowering Power Requirements while Maintaining Chopping Quality

Standards on combine straw chopper are still rising. Good quality has only been achievable in conjunction with higher power requirements till now. The combine chopper is already one of the aggregates with the highest power requirements. This research project should show alternative ways of simultaneously reducing power requirements and improving chopping quality.

Recently the chopping of straw in the field is looked at with more intent by farmers. The system of mulch and direct seeding, which goes along with a reduction in tillage, requires a short straw, which rots in a short time and is distributed evenly on the ground. On behalf of the machine, longer working periods and greater working widths result in harder working conditions and higher requirements concerning the straw chopper. The flail-type chopper is commonly used nowadays. In order to adapt to the increasing throughput, the rotation speed of the chopper has been raised. The knives can reach speeds of over 100 m/s as they revolve at up to 4000 rpm. This results in the chopper being one of the aggregates with the highest power consumption in the combine harvester.

Research Goals

The reduction of power consumption of the combine chopper is the main goal of the project, next to increasing the chopping quality and the ejection velocity, in order to achieve a better lateral distribution.

One way to achieve these goals is to turn away from a "free cut" towards a cut by clamping the straw. The process of cutting and transporting the straw in a combine chopper is described by Kämmerer [1]. As was observed, the main part of the cutting

process takes place at the inlet of the chopper. A high relative velocity between flail knife and the straw is important at this point.

In this project, the straw will be compacted and force fed to the chopper. The compaction results from an increased support of the straw, causing a greater resistance towards the cutting flail knives.

Preliminary Tests

The test rig, as used by Kämmerer [2], was altered in such a way that the straw was fed to the chopper by a conveyor belt from the side (fig. 1). A feed roller was built above the conveyor belt. The roller was attached by an arm, which allowed it to move upwards, if required. The geometry of the roller as well as the position relative to the chopper were adjustable. The straw was moved across a table by the roller into the chopper. There were no counter knives or brake bars installed.

The following tests were carried out using wheat and barley straw:

- variation of the throughput
- different moisture contents of the straw
- different geometries of the feed roller
- different sizes of the feed roller

Results of Preliminary Tests

The power consumption of the chopper was cut by approximately 10% by using a feed

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Keywords

Combine straw chopper, power requirements, cutting length

Literature

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- [2] Kämmerer, D.: Untersuchungen am Mährescherhäcksler. Landtechnik 53 (1998), H. 6, S. 390-391

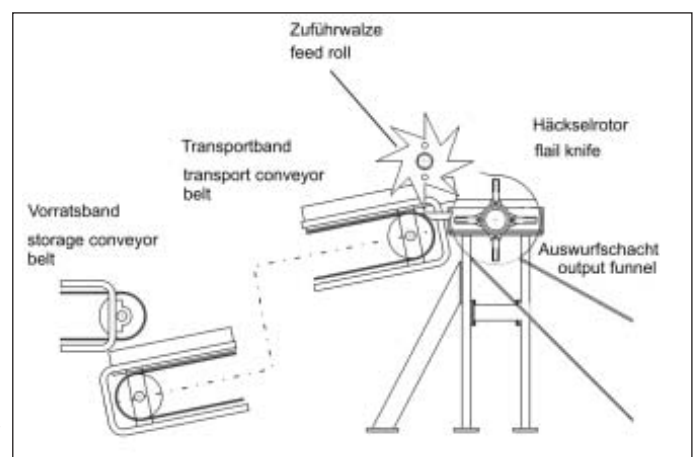


Fig. 1: Combine straw chopper test rig

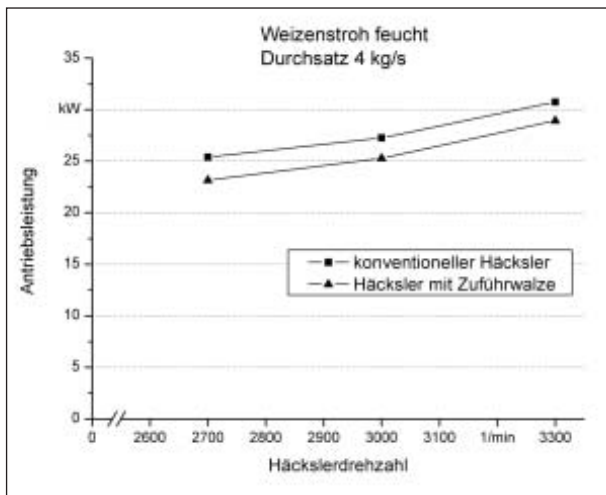


Fig. 2: Power requirements on the straw chopper

roller. It has to be taken into account, that the power used by the roller itself was not included. The cut in power consumption has been achieved without a loss in chopping quality.

Using a feeding device, the intake of the chopper can be optimised by a great amount. Peaks in power intake, resulting from straw falling into the chopper after being held back by a upturned air stream, are avoided.

Figure 2 shows the rise in power consumption in connection with rising throughput, as described by Kämmerer. By applying a feed roller, the power consumption could be cut by 10%. The chopping quality, defined by the length of the cut straw, remained constant. Further tests have shown that reducing the rpm. of the feed roller results in a higher chopping quality. The lower limit in roller rpm was marked by congestions of straw in front of the roller, which were caused by the geometry of the roller used in the tests. The transport conveyor belt used had no fingers to force feed the straw. It slipped under the straw.

The test rig used in the preliminary tests was not sufficient and has to be optimised for further tests. It can be concluded:

- feeding devices have to force feed the straw in order to avoid slippage
- using only one feed roller does not result in sufficient compaction of the straw

In order to improve the comparability of the test results, the tests with and without a feeding device should be carried out successively.

Future proceeding

Future research work at the ILF will focus on feeding devices, which should enable a continuous intake of compressed straw.

The modular integration of these devices allows a fast change of the mode of operation (e.g. with or without feeding device), which is necessary to make comparing tests. The

effects on the power consumption of the combine can be evaluated by the measurement of the driving torque of the chopper on the one hand and the driving torque of the feeding device on the other hand.

The frequency converters, which are used for the electric drive of the feeding devices, offer a simple possibility to measure their driving torque. In order to achieve quite realistic test conditions, the straw has to be mixed up before entering the chopper or the feeding device.

Subsequent to the test series with “fresh” straw during the harvest time, test series with stored straw will take place. The round bales which are used, are pressed with low compaction in order to change the characteristics of the straw as little as possible.

Figure 3 shows an add-on module for the

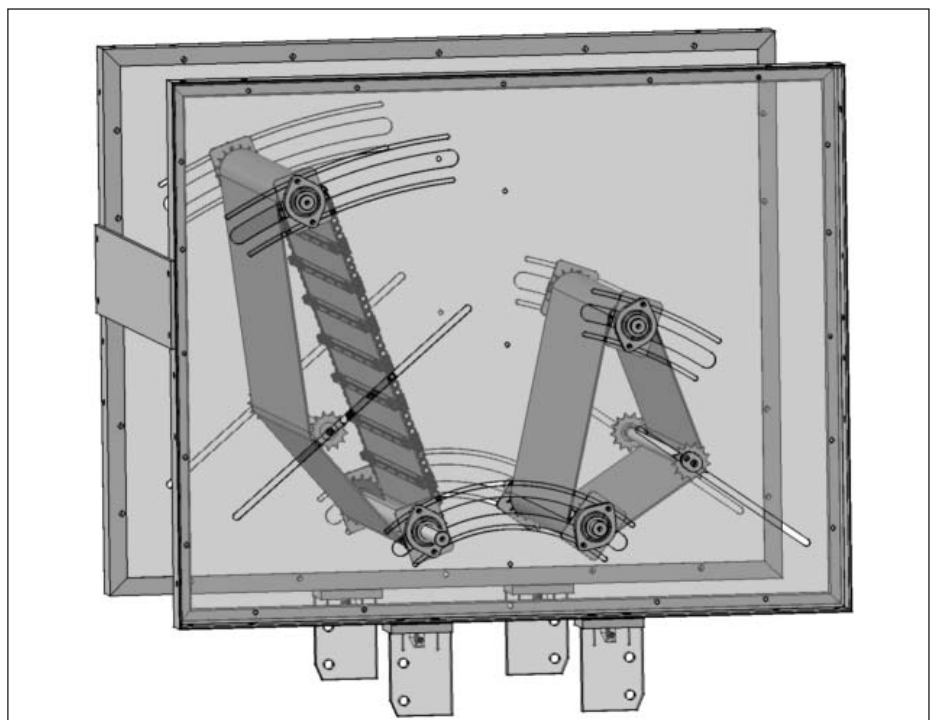


Fig. 3: Add-on module for the test rig

test rig. The intake funnel is substituted by two approaching conveyor belts. The belts consist of structured endless plastic straps, which are fixed on metal bars. These bars are mounted on two parallel-running chains (partially illustrated). This construction leads to well running characteristics on the one hand and to a high stiffness on the other hand, which is needed for the compaction of the straw.

The variable attachment points of the conveyor-ends allow different grades of compaction by the variation of the angle between the belts and their minimum distance.

Together with the infinitely adjustable velocity of each belt, which is made possible by the frequency converters, there are a lot of test parameters to find the optimal working condition.