Alignment of straw before a combine's straw chopper
Results from simulation and experiments

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Motivation

• The cutting of threshed straw and its uniform distribution is of major importance
• Especially in conservation tillage systems an even and short cutting length is desirable
• Any stalk cutting operation requires energy
• The shorter the straw is chopped the more cuts are needed and the more power is required

[www.landtechnikvideos.de]
Agenda

• Theoretical considerations
• The influence of stalk alignment on cutting quality
• Possibilities to improve the alignment quality
• Results from simulation and experiments
• Conclusion and outlook
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Theoretical considerations

Combine straw chopper

- Cutting length in a combine straw chopper varies considerably
- Theoretical cutting length $L_1$ differs significantly from the effective cutting length $L_2$
- A sufficient small distance $L_1$ between the cutting zone 1 and 2 enables cutting of unfavourable oriented stalks
- The distance $L_1$ is influenced by chopper speed and number of blades

[www.masseyferguson.com]
Theoretical considerations

Forage harvester

- Long stalks like maize are aligned almost parallel
- Theoretical cutting length $L_1$ is nearly equal to the effective cutting length $L_2$
- The power consumption is just on the required level

[www.kemper-stadtlohn.de]
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Experimental setup

- Optional: Countershear, counter knife and cross bar
- Chopper speed and driving torque are measured
Test execution

Implementation

• A conveyor feeds the chopper continuously with straw stalks
• For the experiments straw stalks are arranged manually on the conveyor belt with a defined orientation

Evaluation of cutting quality

• An oscillating screen is used to divide the straw samples into six categories of cutting length
• The screen diameters are 67 mm, 30 mm, 16 mm, 8 mm, 4 mm and 2 mm
Acceptable cutting length distribution and power requirement with counter knife and cross bar.
Cutting length distribution according to the alignment angle

- Improvement of the cutting quality by optimising the alignment of stalks

Chopper speed: 3400 rpm
Mass flow: 2.8 kg/s
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Modification on straw walker

- Modification on straw walker, base component of many combine harvester
- Conveying path should be long enough to improve the alignment quality
- Based on literature review and simulation results
- Side panel elevations of the straw walker
Simulation of the conveying process

Current state of the simulation model

- The “Discrete-Element-Method” (DEM) is used for the simulation
- Stalks are modeled as chains of connected balls
- The parameter setting is based on literature
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Cutting length distribution according to the modification on straw walker

- Increase of the weight at screen diameters 16 mm and 30 mm

Chopper speed: 3400 rpm
Alignment angle: 0°
Results from simulation

Influence of straw walker design on stalk orientation

Mean angle of orientation
(Height of walker side wall: 50 mm)

Mean angle of orientation
(Height of walker side wall: 200 mm)
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Conclusion

• Experiments with aligned straw stalks demonstrate an influence on chopping quality

• Simulating the behaviour of straw movement will support the practical experiments

Outlook

• There is potential to improve the cutting length distribution

• Adaptation of the combine chopper concept to longitudinal straw alignment

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Thank you for your attention!

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