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Adaptions of harvesting methods to reduce weeds on agricultural fields and to gain an unexploited biomass feedstock

Dr. C. Glasner*, Prof. C. Andreasen, C. Vieregge, Prof. A. Dikiy

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Project Sweedhart (www.sweedhart.eu)

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Sweedhart is a transnational research project funded in the frame of the ERA-NET Cofund FACCE SURPLUS in the frame of the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI).

- Duration: May 2016 – April 2019
- **Aim:** Reduction of weed infestation on fields
- **Idea:** Reduce weed seed infestation by…
  - …killing harvested weed seeds before they are returned to the field
  - …removing weed seeds from the field by new harvesting methods
  - …and utilize so far unused side streams

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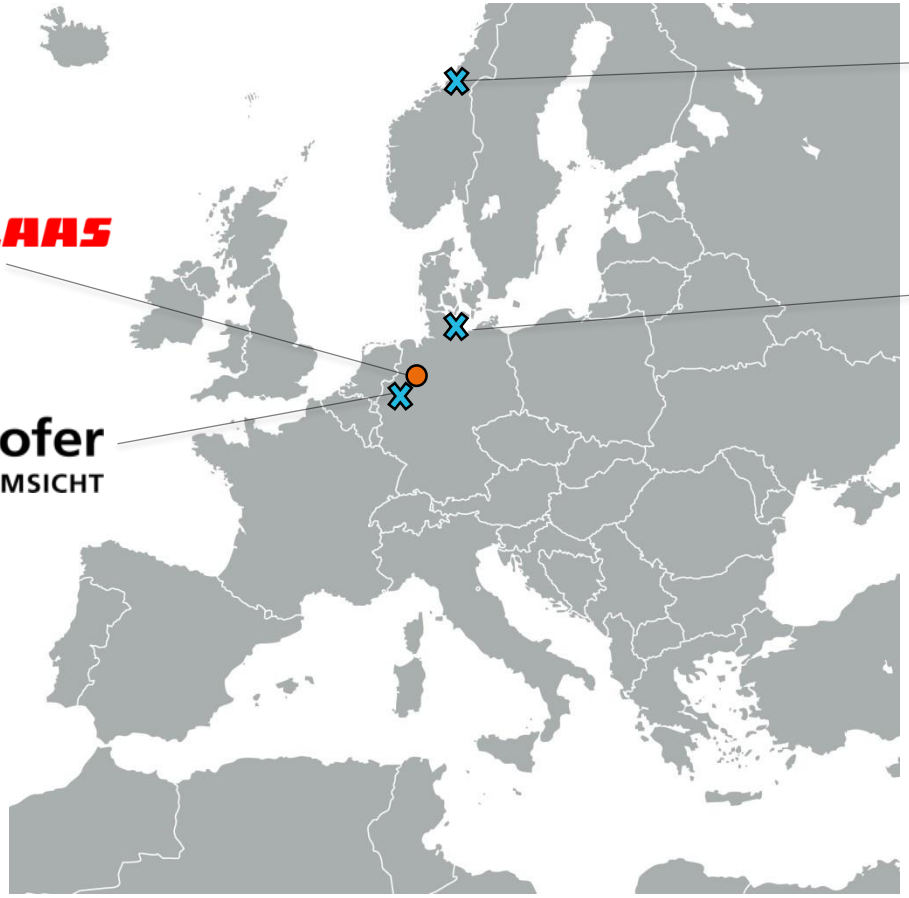
Overview of Sweedhart partners



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Norwegian University of Science and Technology

CLAAS

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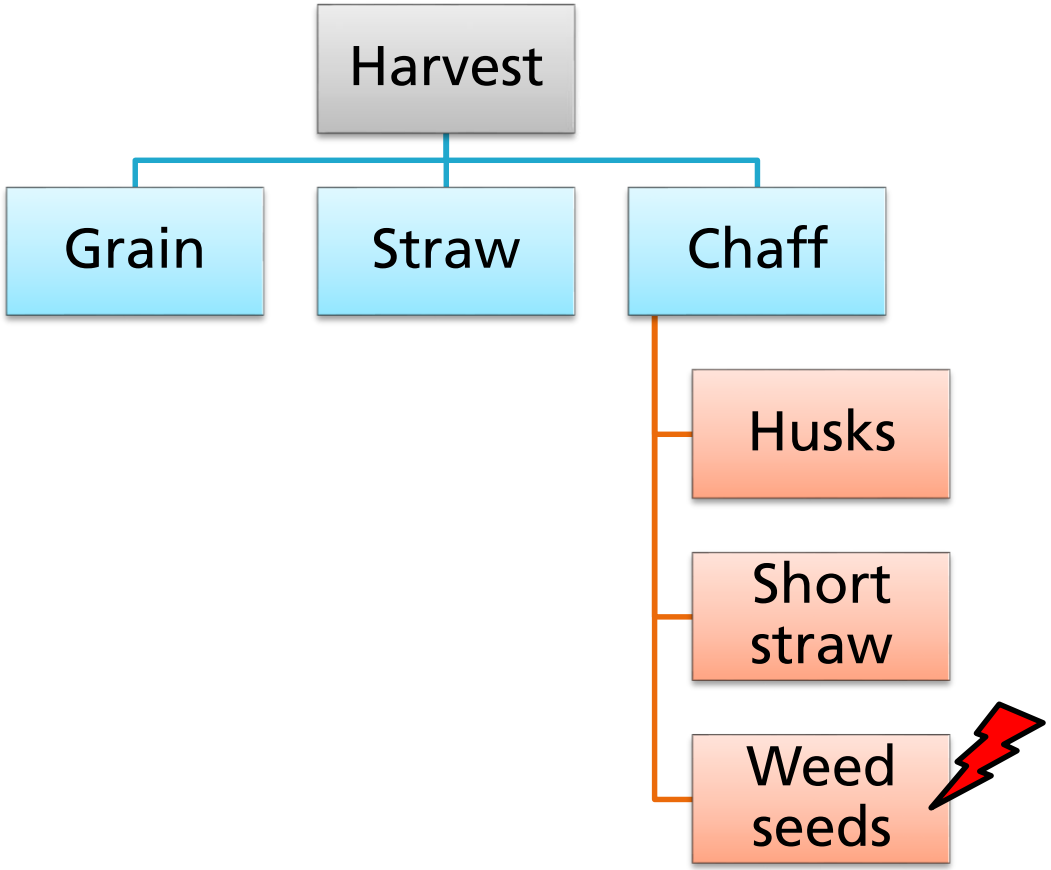

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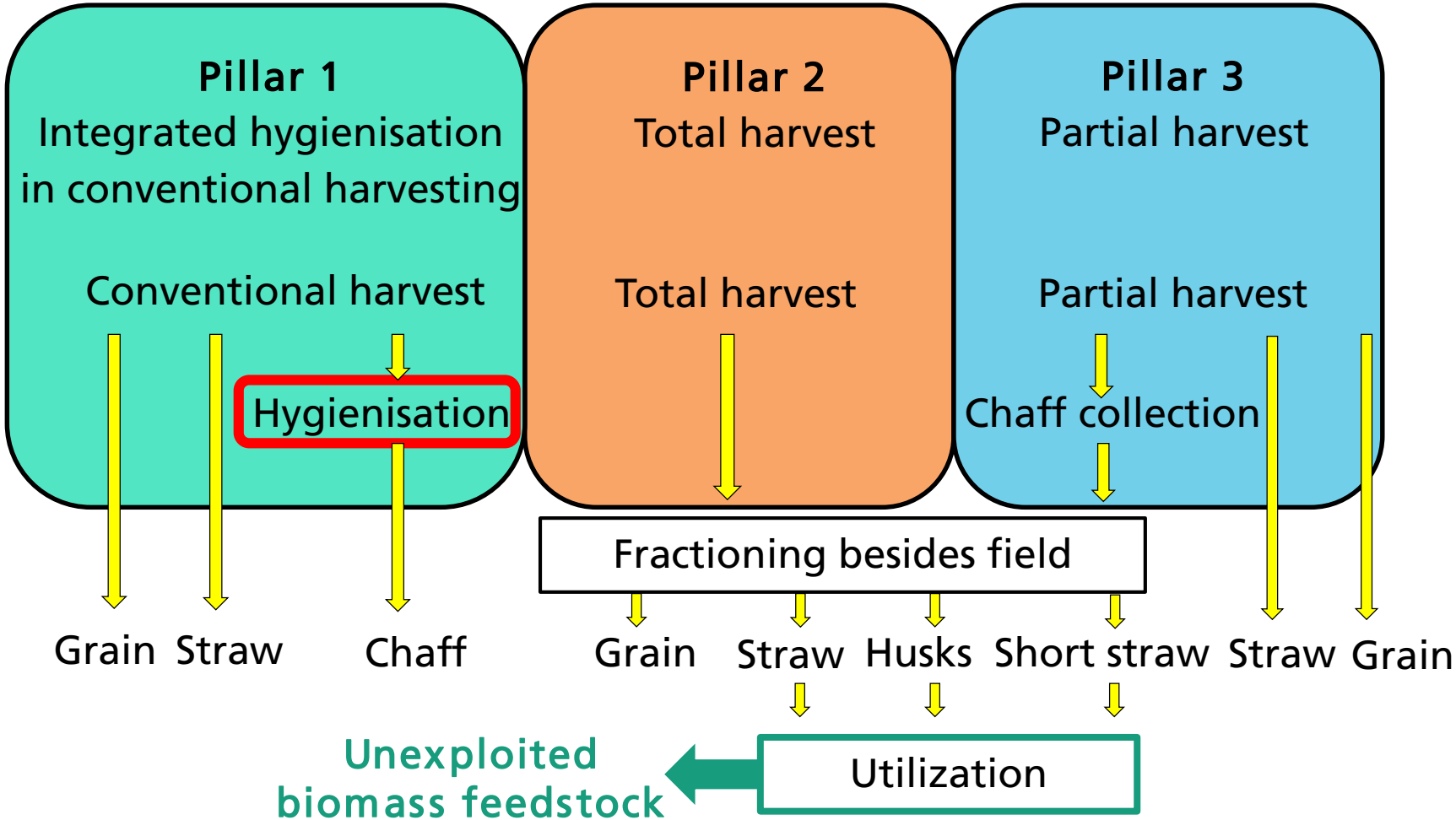

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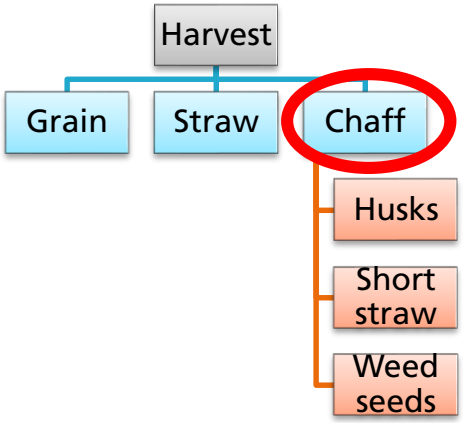
Pillar 1: Hygienisation of chaff during harvesting

- Exhaust gas of combine harvester is available as heat source
- Inactivation of viable weed seeds at 80 °C
- Challenge:
  - Heat transfer into the seeds
  - Low residence time (<= 2 s)
  - Enough heat amount



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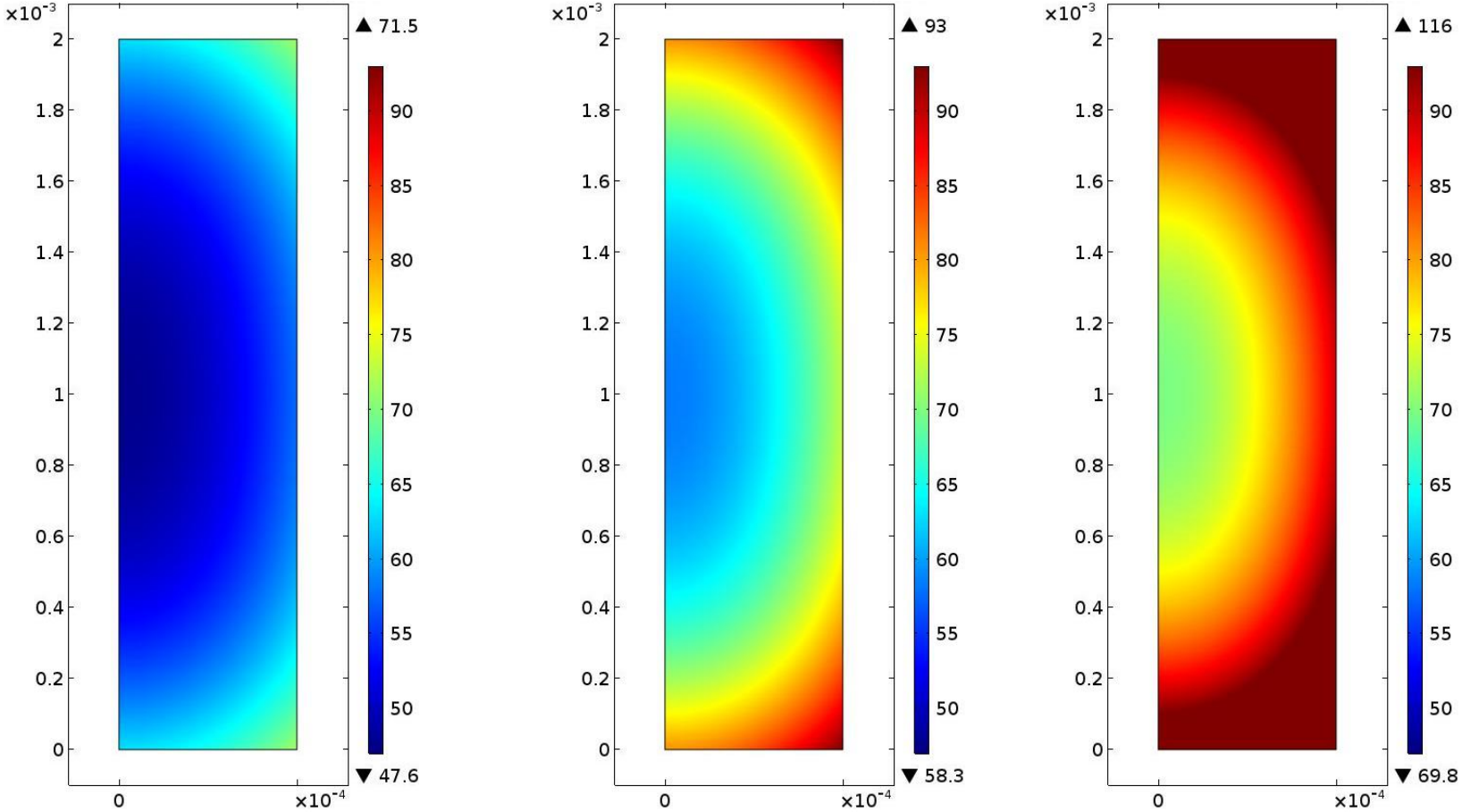
Pillar 1: Simulation of temperature profile (t = 2 s)

T_{gas} = 150 °C 200 °C 250 °C



Core: 47.6 °C 58.3 °C 69.8 °C

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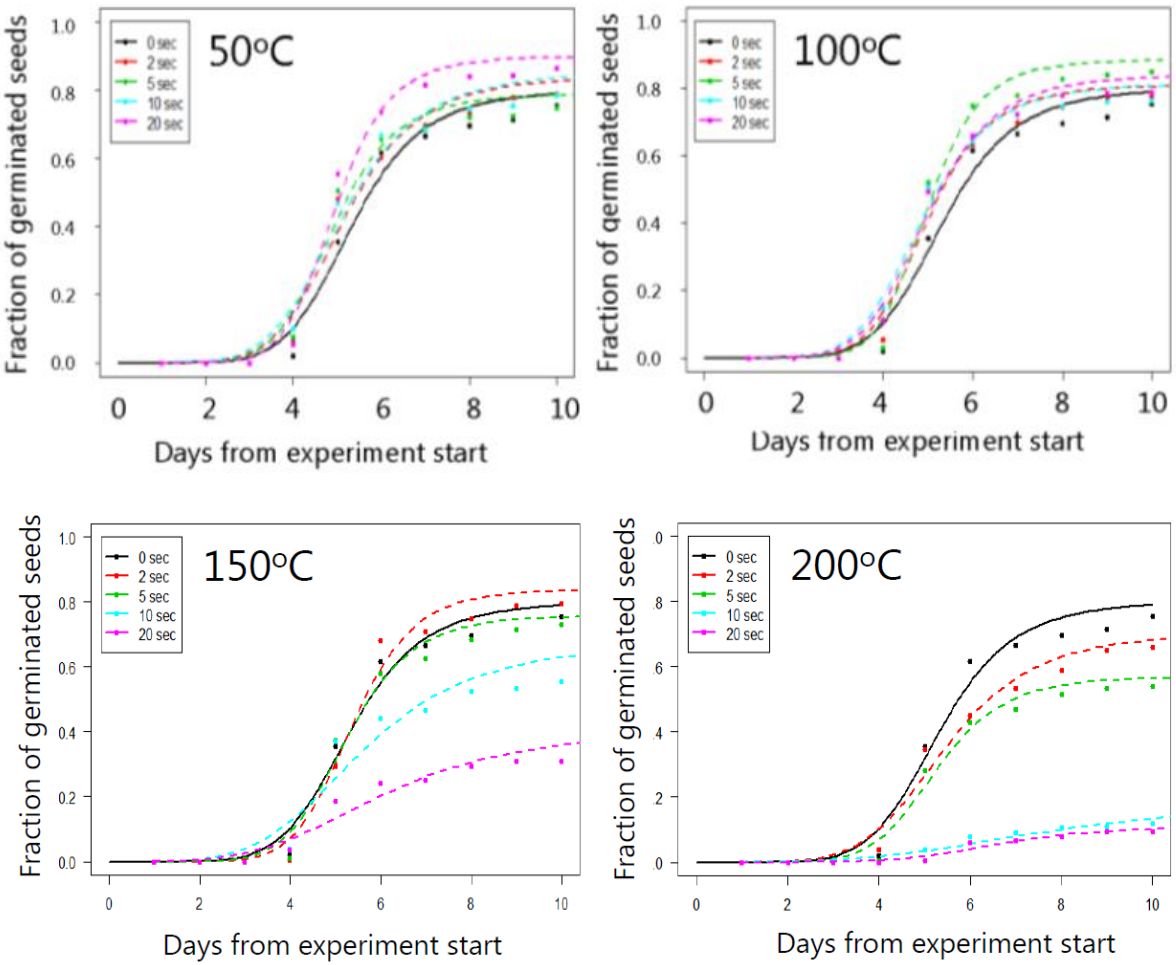
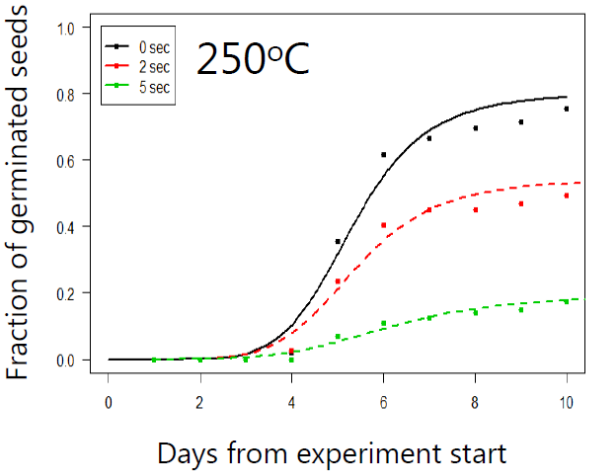
Pillar 1: Interim results (pure heat, no exhaust gas effect)



Alopecurus myosuroides
(=Black-grass)



[1] Andreasen, C.; Bitarafan, Z.; Fenselau, J.; Glasner, C. (2018): Exploiting waste heat from combine harvesters to damage harvested weed seeds and reduce weed infestation, Agriculture, 8, 42; doi:10.3390/agriculture8030042

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Pillar 1: Preliminary conclusions

Pillar 1: Hygienisation of chaff during harvesting

- Higher temperatures are necessary to guarantee an effective hygienization
- Better results with other weed species (=smaller seeds)
- Effect of exhaust gas itself
  - First investigations indicate that more moderate conditions can be used
  - Does negative side effects may occur (→ toxic substances)?

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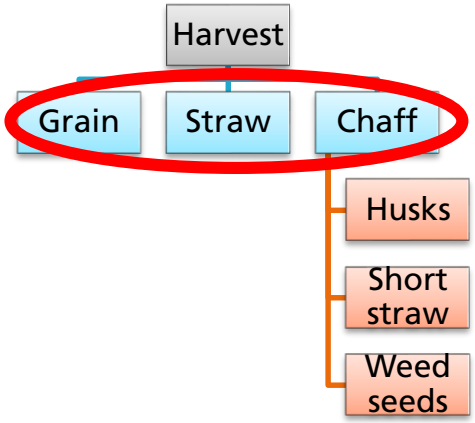
Pillar 2: Total harvest



- No cleaning step during harvesting.
- Grains, straw and chaff is stored together in a tank and removed from the field
- **<u>The harvested material is separated into:</u>**
  - Grains
  - Straw
  - Husks
  - or mixtures of it

  → Unexploited biomass feedstock

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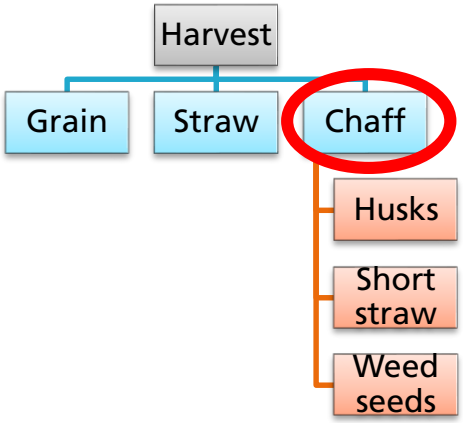
Pillar 3: Partial harvest

- Chaff is collected completely



- Chaff as resource for energetic use
  - Annual side product
  - **Sustainable** removal rate [2]: 0.33
  - Theoretical energetic potential: <u>191 PJ/a in EU</u>

[2] Weiser, C.; Zeller, V.; Reinicke, F.; Wagner, B.; Majer, S.; Vetter, A.; Thraen, D. (2014): Integrated assessment of sustainable cereal straw potential and different straw-based energy applications in Germany. Applied Energy 114, 749–762.

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Pillar 3: Partial harvest

Harvest ⇨ Chaff collection ⇨ Pre-treatment ⇨ Com-pressing ⇨ Com-bustion

Evaluation of **energetic usage** of wheat chaff [3]

- Pretreatment: Sieving
  - Increased bulk density by 47 %
  - Homogeneous particle sizes ≤ 5 cm
  - Better characteristics for combustion
- Pelletizing: Parameter variation
- Combustion: Kinetics and burnout behavior

[3] Weiß, B.; Glasner, C. (2018:): Evaluation of the process steps of pretreatment, pellet production and combustion for an energetic utilization of wheat chaff, Frontiers in Environmental Science - Agroecology and Land Use Systems, submitted and accepted.

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Pillar 3: Conclusions

Required measures:

- High ash content → optimized ash removal and dedusting
- High nitrogen content → primary measures to reduce NOx formation
- Low sintering temperature → stoking to break sintered ash

Possible applications:

- Bubble fluidized bed furnaces: economically for > 5 MWth
- Moving grate furnaces: economically for > 150 kWth

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Conclusions and Outlook

Conclusions:

- All measures showed promising results
- Weed infestation in the fields can be reduced significantly
  - without using herbicides
- Additional biomass is made available by Sweedhart measures

Outlook:

- Material use applications for chaff still under investigation
- Further field tests in 2018
- Catalogue of weed reduction methods by April 2019 available

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