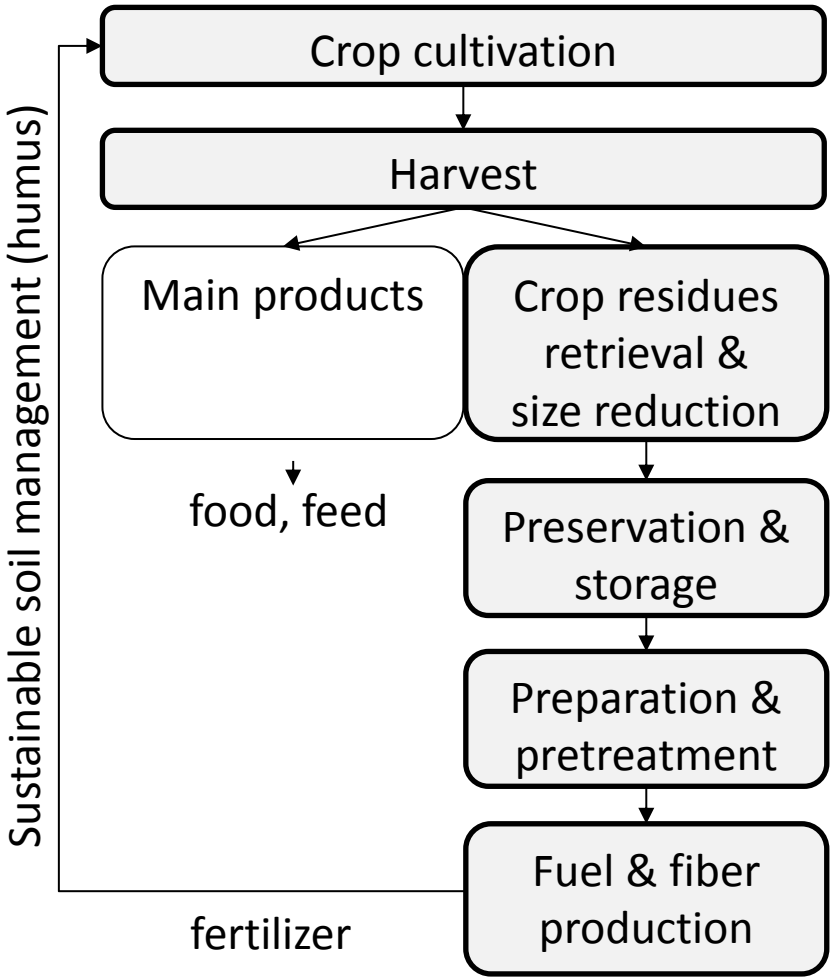
Maize straw for anaerobic digestion:

technologies to open up new resources

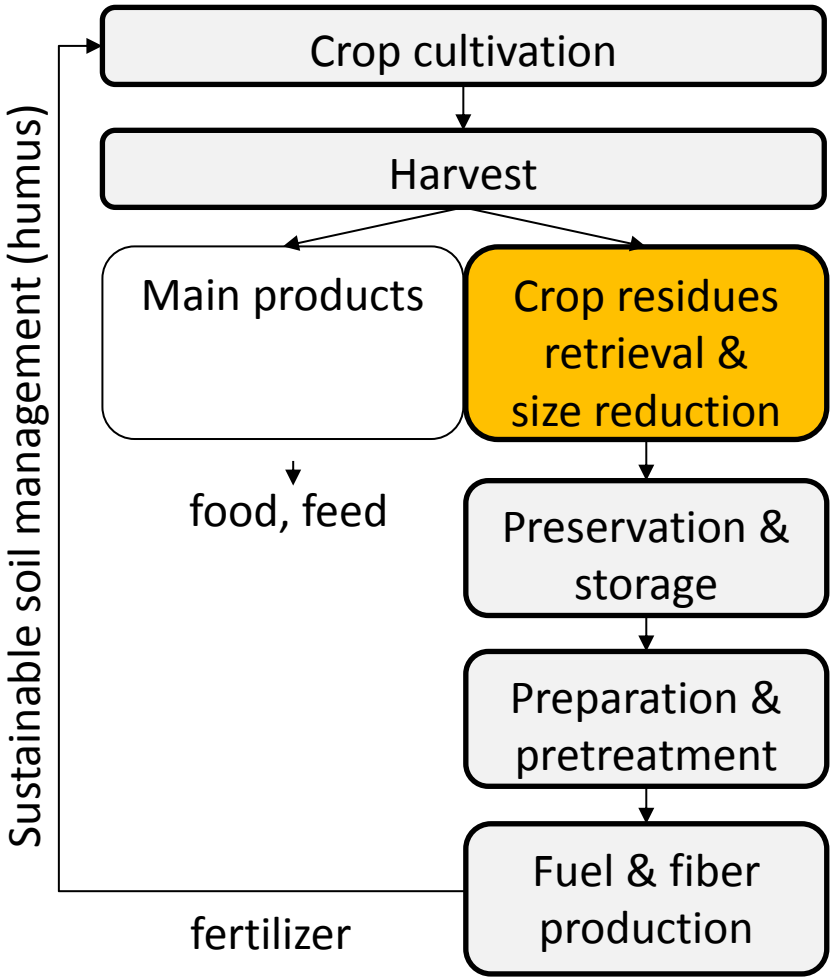
Javier Lizasoain

Challenge for a technical implementation and management



Challenge for a technical implementation and management

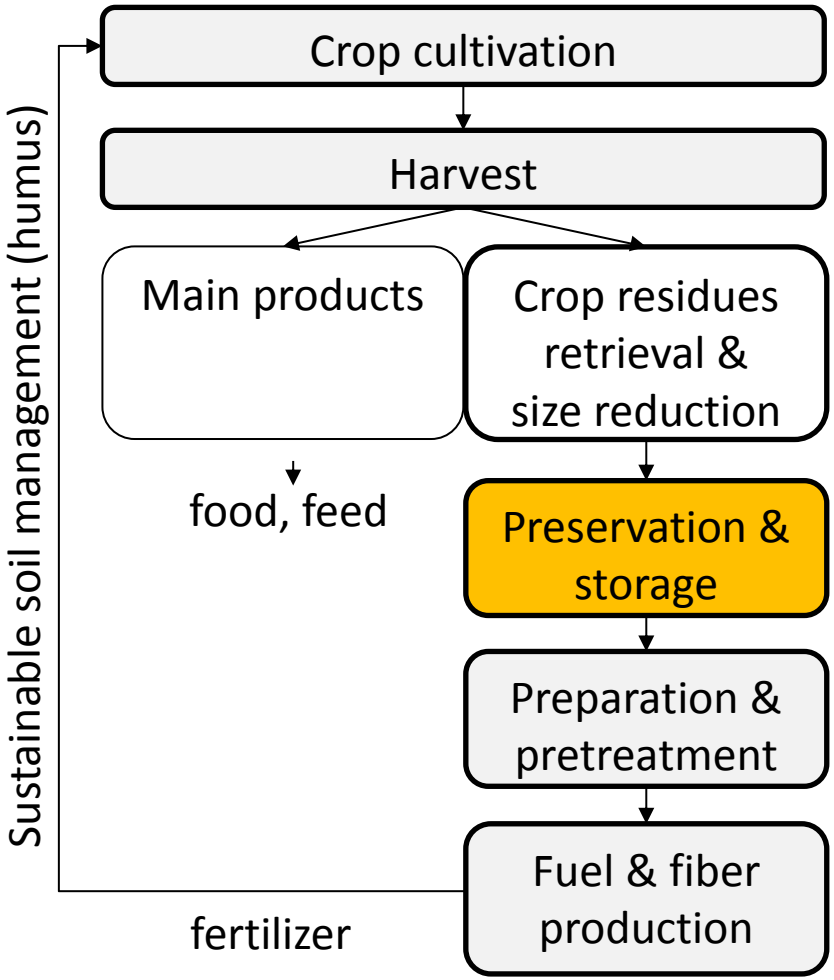
Harvesting technologies



- Adaptation of existing harvesting systems
- Short chopping lengths (compaction at the silo) or dried straw bales
- Avoidance of substrate contamination

Challenge for a technical implementation and management

Preservation and storage



Preservation and storage

Maize straw ≠ Maize straw

- Highly dependent on biomass type, maturity, harvest time, etc.

Options:

- 1. Ensiling
- 2. Storage as dry material

Preservation and storage

Ensiling:

- 28-45% DM → Early harvesting time → Post-drying corn grains
- Improvement of ensiling ability by combination with catch crops and green wastes

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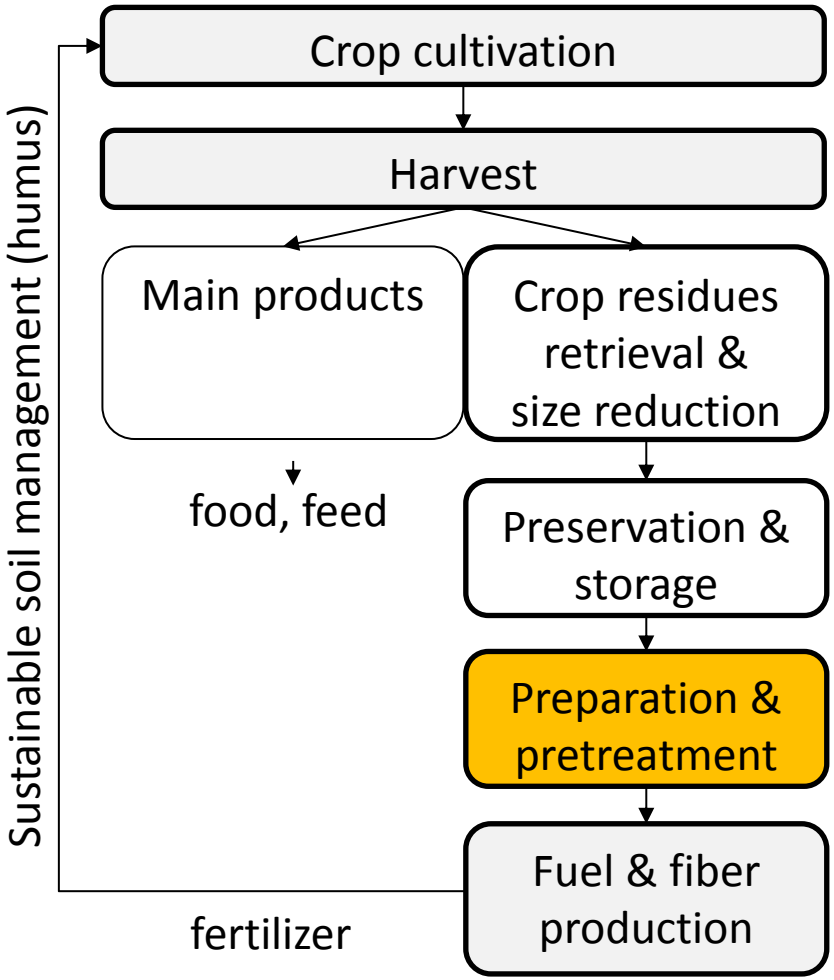
Dry storage:

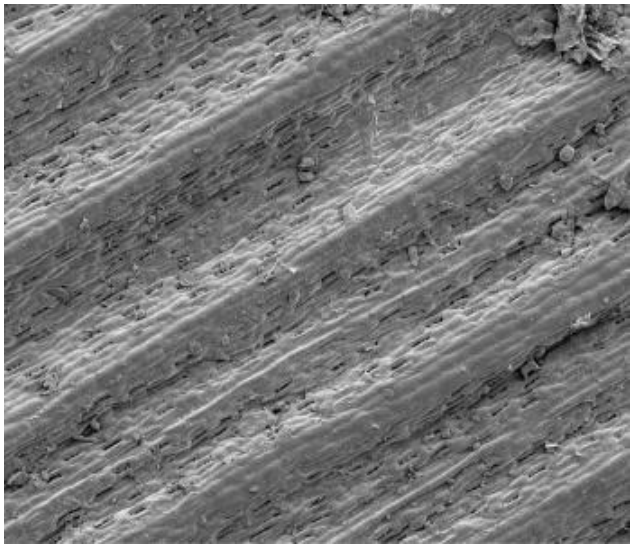
- Low water content→ later harvesting time
- Big storage volumes
- Strong lignification→ need of pretreatment for biogas production

Challenge for a technical implementation and management

Pretreatment of biomass



Pretreatment: background I



- Strong lignification prevents degradation of biomass
- Additional process step (pretreatment) is necessary in the process chain

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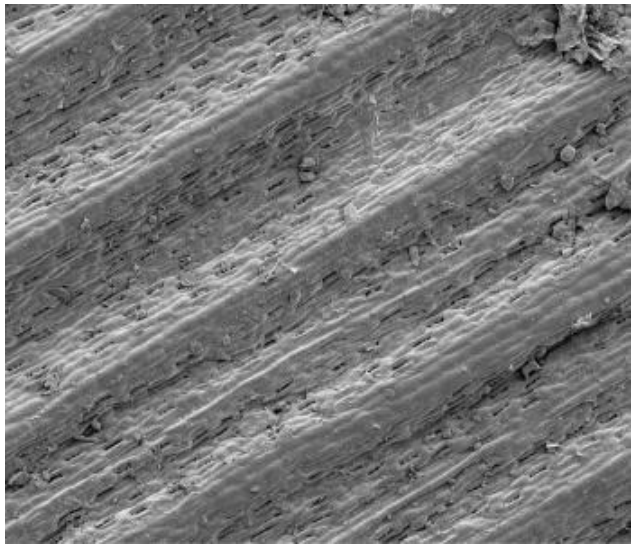
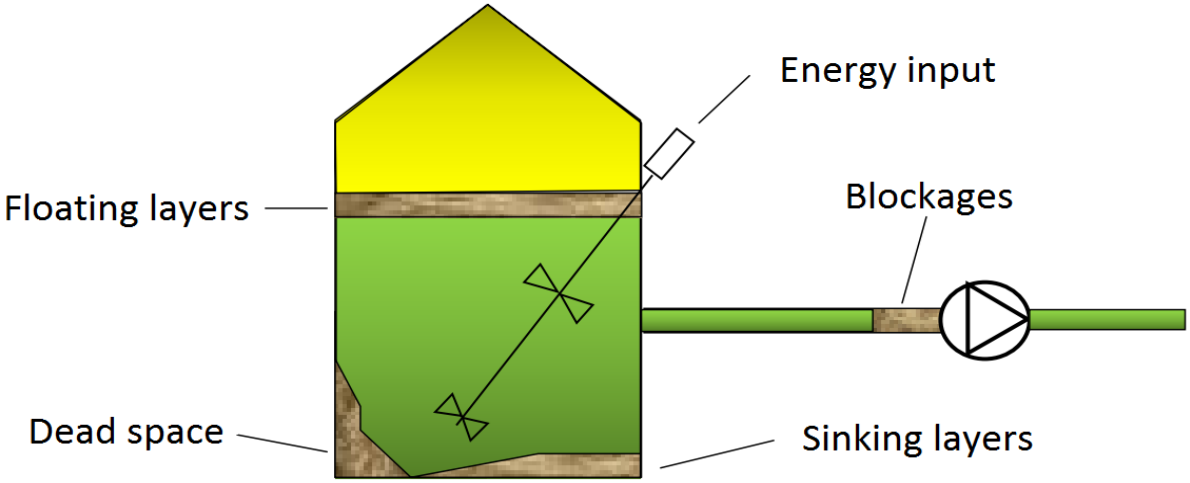


Challenge for a technical implementation and management

Pretreatment: background II



Source: Björn Schwarz, Fraunhofer IKTS, Dresden 2012

Possible problems

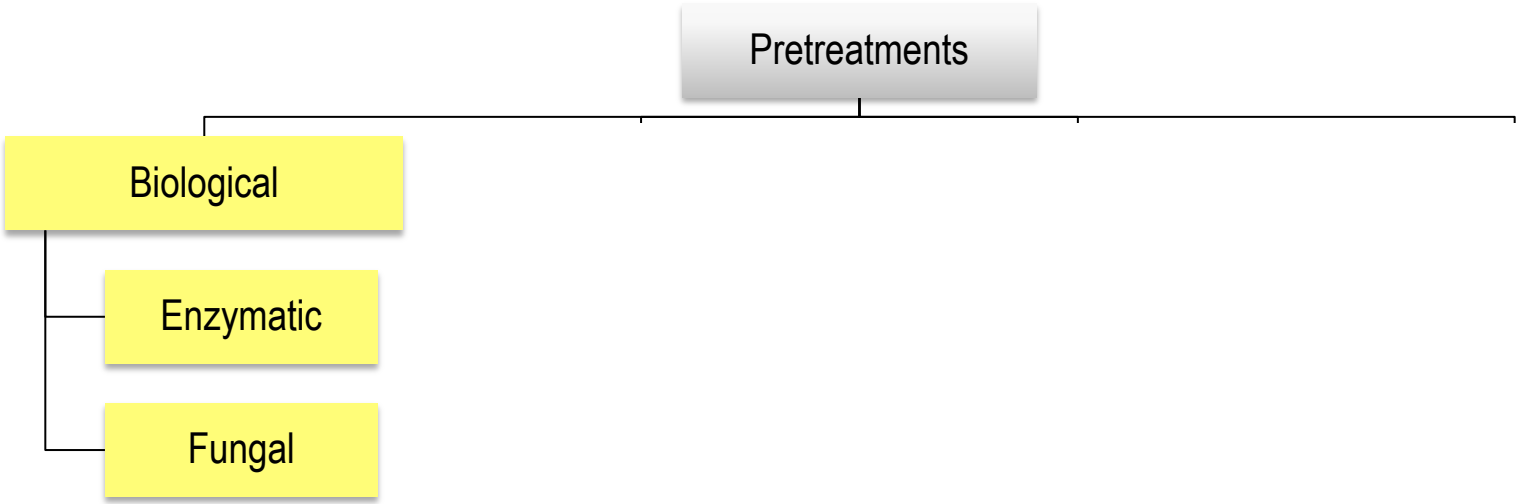
- Reduction of usable reaction space
- High energy requirement
- Operational disturbances

Pretreatment

Improvements

- Viscosity / pumping hability
- Stirability and homogeneisability
- Degradability

Pretreatment of biomass



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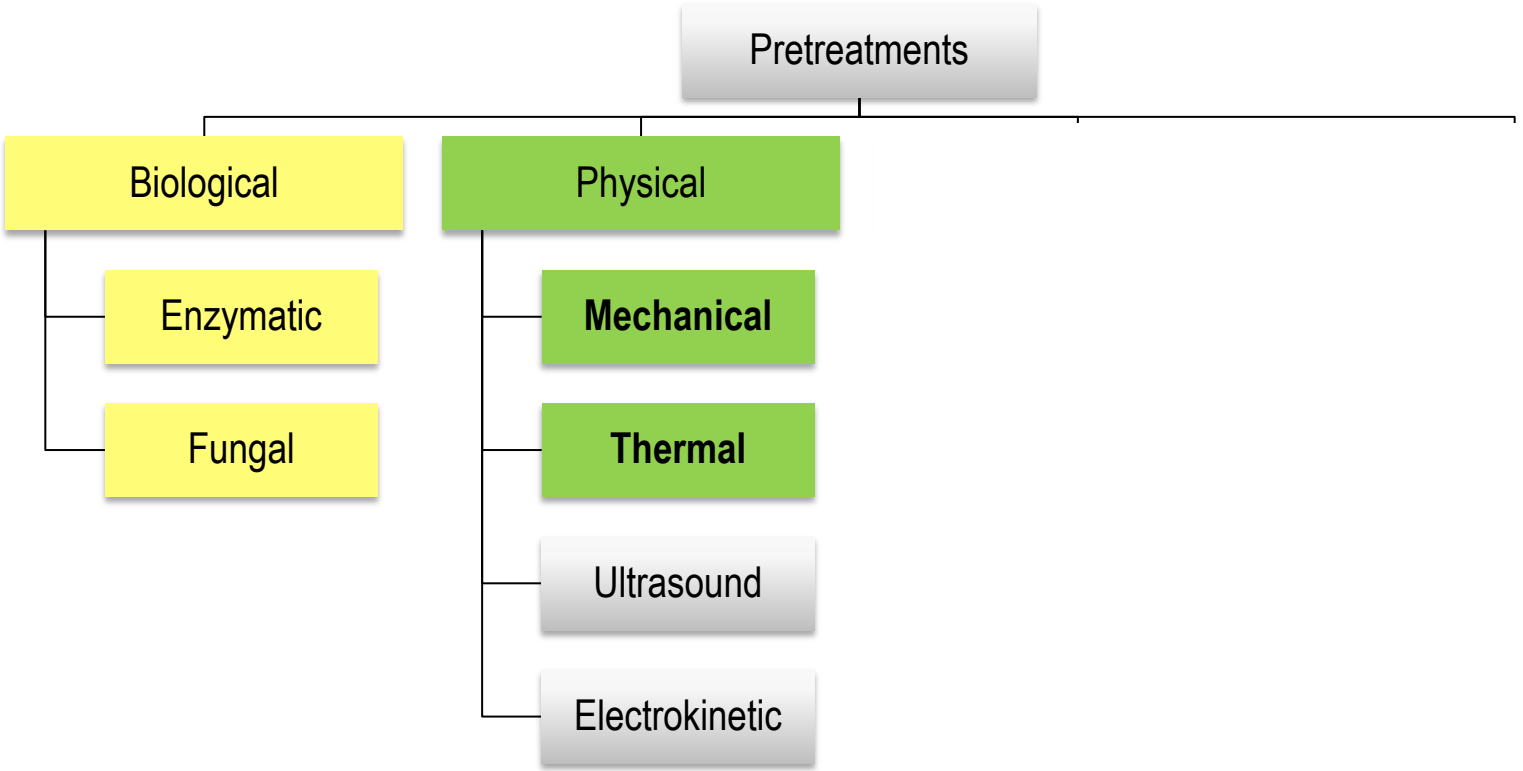

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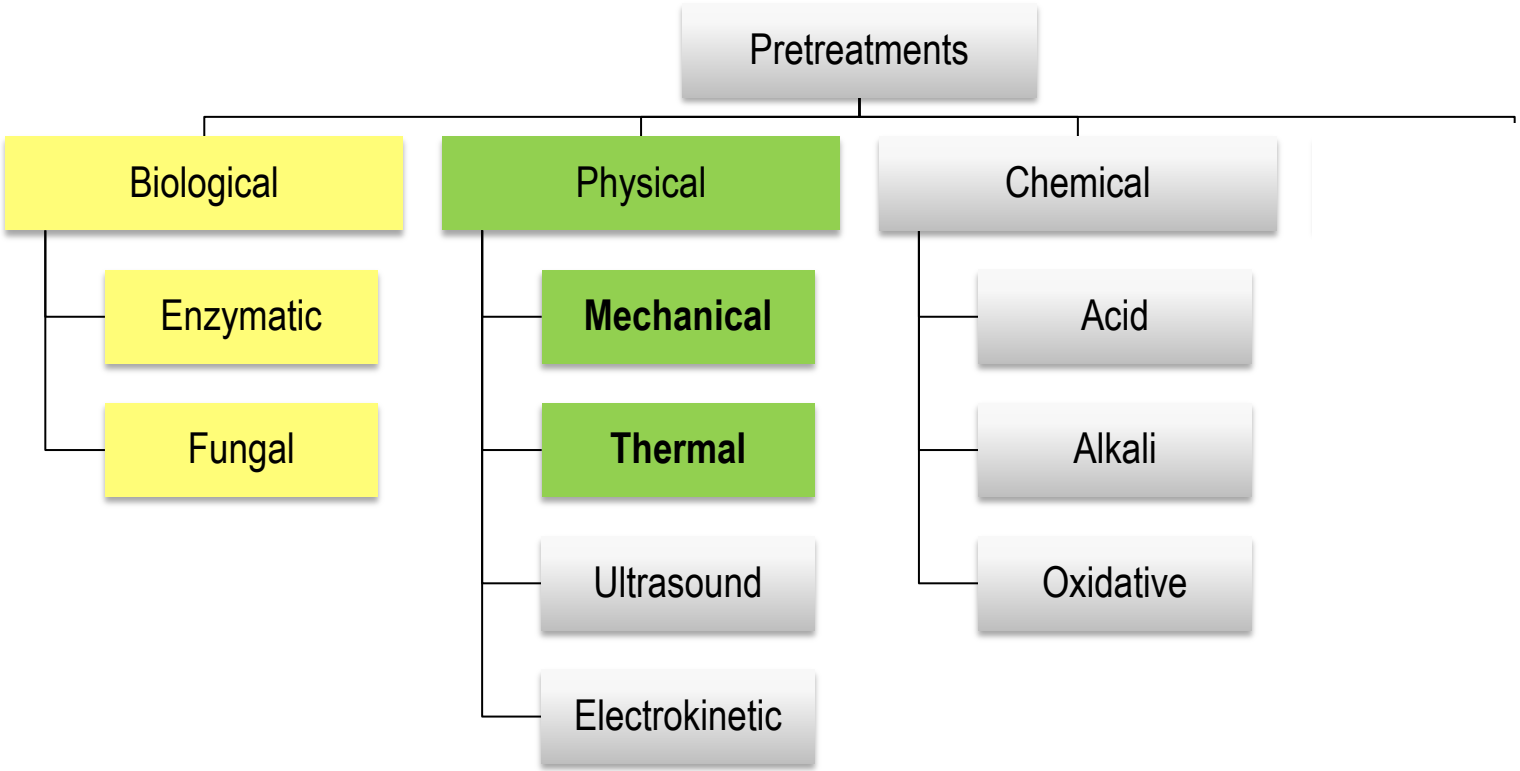

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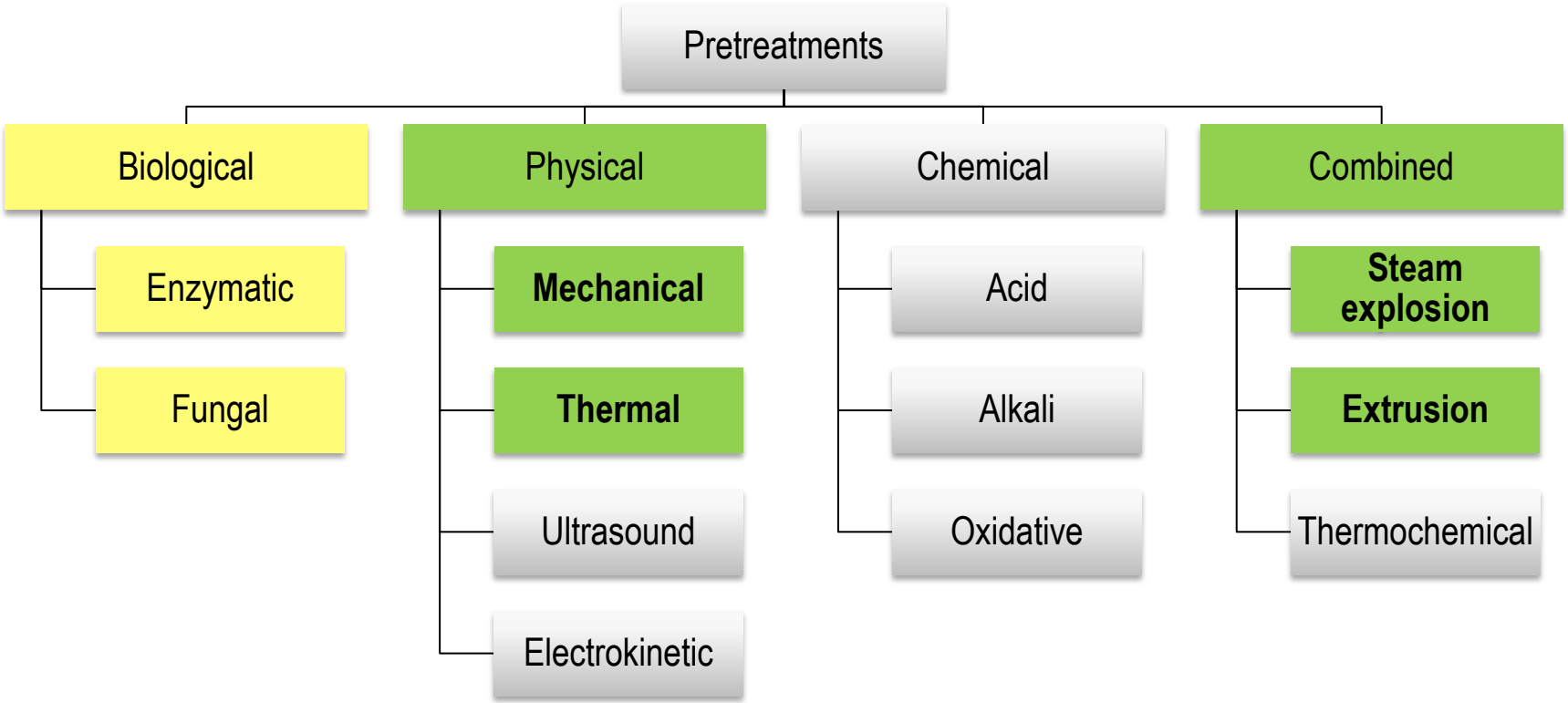


Pretreatment technologies:

Mechanical pretreatment

Grinding

Cutting

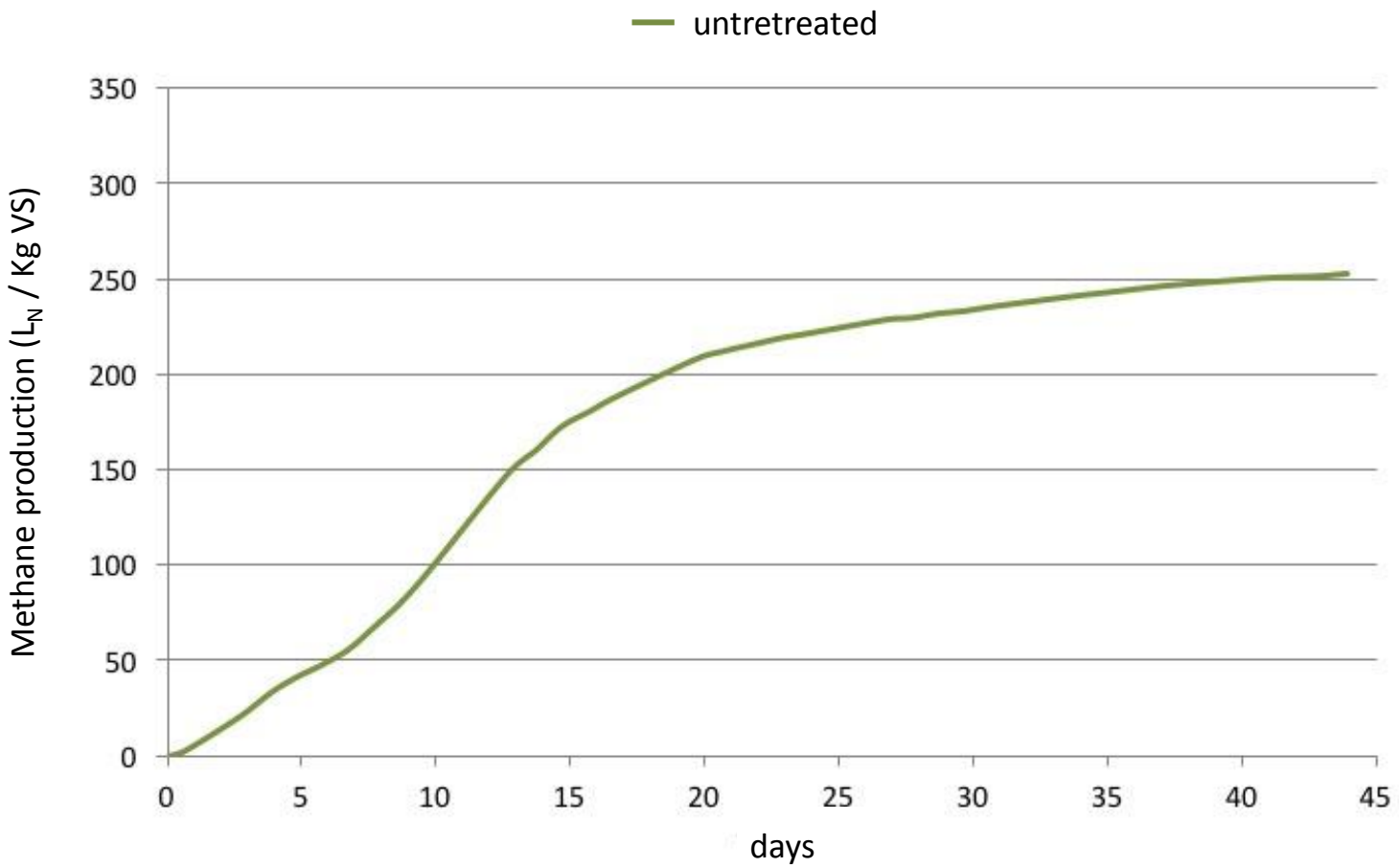
Extrusion

Mainly related to surface reduction

- Grinding (pressure, impact)
- Cutting (shear)
- Extrusion (pressure, friction, defibration)

Pretreatment technologies:

Mechanical pretreatment



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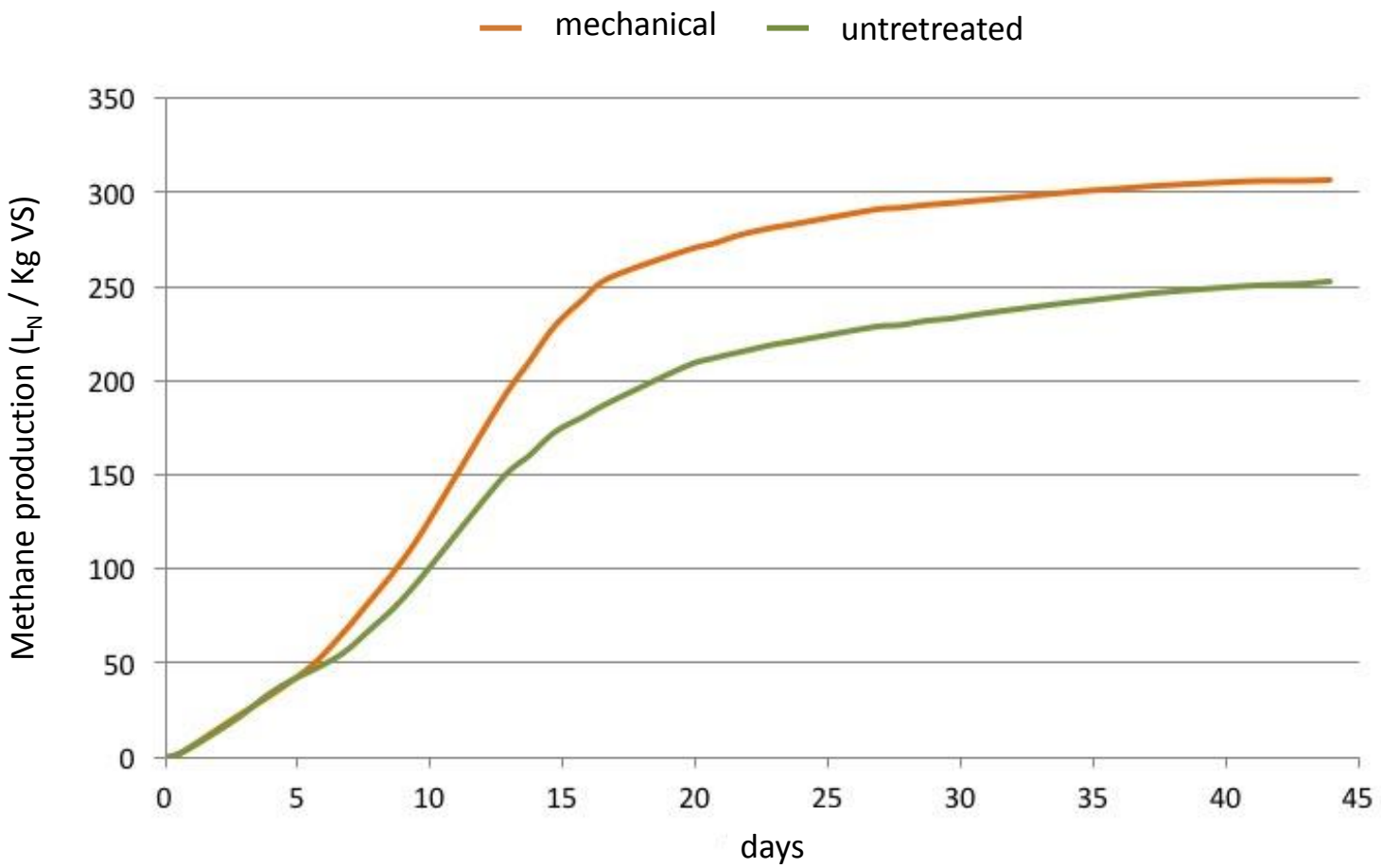

Pretreatment technologies:

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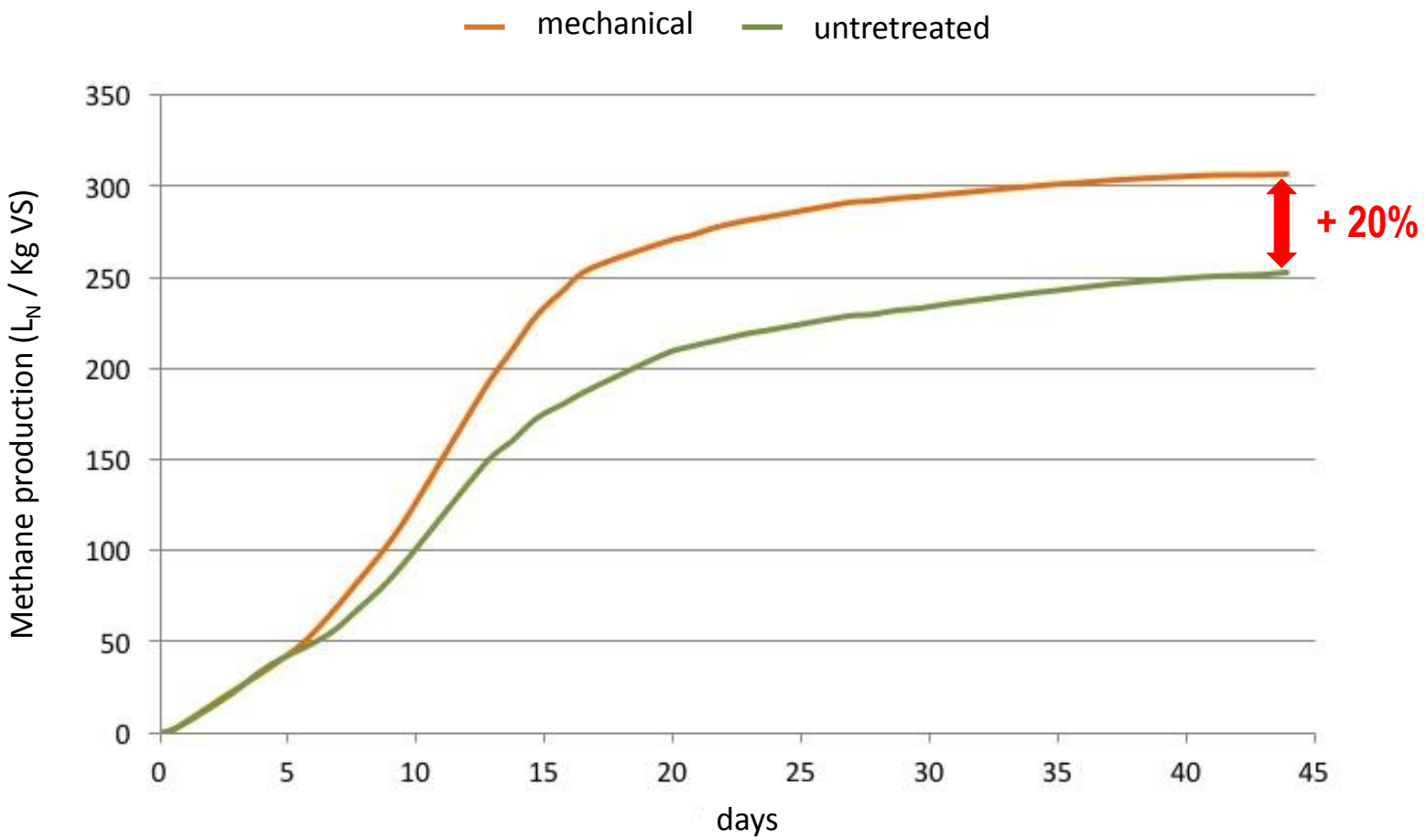
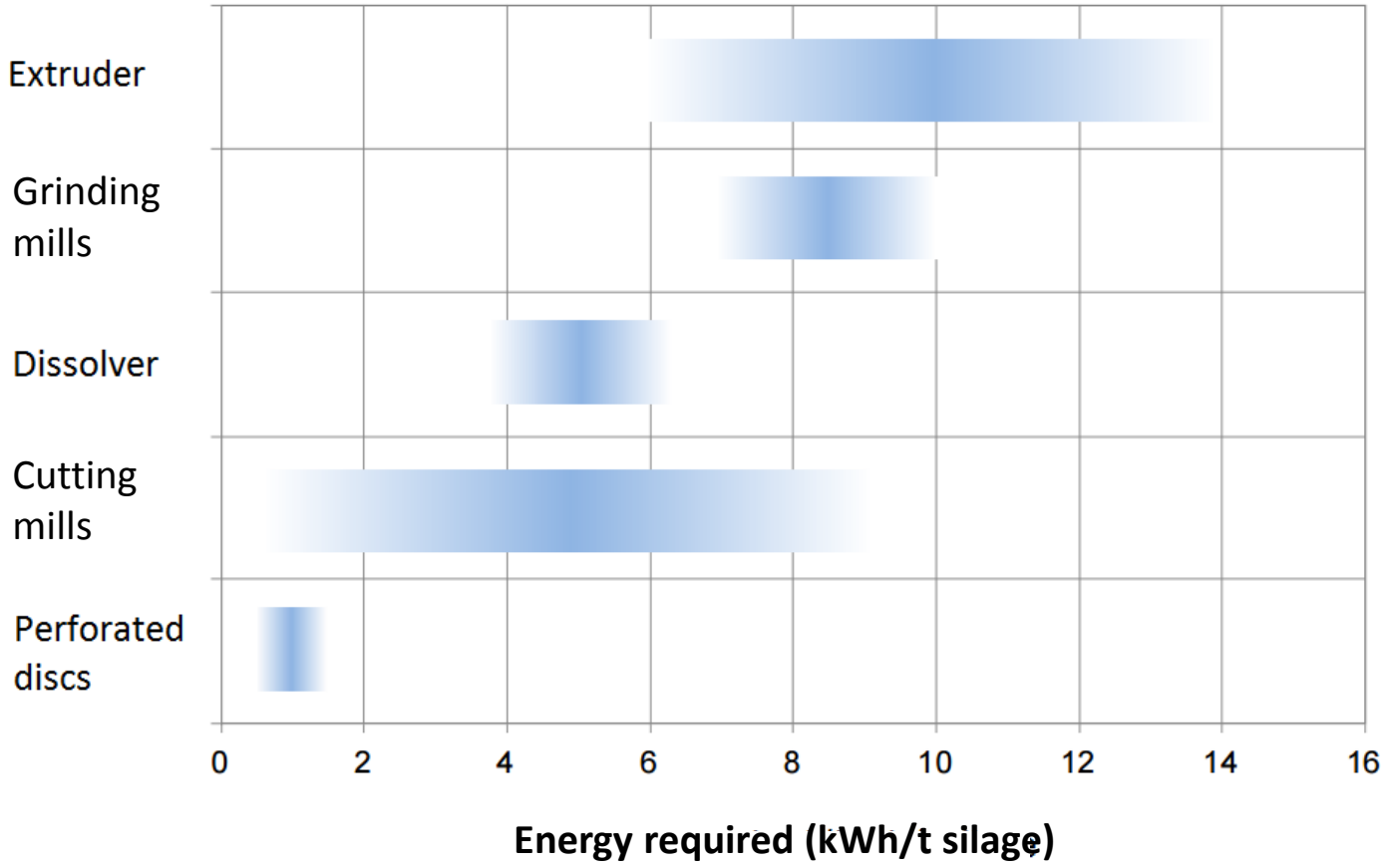


Mechanical pretreatment:

Energy requirement



Quelle: Björn Schwarz, Fraunhofer IKTS, Dresden 2012

Mechanical pretreatment:

Advantages and disadvantages

Advantages

- Easy integration in biogas plant
- Reduction of floating layers
- Improving mixing properties (stirring ability)
- Faster degradation
- Increased gas yield

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Disadvantages

- High electrical demand
- Milling tools are usually sensitive to contaminants (stones, metal parts, etc.)
- Corrosion or abrasion by organic acids and minerals (sand)

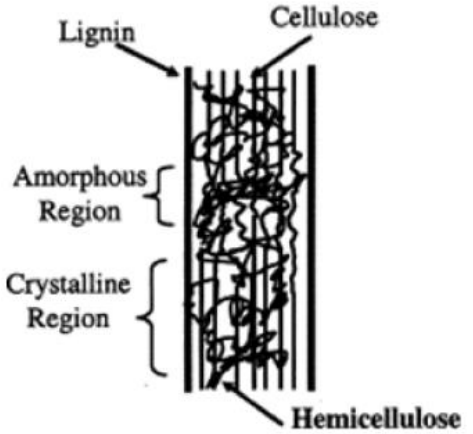
Pretreatment technology:

Combined - Steam explosion

- Treatment of biomass for a defined time with high temperature under high pressure
- Pressure suddenly drops → Water evaporates suddenly
- Thermochemical and mechanical digestion of the biomass

Pretreatment technology:

Combined - Steam explosion



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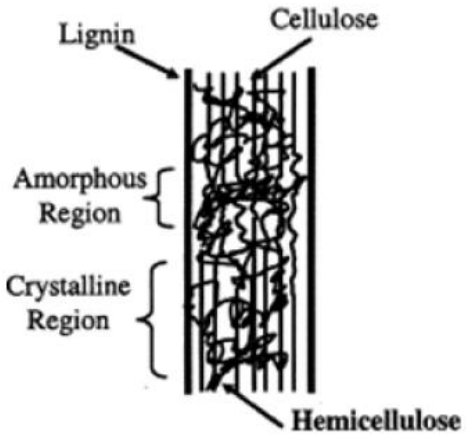
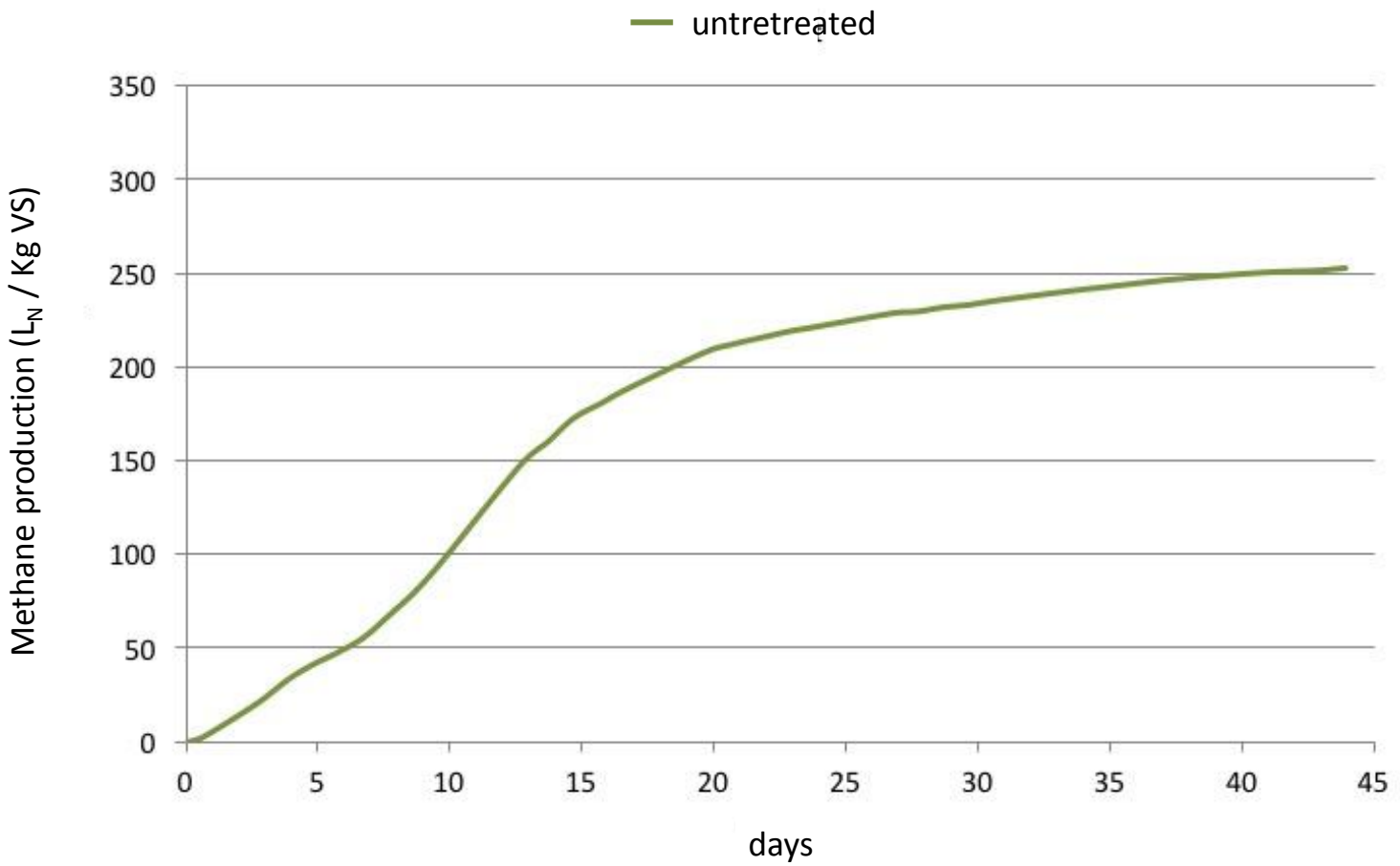


Differences in gas yields (45 days)



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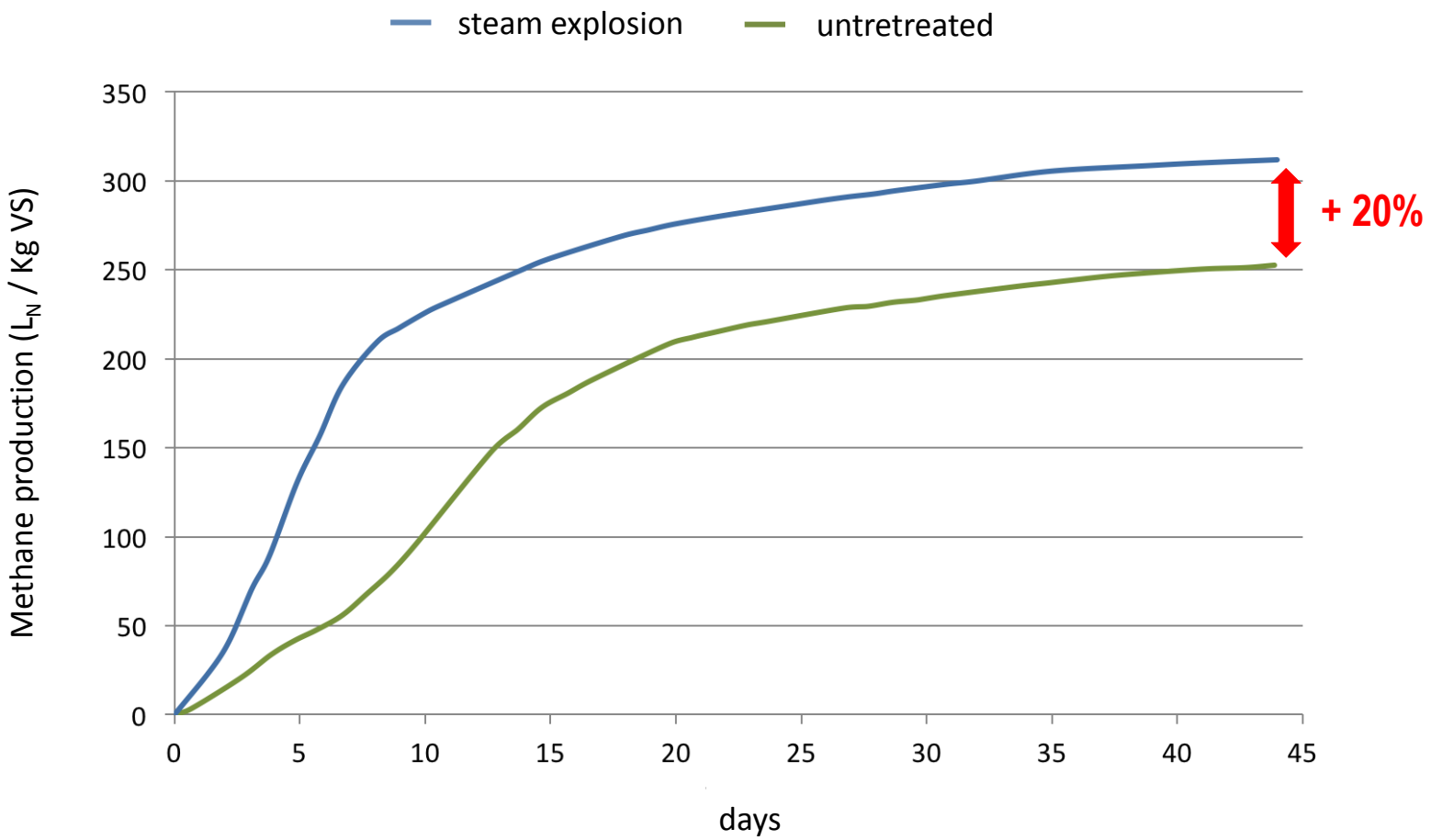

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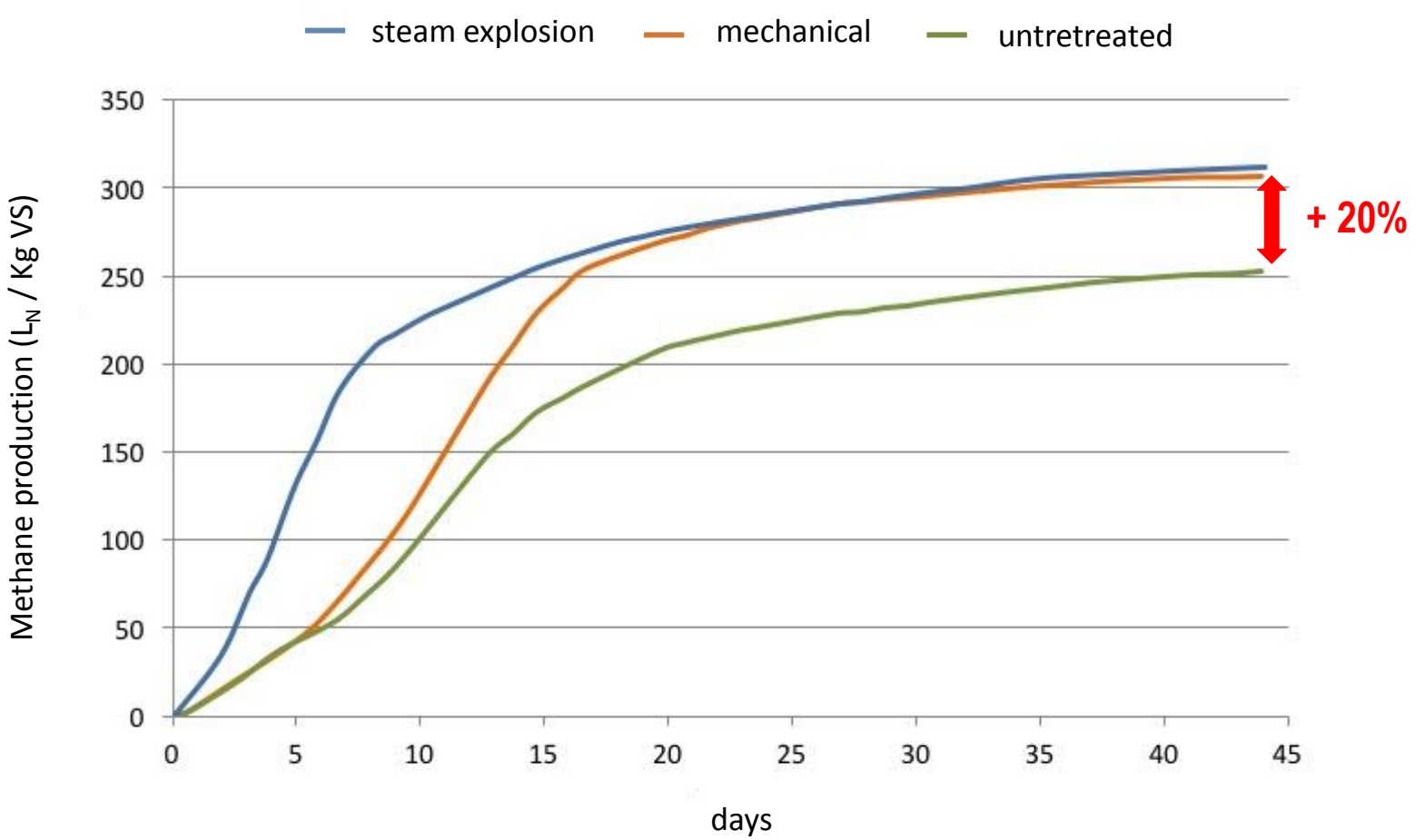

Power requirements

Electricicity demand	**36 kW**	**3,6 %**
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Combined pretreatment– Steam explosion

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Heat demand	**250 – 300 kW**	**25 - 30 %**
	6600 kWh/d	392 kWh/t VS
Water demand	30% DM input	
	13.500 to 15.000 m^3/year	

Reference performance: 1 MW electrical capacity (Economizer SE, BiogasSystems)

Advantages and disadvantages

More biogas and faster degradation due to higher surface area and a change in the chemical composition

Advantages

- Possibility to use waste heat from CHP
- Potential to speed up digestion
- Suitable for hygienisation (sludge, slaughterhouse residues, …)

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- Possibility to use waste heat from CHP
- Potential to speed up digestion
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Disadvantages

- Partially complex integration into the biogas plant
- Suitable for large biogas plants (> 1 MW)
- Waste heat must be sufficient for the process (no additional heating)

Key points

→ Consistent and effective pre-treatment is imperative to avoid operational problems in biogas plants

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→ Selection of pretreatment

- Economical
- Effective degradation of the feedstock
- Adapted to the installed technology (feeding systems, pumps, agitators)

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→ The adaptation and optimization of the pretreatment technologies require the performance of individual studies for every specific biogas plant

Thank you for your attention

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