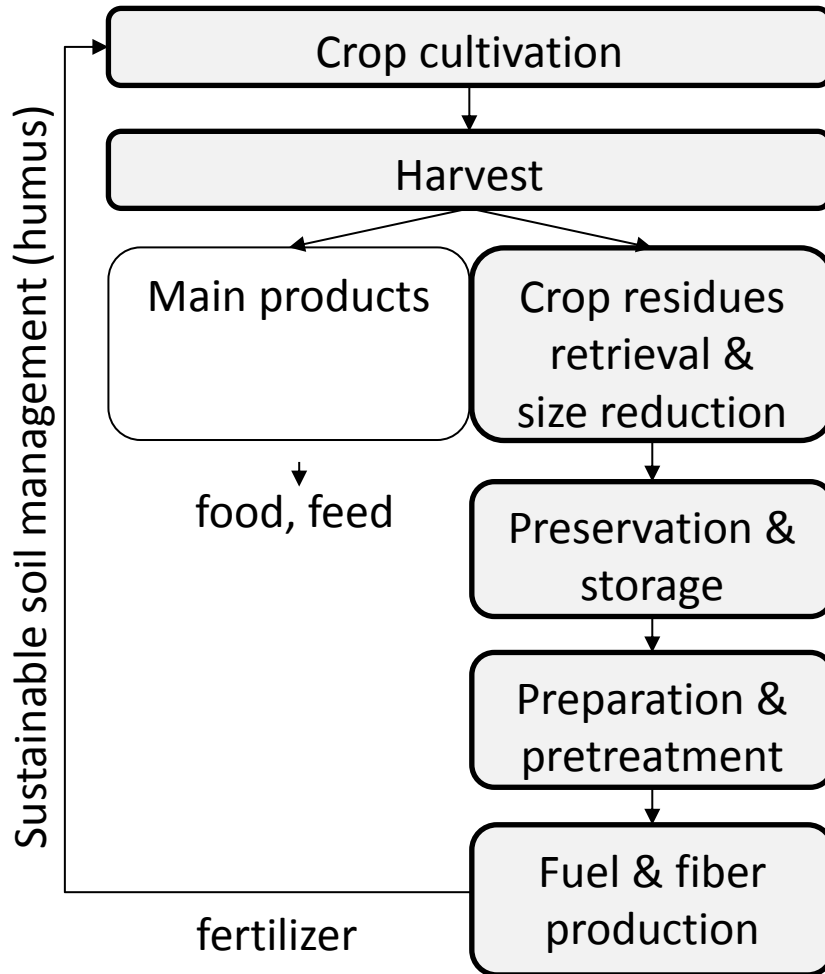


Maize straw for anaerobic digestion: technologies to open up new resources

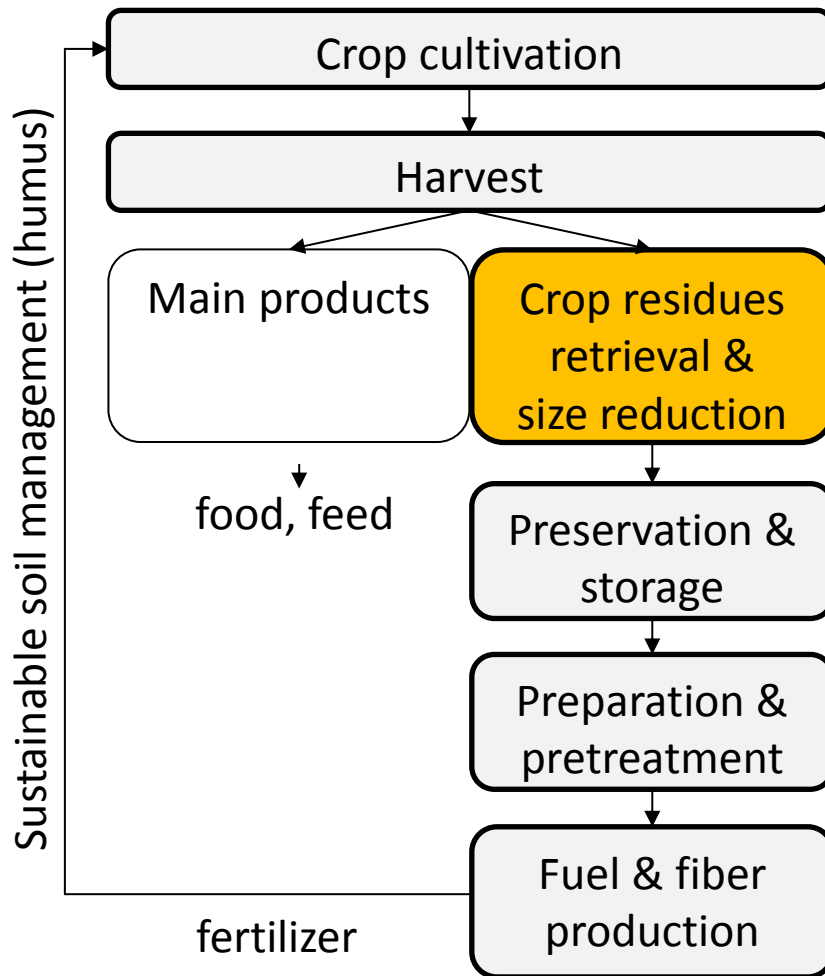
Javier Lizasoain



Challenge for a technical implementation and management

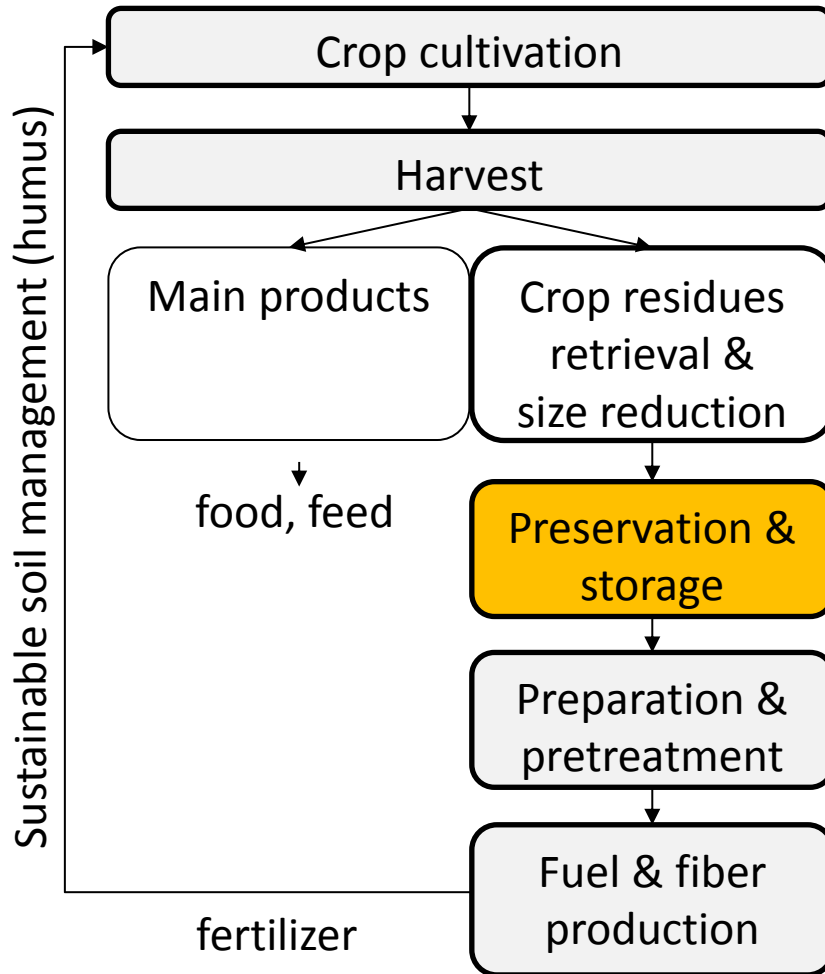


Harvesting technologies



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

Preservation and storage



Preservation and storage



Maize straw \neq 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

Preservation and storage



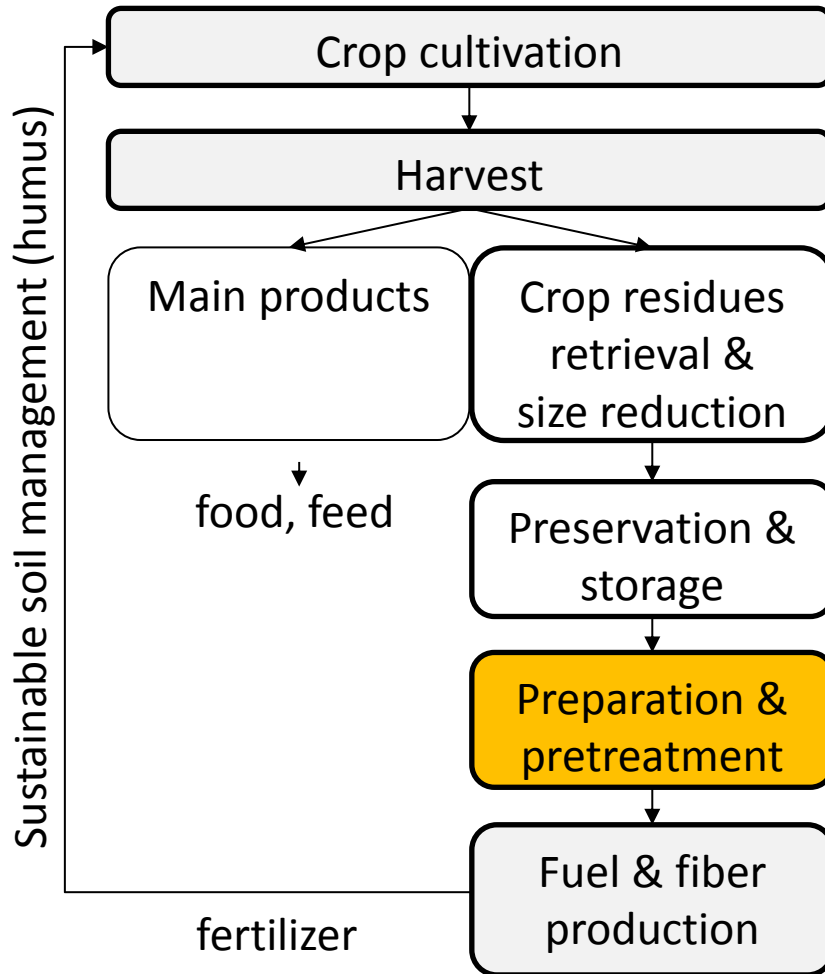
Ensiling:

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

Dry storage:

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

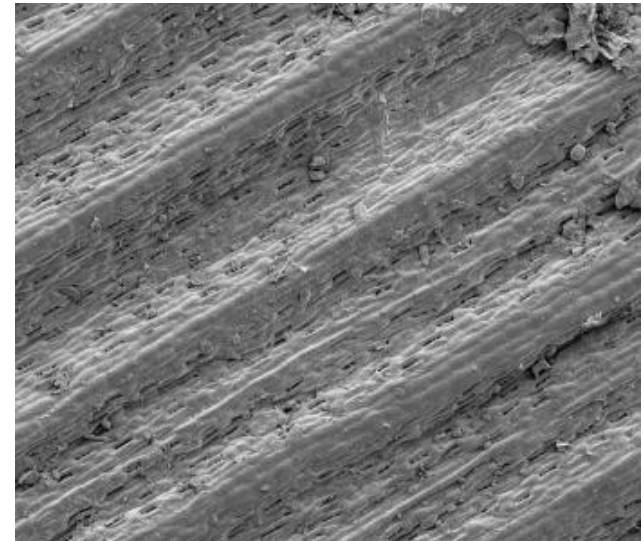
Pretreatment of biomass



Challenge for a technical implementation and management

Pretreatment: background I

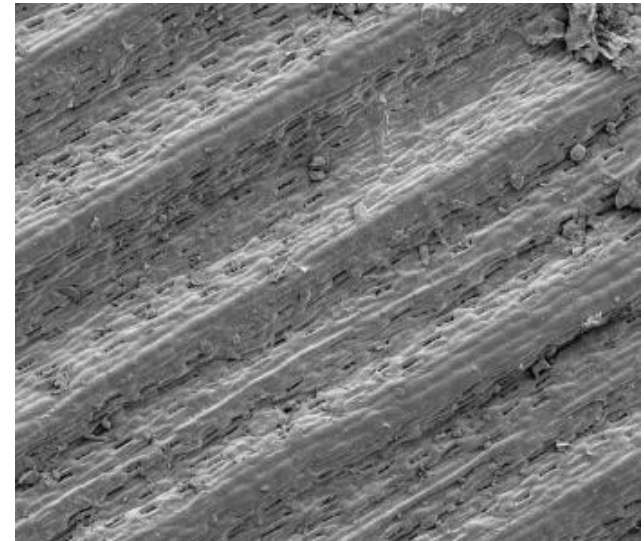
- Strong lignification prevents degradation of biomass
- Additional process step (pretreatment) is necessary in the process chain



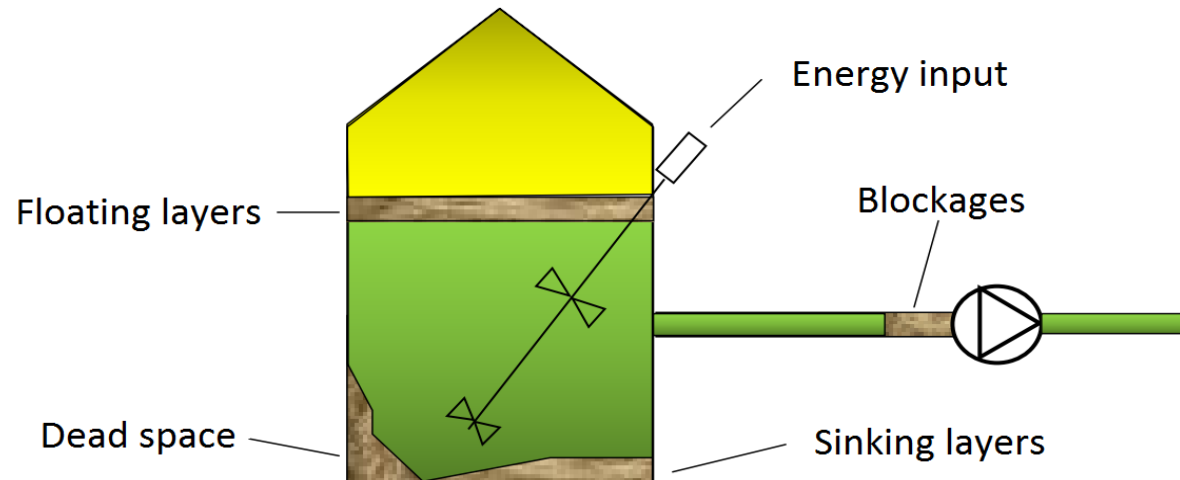
Challenge for a technical implementation and management

Pretreatment: background I

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



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

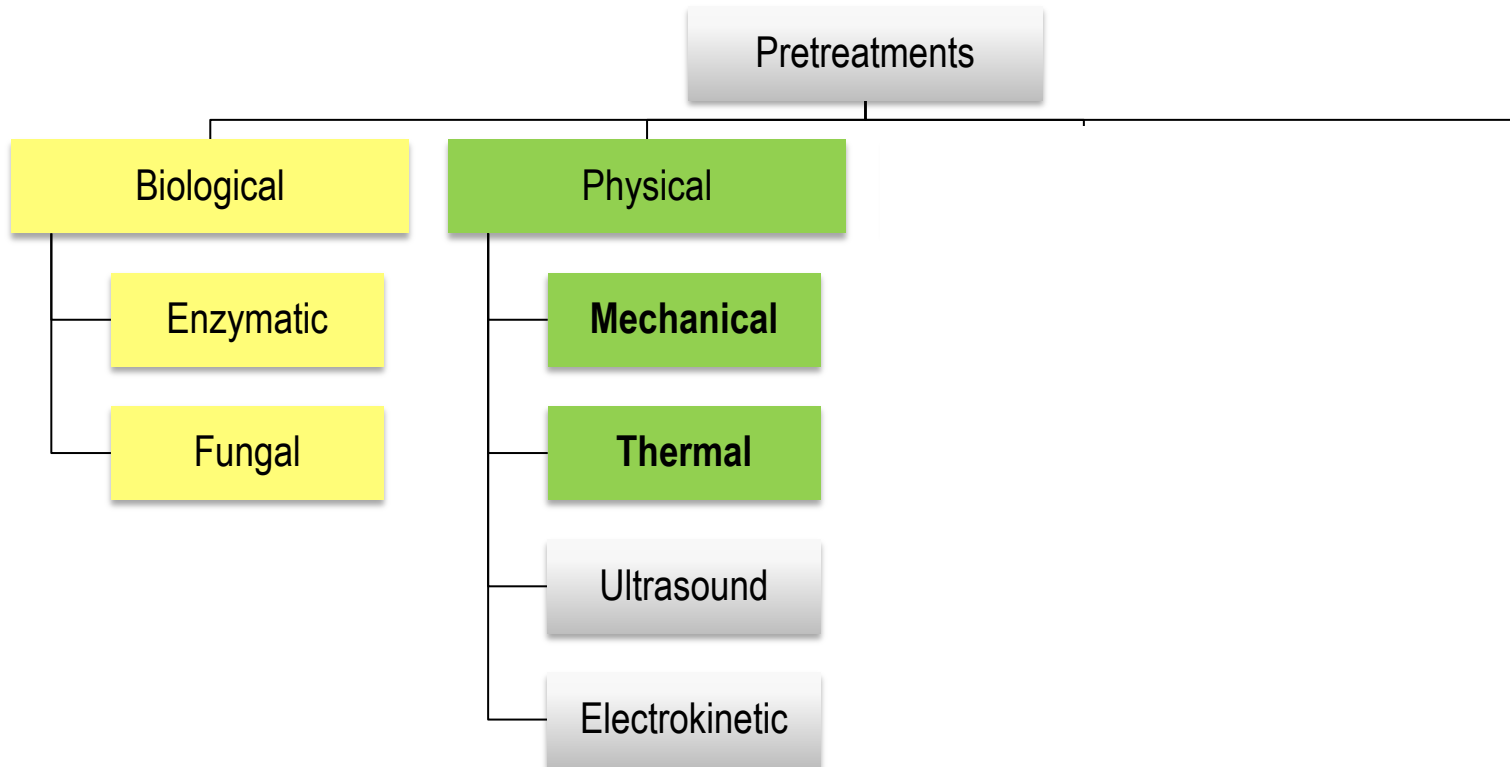
Pretreatments

Biological

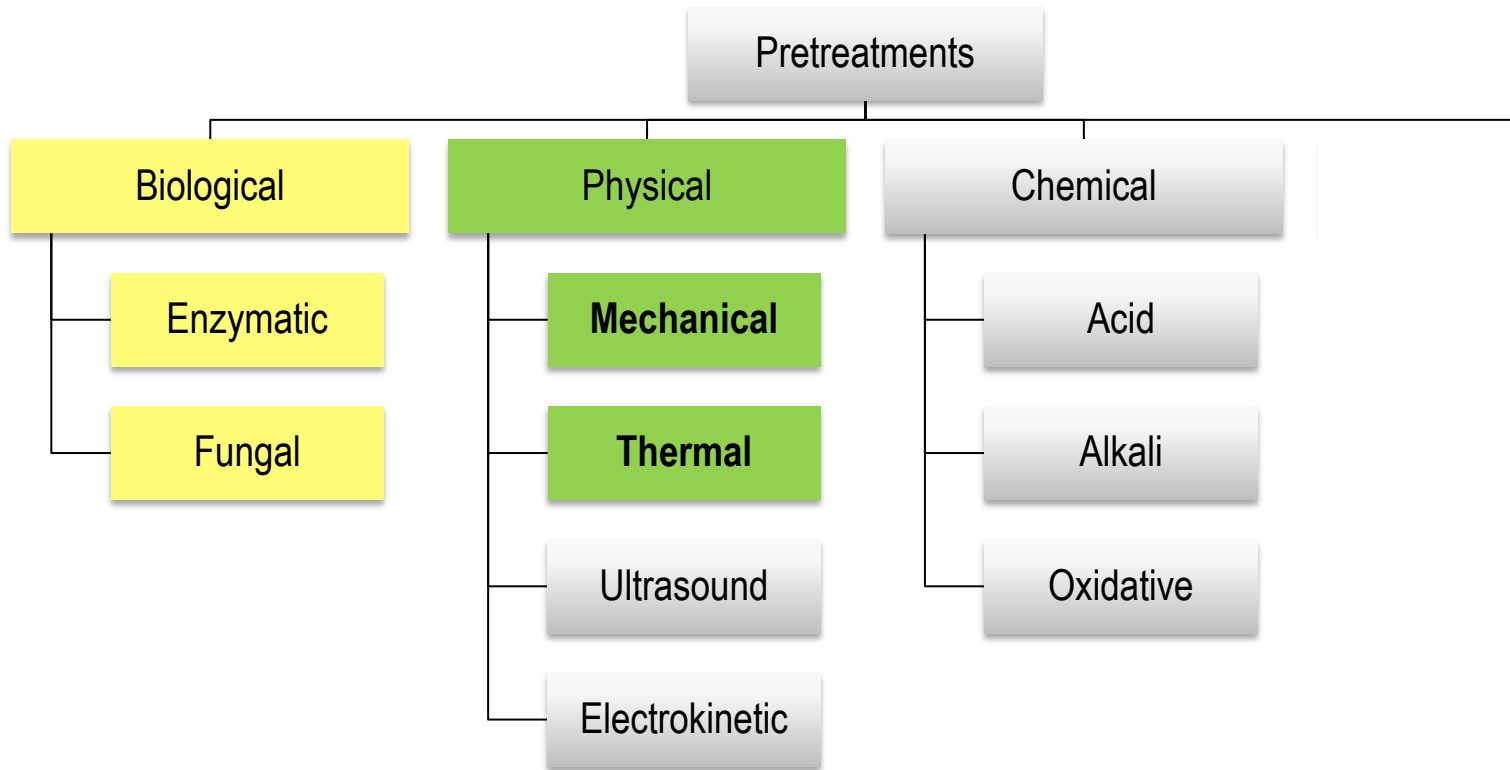
Enzymatic

Fungal

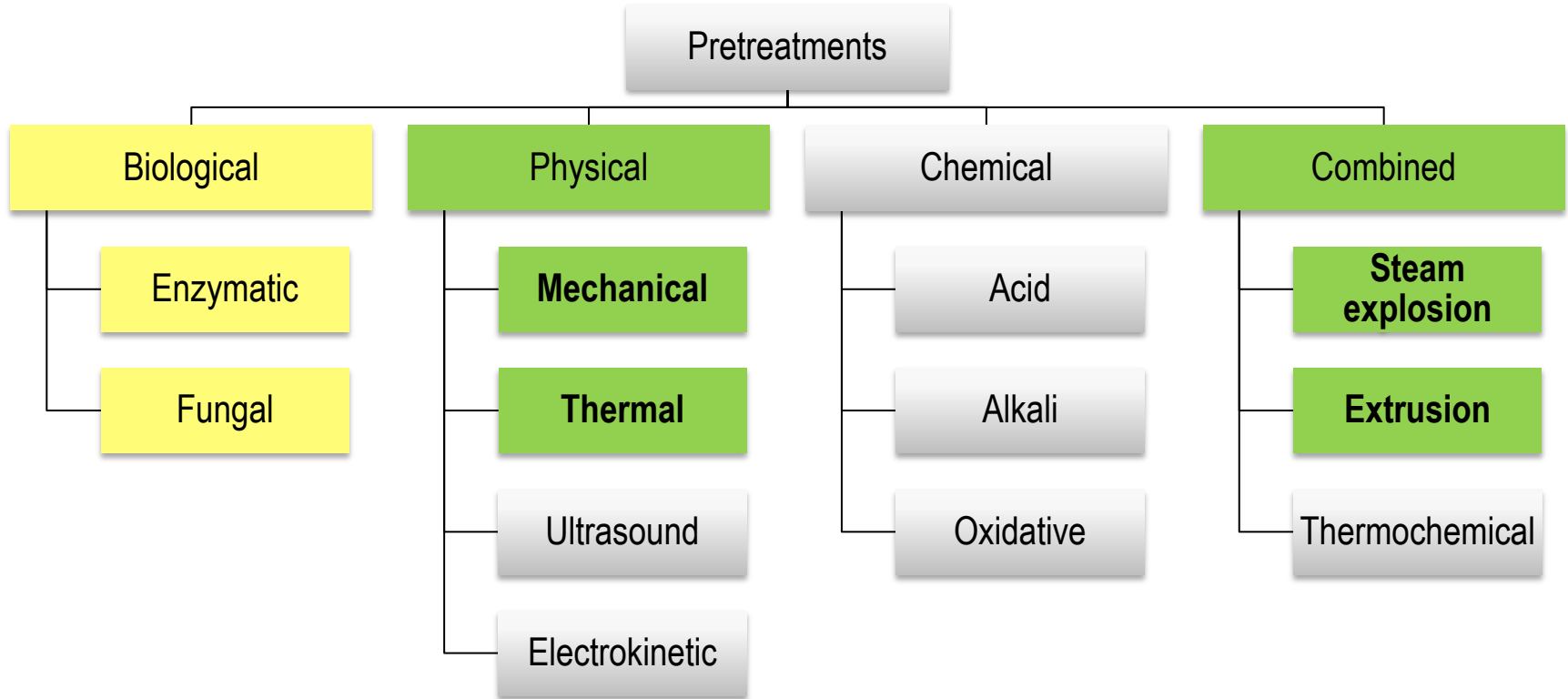
Pretreatment of biomass



Pretreatment of biomass



Pretreatment of biomass



Pretreatment technologies:

Mechanical pretreatment



Grinding



Cutting

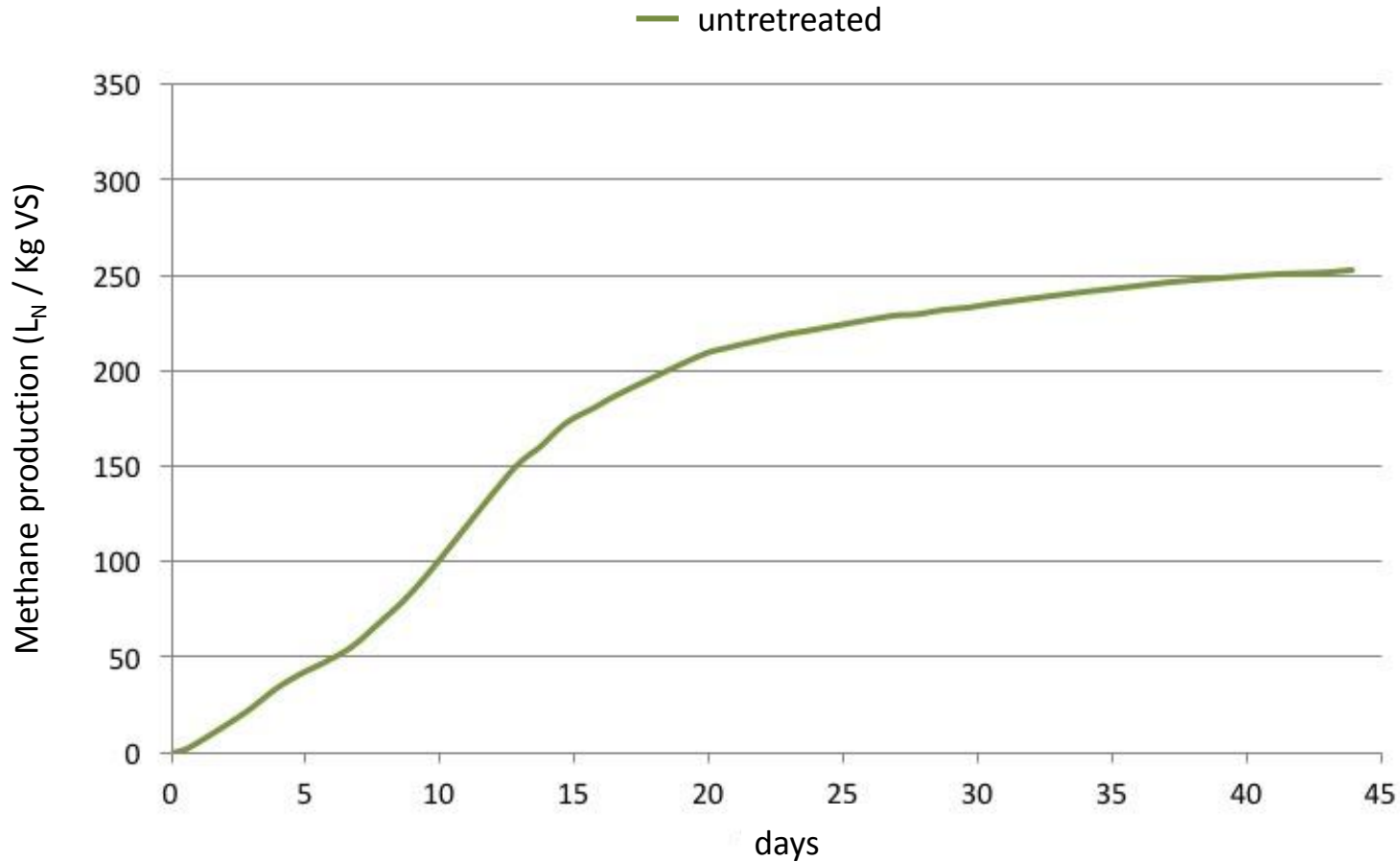


Extrusion

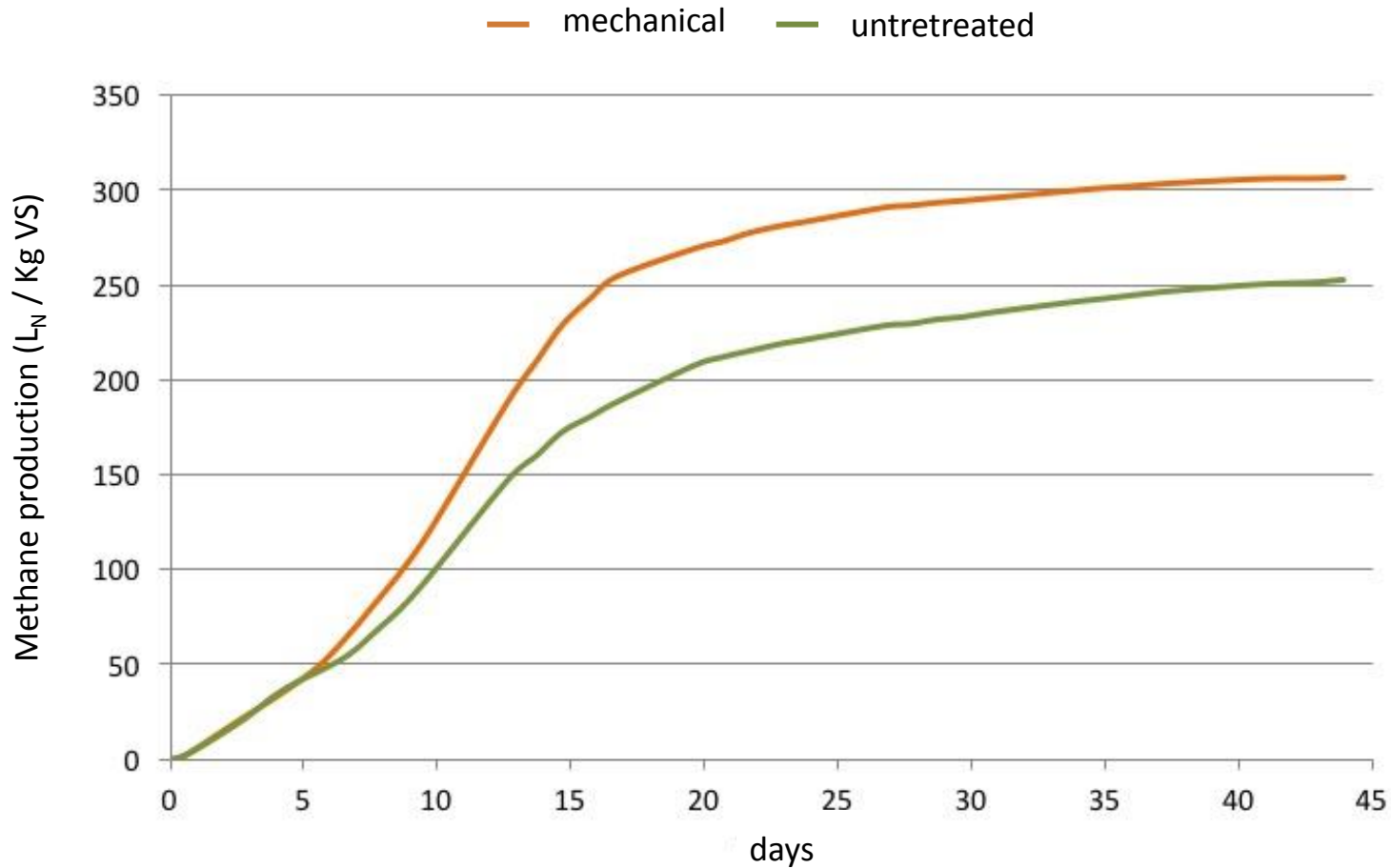
Mainly related to surface reduction

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

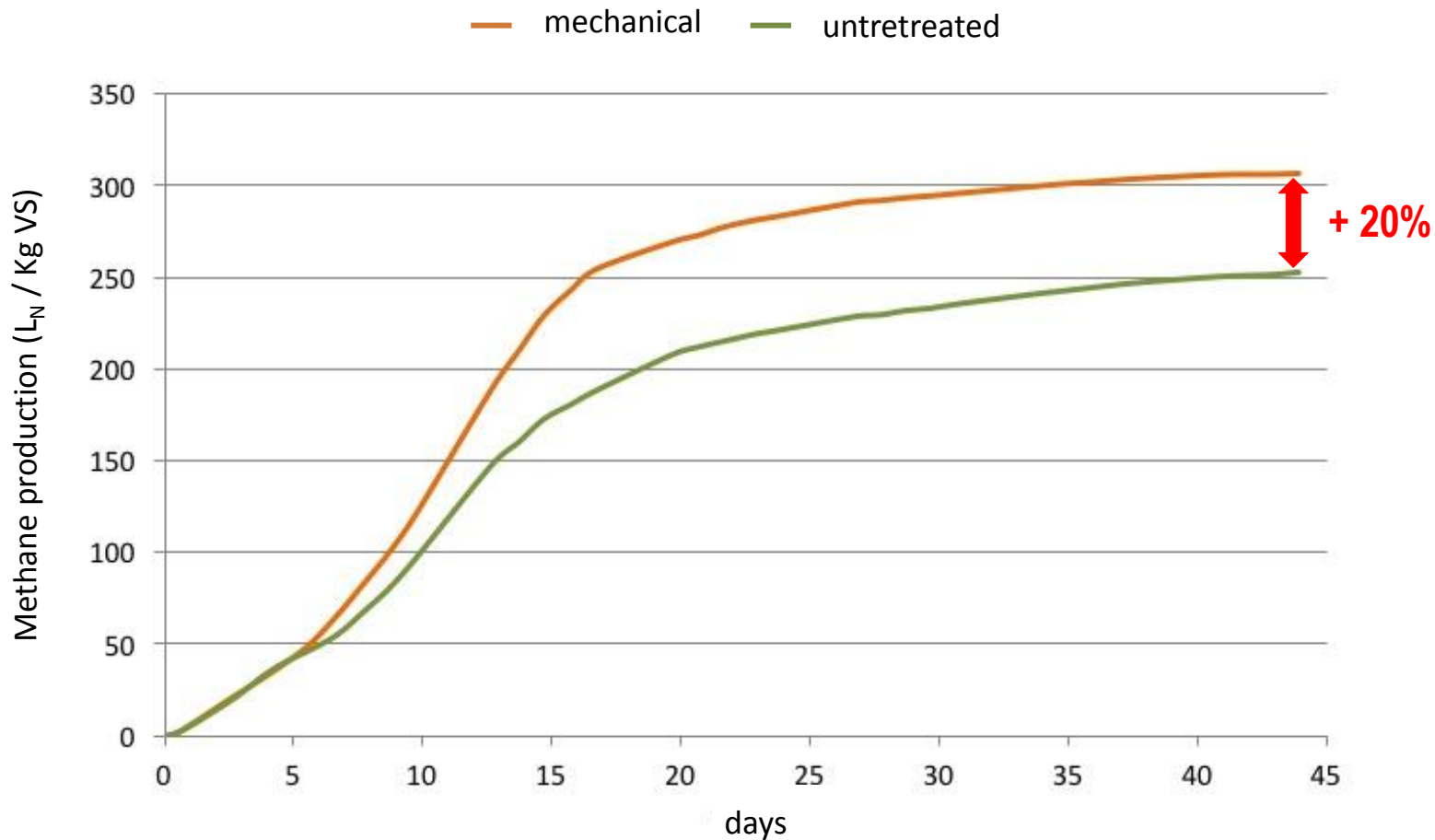
Mechanical pretreatment



Mechanical pretreatment

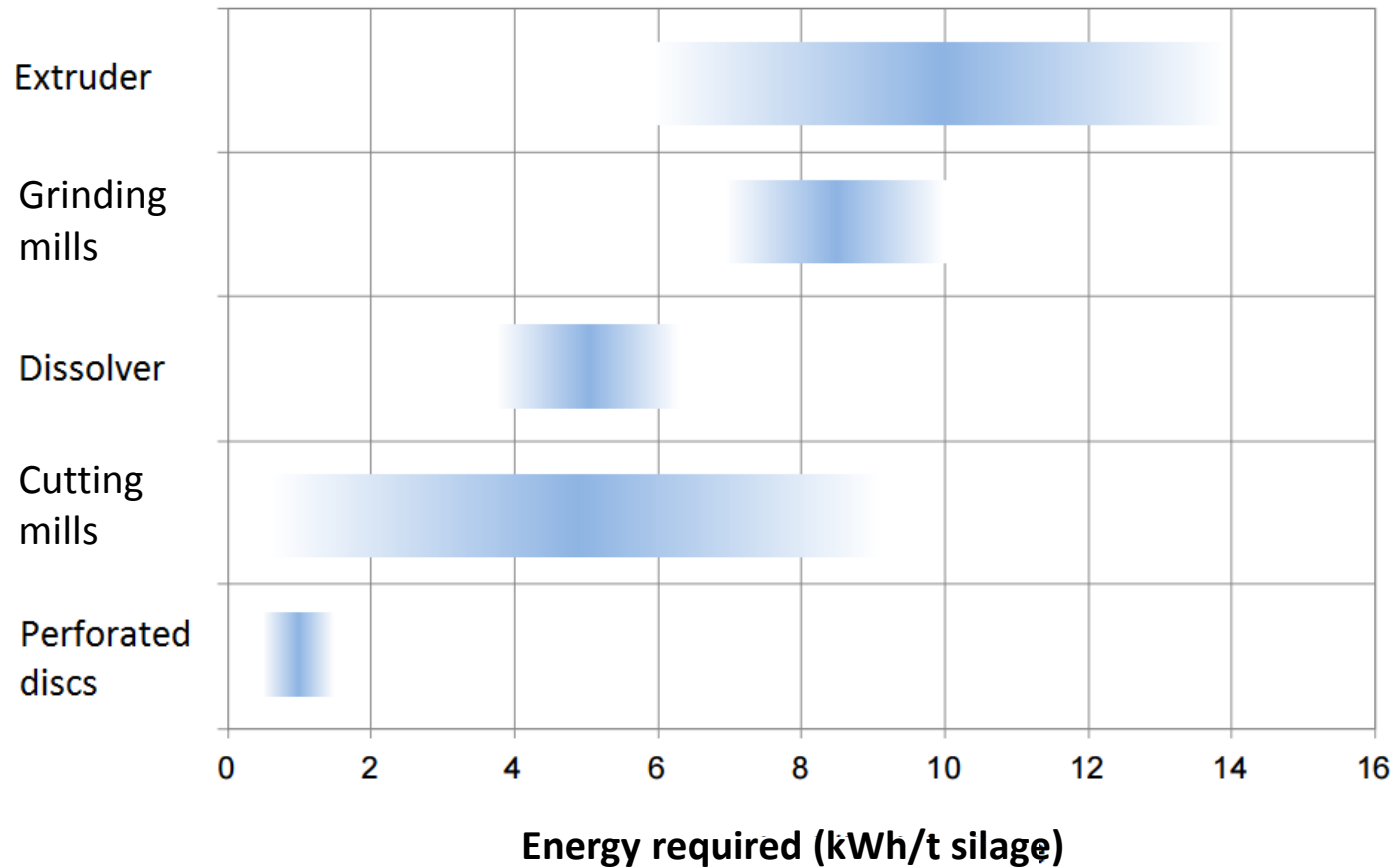


Mechanical pretreatment



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

Advantages and disadvantages



Advantages

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

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:

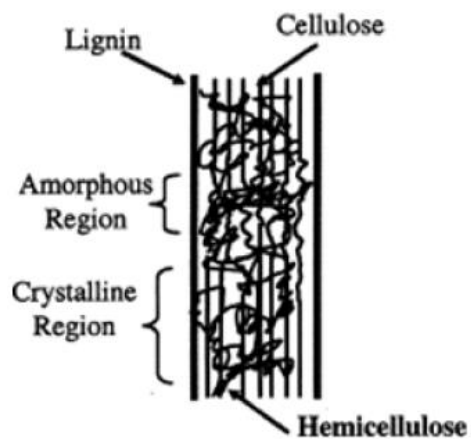
Combined - Steam explosion



- 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

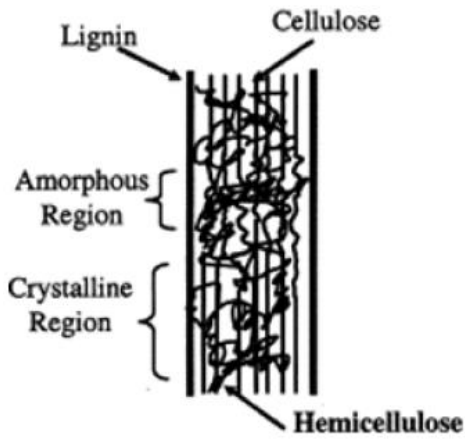


Pretreatment technology:

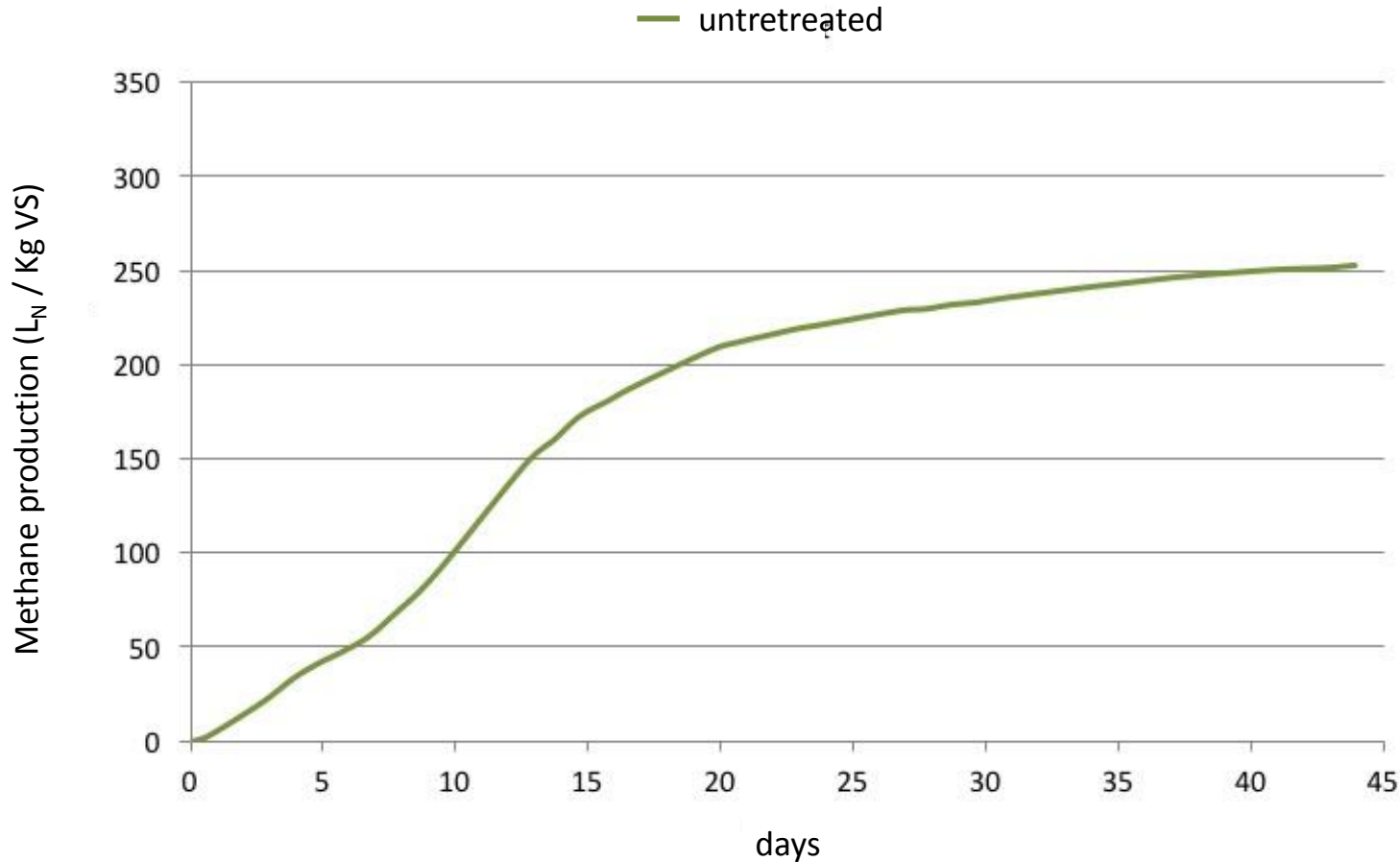
Combined - Steam explosion



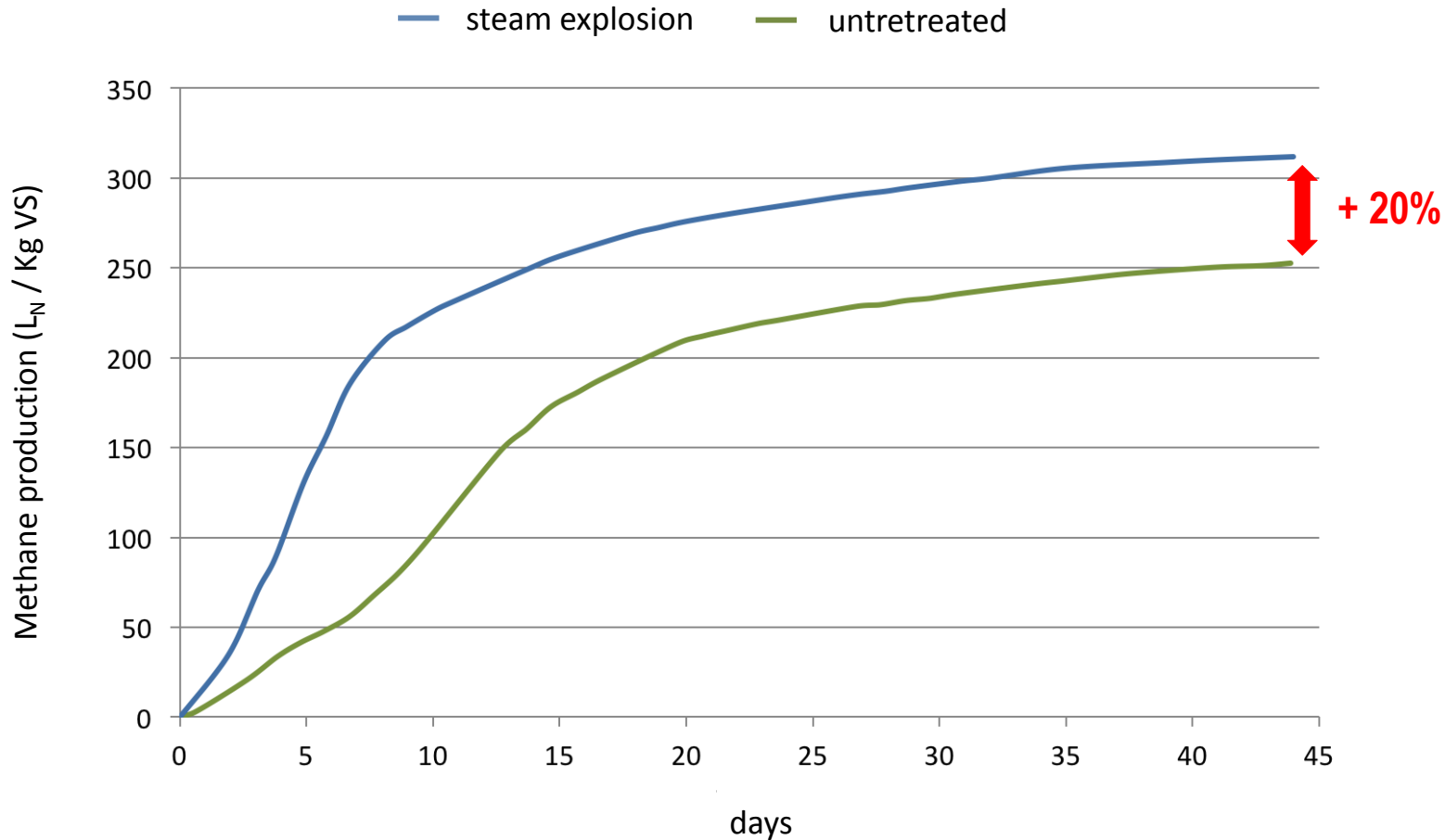
© BiogasSystems



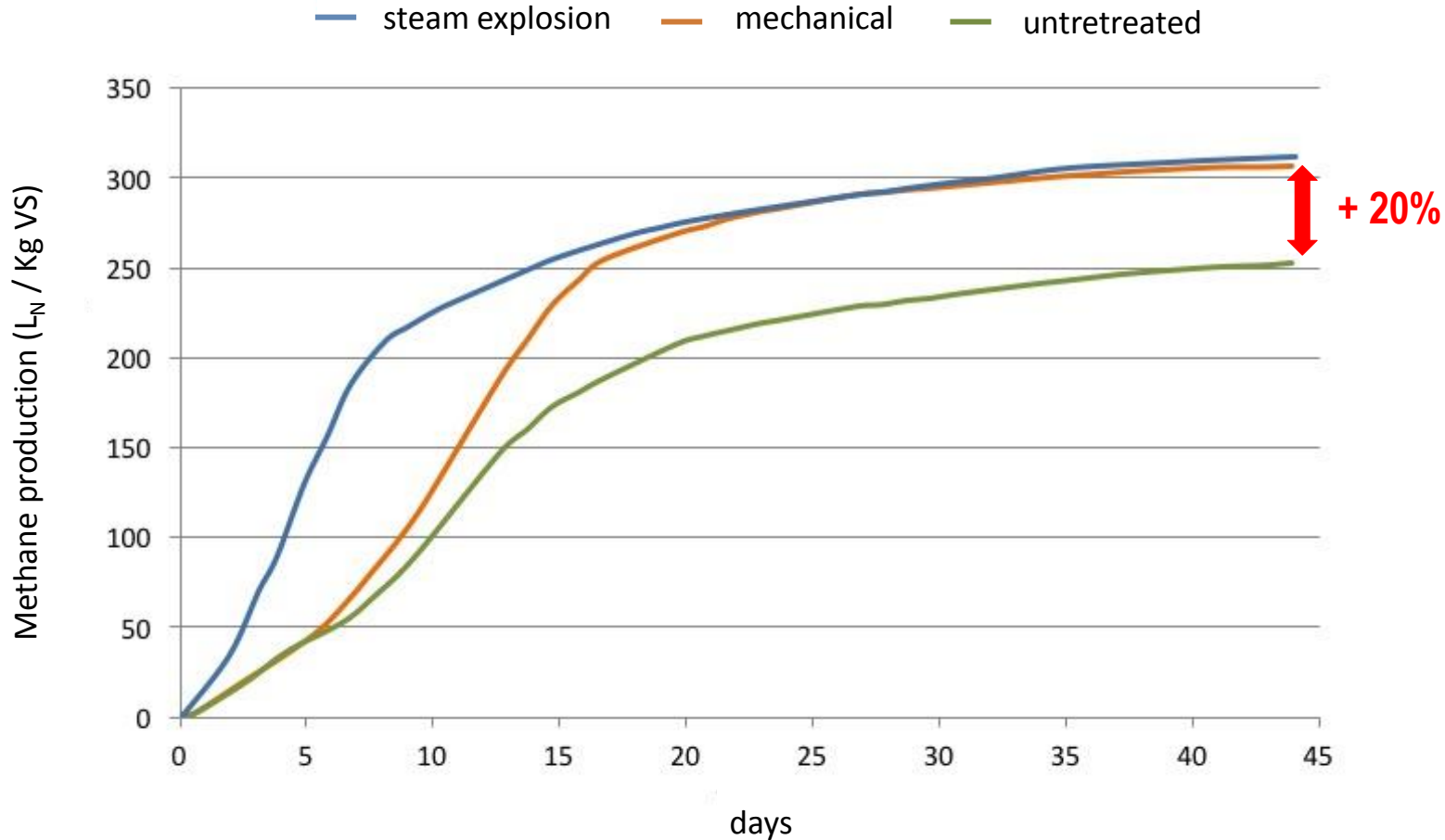
Differences in gas yields (45 days)



Differences in gas yields (45 days)



Differences in gas yields (45 days)



Combined pretreatment– Steam explosion

Power requirements



Electricity demand	36 kW	3,6 %
	580 kWh/d	35 kWh/t VS

Power requirements



Electricicity demand	36 kW 580 kWh/d	3,6 % 35 kWh/t VS
Heat demand	250 – 300 kW 6600 kWh/d	25 - 30 % 392 kWh/t VS

Power requirements



Electricicity demand	36 kW 580 kWh/d	3,6 % 35 kWh/t VS
Heat demand	250 – 300 kW 6600 kWh/d	25 - 30 % 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, ...)

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, ...)

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

- 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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