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Mechanical pretreatments of cattle manure before anaerobic digestion

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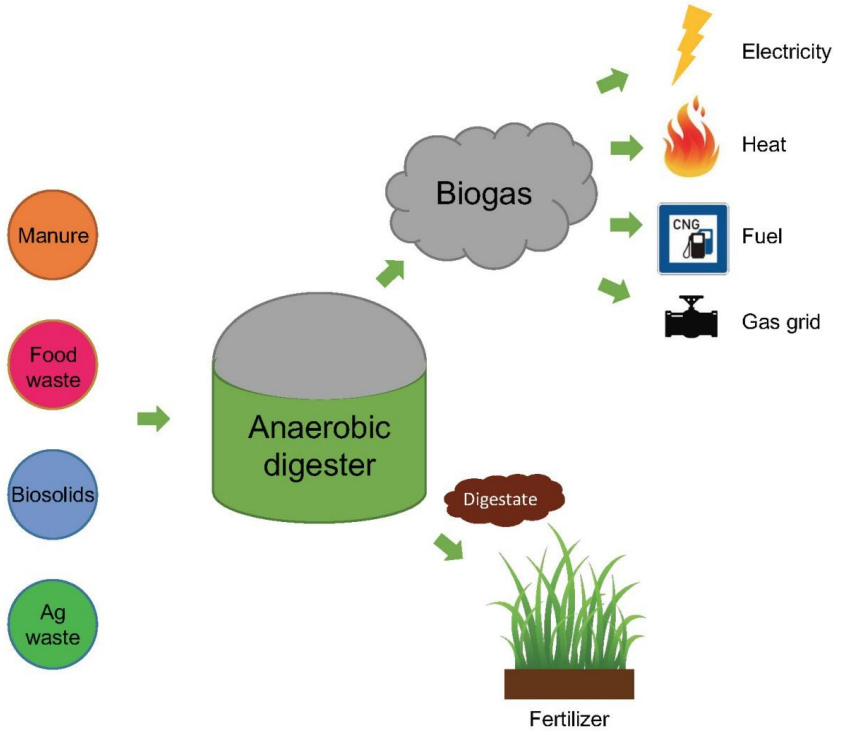


AD is a complex decomposition process of organic substrate by anaerobic microorganisms under oxygen-free conditions

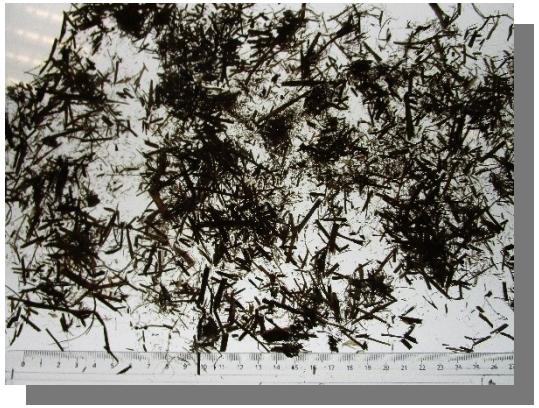
Anaerobic Digestion (AD) represents nowadays an attractive and efficient technology to convert energy from biomass feedstocks and a interesting wastes management.

In Europe, biogas is mainly produced from anaerobic digestion using agricultural wastes, manure and energy crops. (74% in 2015)

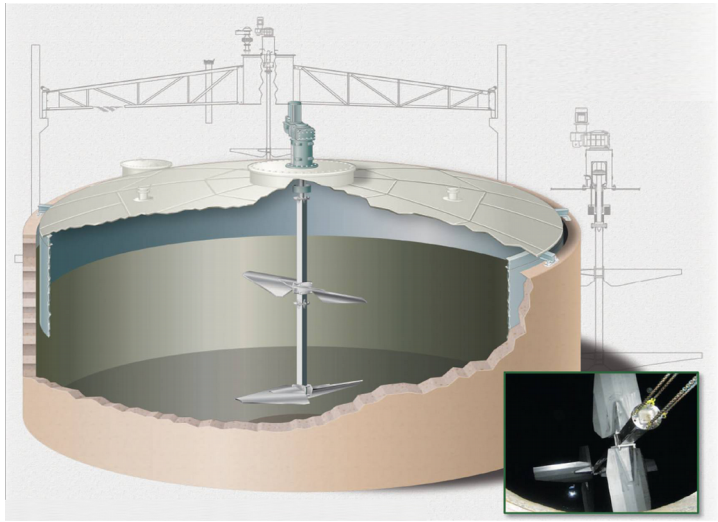
Cattle manure is a major input to produce green energy by AD, in particular from countries in Northern and Western Europe

87Mt/an of cattle manure in France .

- Manure is often mixed with crops and fibers



- Recalcitrant compounds, floating layers, heterogeneous feedstocks



Several pretreatments have been developed in order to achieve a better performance on AD.

PRETREATMENTS: CHALLENGES

- A higher methane yield and rate
- A better organic accessibility
- Avoiding inhibitors formation
- Minimize energy and water demand
- Economically feasible.

Three types of pretreatments can be in general distinguished: physical (mechanical), chemical and biological and often a combination among them.

PHYSICAL PRETREATMENTS

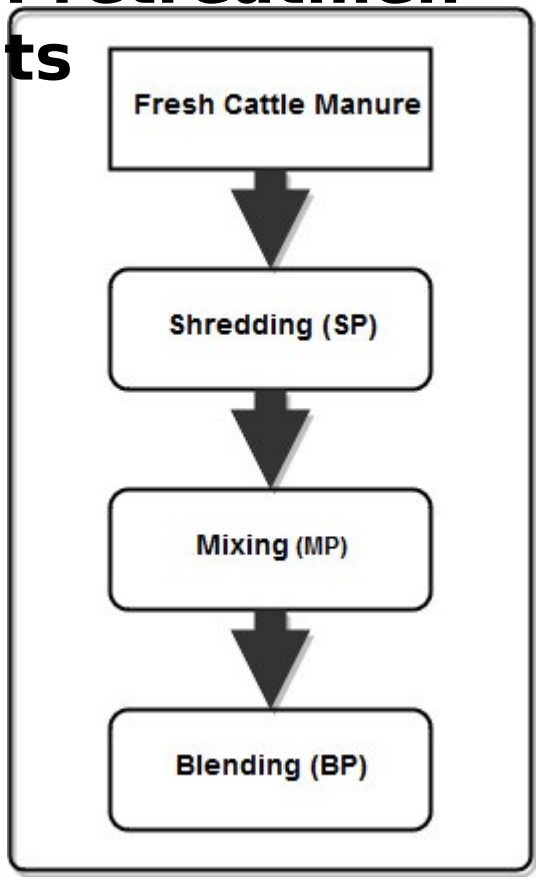
- Easy to implement.
- Reduce solid particle size
- Used to facilitate feeding operations and mixing.
- Increase solubilisation of organic substrates
- Increase biogas production rate and biogas yields.

Evaluate biochemical and physical effects of mechanical pretreatments operation particularly *comminution* on cattle manure at lab-scale before AD

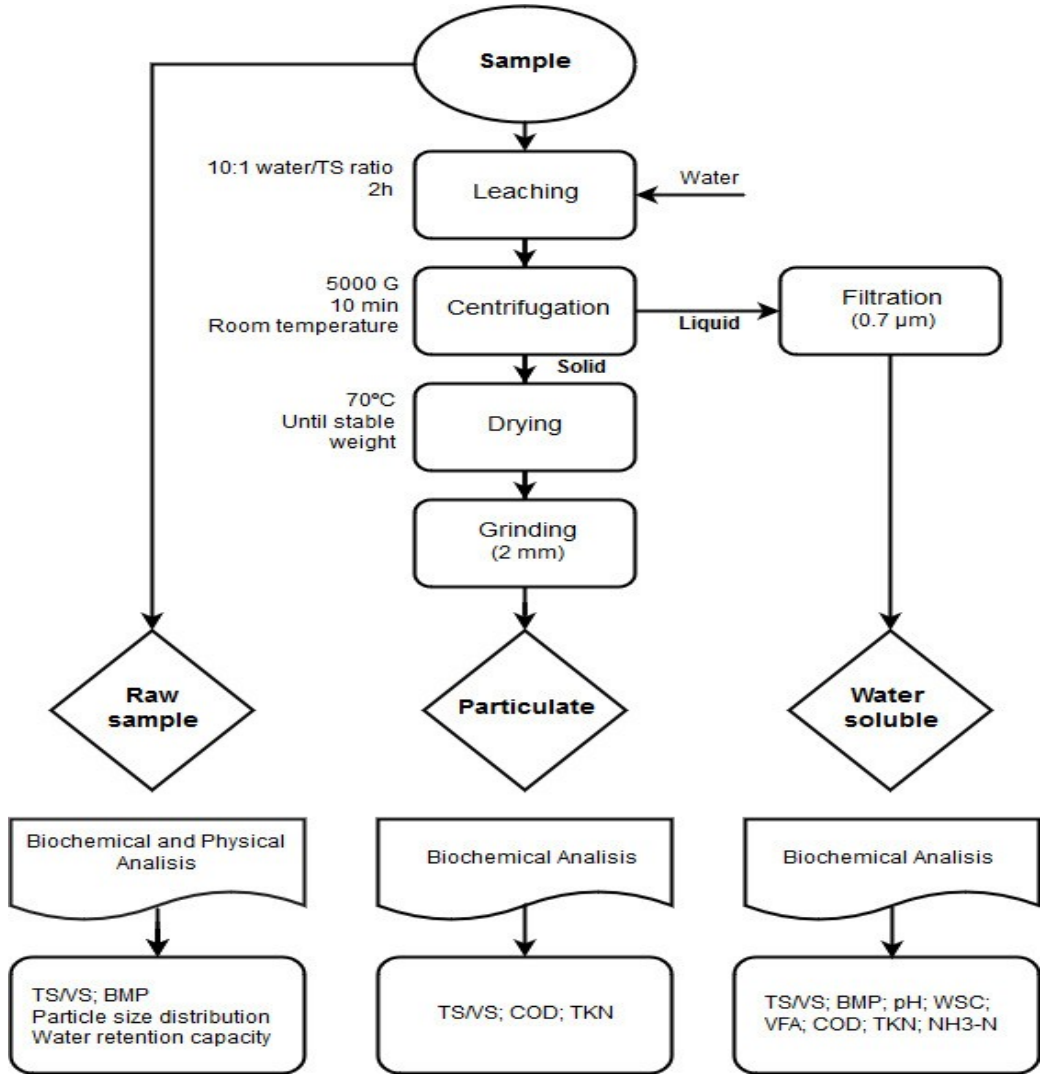
1. Feedstocks

Cattle manure of a local livestock farm (Mont du Lyonnais, Lyon-France)

2. Pretreatments



3. Experimental procedure



BMP test (Holliger et al. 2016)
Mesophilic (35°C)
Batch assays

Inoculum:
Anaerobic sludge from a wastewater treatment plant (Lyon, France)

- ✓ **Biochemical characteristics :** organics compounds solubilization
- ✓ **Physical characteristics:** particle size distribution, water retention capacity

Methane yield and rate

Enhancement of physical properties

Pretreatment evaluation

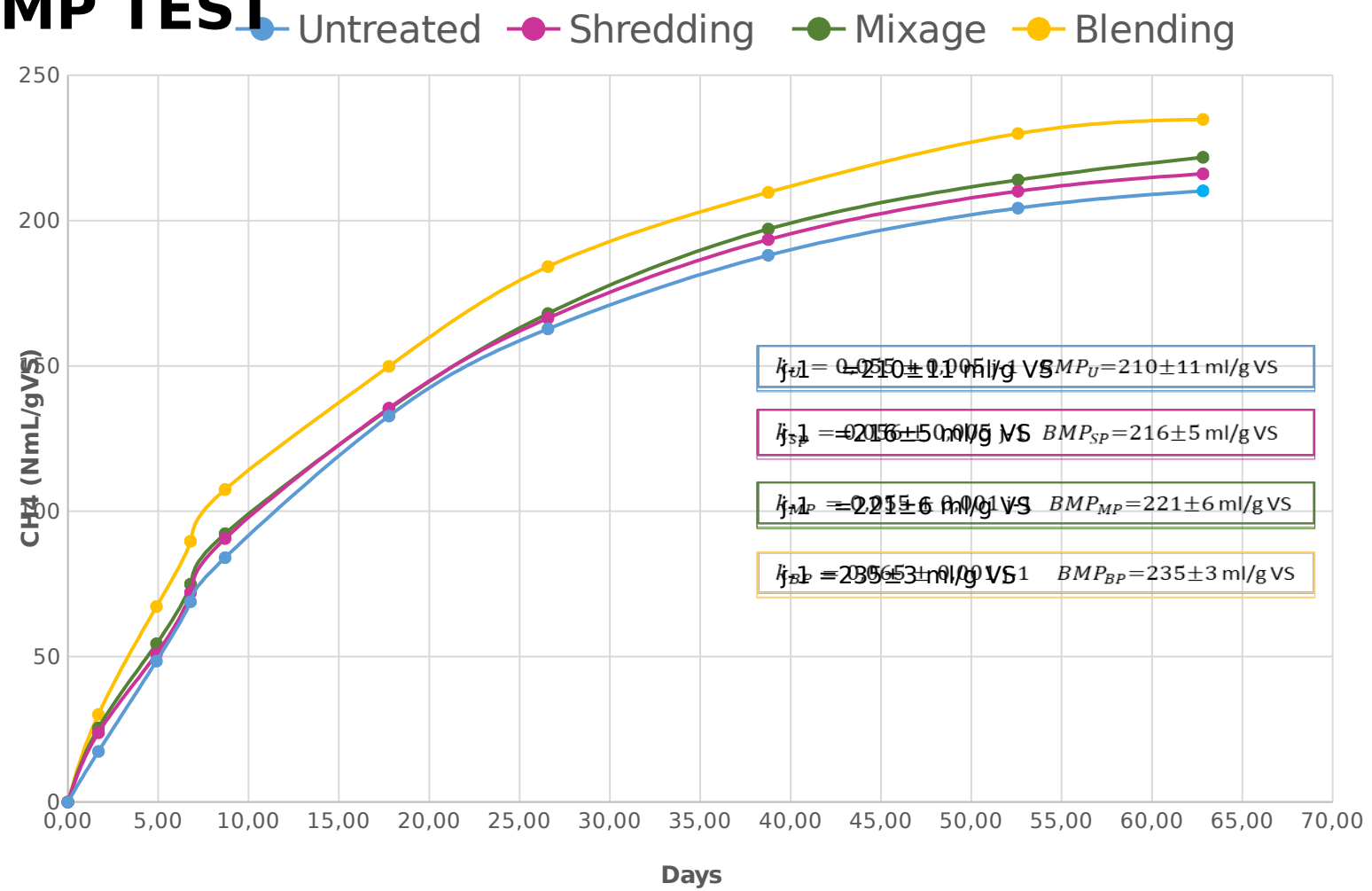
MAIN CHARACTERISTICS

Parameter	Unit	Untreated	Shredding	Mixing	Blending
TS	%(total weight)	15.9±0.2	15.2±0.1	9.1*±0.1	9.8*±0.4
VS	% (TS)	78.4±0.2	77.3±0.1	77.3±0.6	74.0±0.4
pH	-	8.44	8.73	8.58	8.40
BMP	mL/gVS$_{RS}$	210±11	216±6	222±6	235±3
WSP**/BMP	%$_{RS}$	7.5±0.6	12,0±0.7	14.1±0.7	20.2±1

*TS contents after water addition for pretreatment **Water Soluble Phase

$BMP_{BP} = 235 \pm 3$

BMP TEST

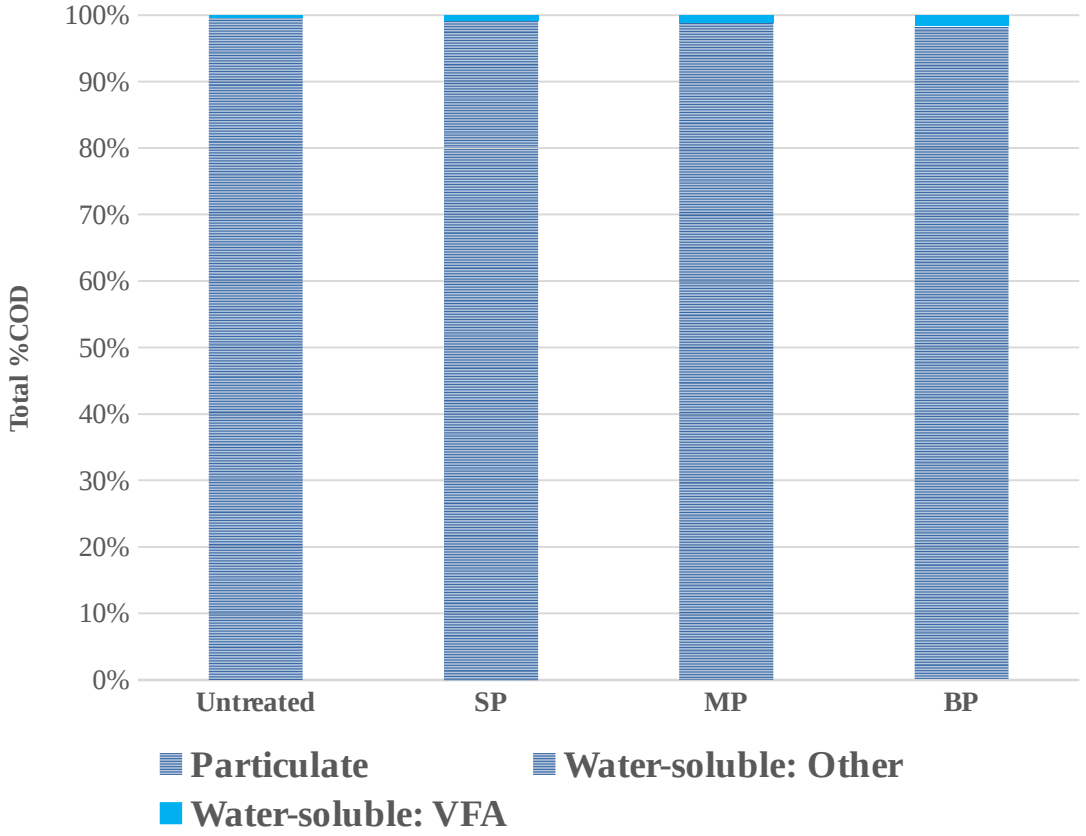


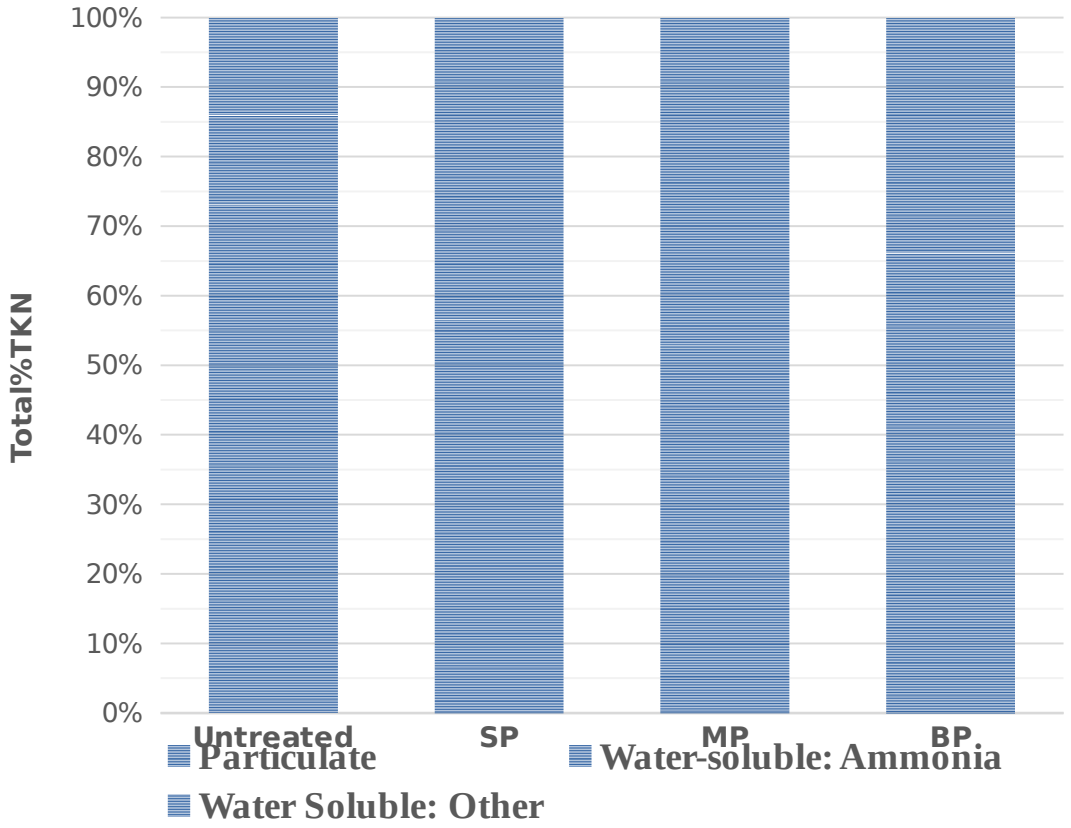
BLENDING PRETREATMENT

- ✓ Increase of 11% on methane yield
- ✓ Increase of 18% on methane rate.

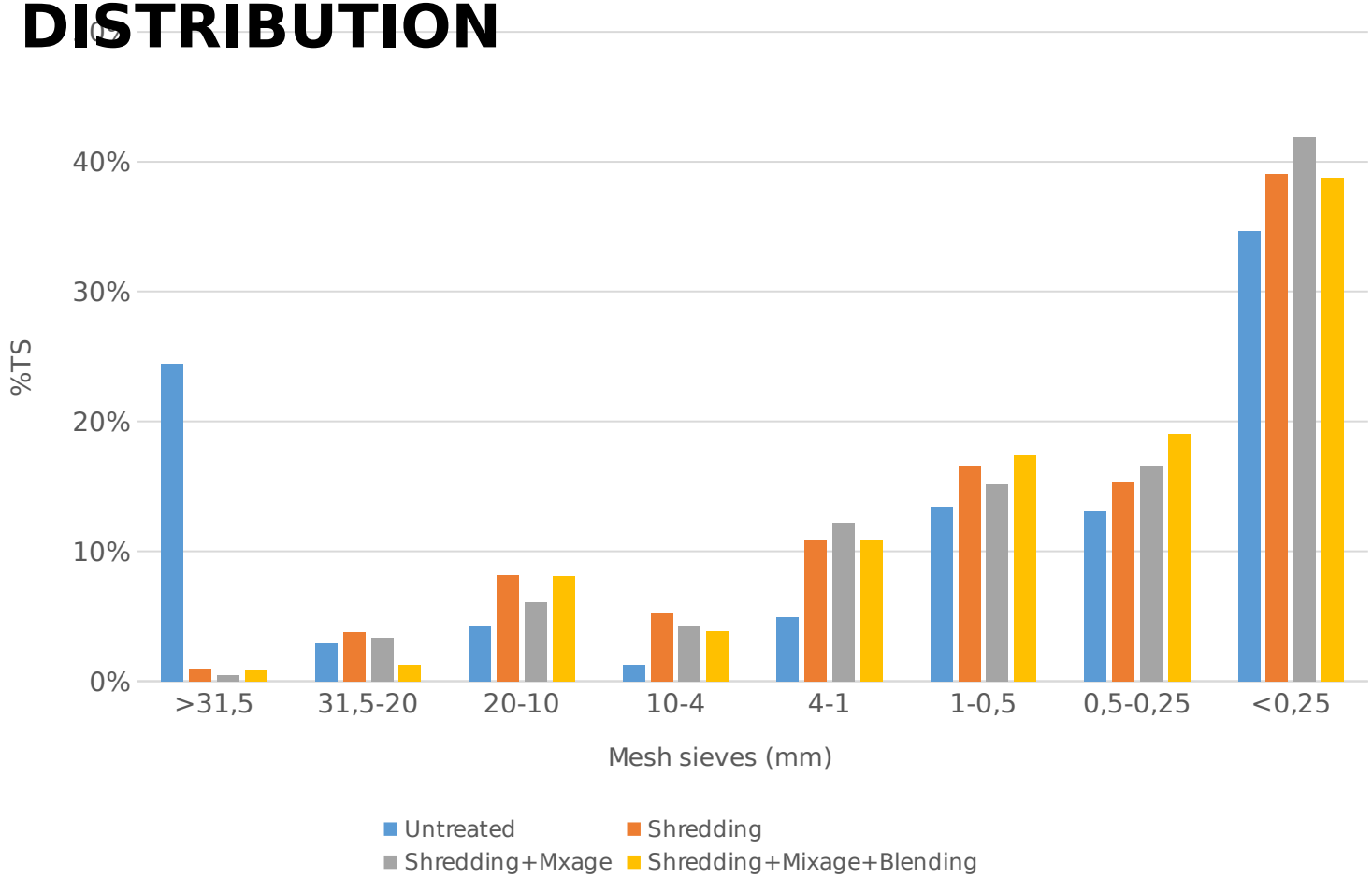
Increase of water-soluble contribution to BMP from 7% to 20% with pretreatment application.

COD and TKN Balance





PARTICLE SIZE DISTRIBUTION



WATER RETENTION CAPACITY

Untreated (g water/TS)	SP (g water/TS)	MP (g water/TS)	BP (g water/TS)
6.50±0.14	7.32±0.45	7.30±0.29	7.33±0.07

Increase of 12% between untreated and mechanical pretreatments applied

- The feedstock characterization proposed enabled to evaluate the mechanical pretreatments effects on cattle manure.
- Particulate fraction of TKN and COD was reduced with pretreatments.
- The water-soluble COD phase and methane production also increased.
- Blending pretreatment increased 11% on methane yield and 18% on methane rate regarding to untreated manure.
- Physical properties as reduction of particle size and water capacity retention were only improved with **Shredding pretreatment.**

PERSPECTIVES

- Evaluation at full-scale with different mechanical devices
- Rheological properties
- Energy consumption

Thank you for your attention!

This work is fund by

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

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