Optimizing agricultural wastes storage before anaerobic digestion

Impact of ensiling on methane potential of lignocellulosic biomass

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Ruben Teixeira Franco, Rémy Bayard, Pierre Buffière
DEEP Laboratory, Université de Lyon, INSA Lyon

A few words about anaerobic digestion (AD)…

- Series of anaerobic biological processes in which microorganisms break down **biodegradable complex material** into **biogas** (CH_4 and CO_2)
- **Established renewable energy source**: heat, electricity and vehicle fuel



- But… still quite **fragile financial health** : research in its infancy, diversification of processes and inputs, etc.

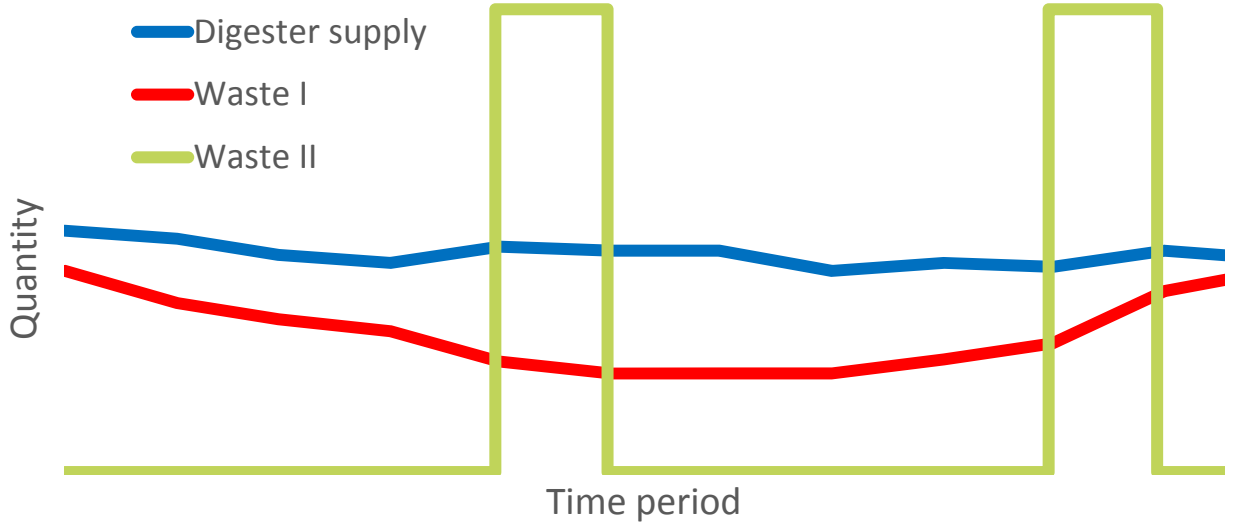
Need for focus in energy efficiency of AD value chain

Why the agricultural wastes storage?

Continuous feeding of AD plants

vs

Part of biomass **seasonally** produced



Doubts on good preparation and management practices of these wastes before AD

Role of storage

Keep up (or increase) the biochemical methane potential (BMP) of biomass

WHICH METHOD ?

Ensiling | **Hay** | **Open air**

Better BMP preservation ⟷ **Higher weight losses**

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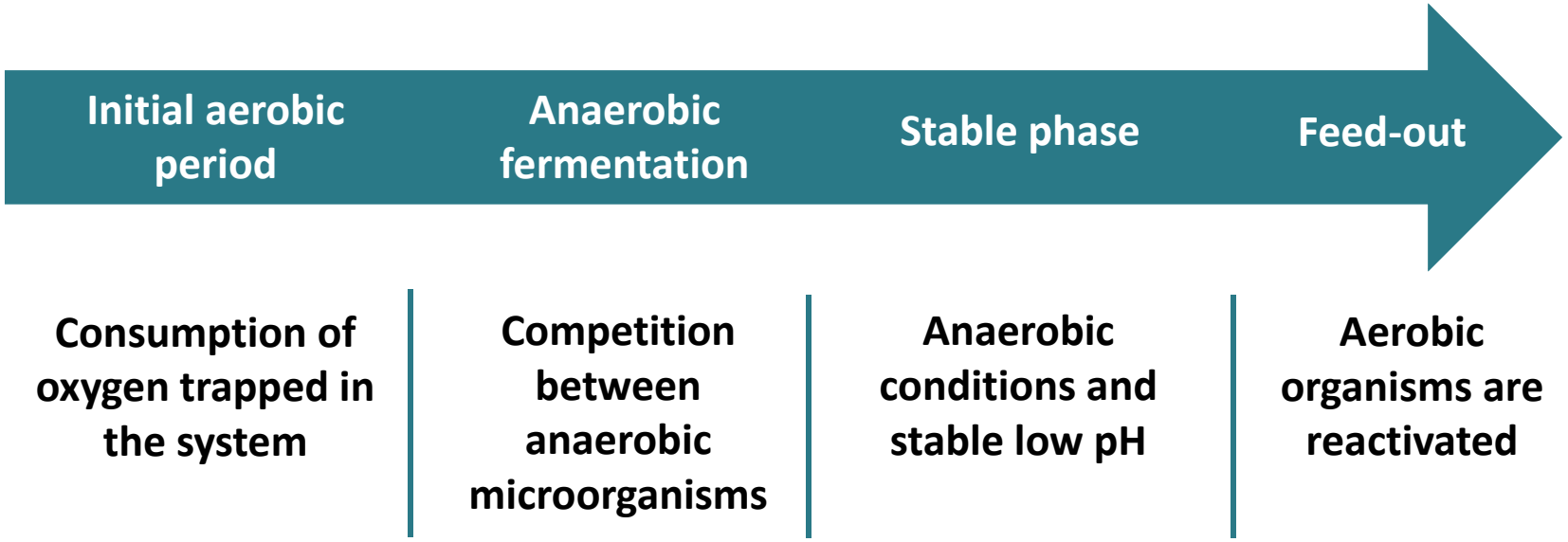
Ensiling: biochemical-based preservation

➢ Four step process



➢ Critical parameters:

- Feedstock, moisture, density, duration, temperature, additives…

« ***Ensiling for biogas production: critical parameters. A review*** »
R. Teixeira Franco, P. Buffière, R. Bayard

Laboratory scale tests

Objectifs

- Evaluate the impact of **ensiling** and its **operating conditions** on methane potential of lignocellulosic biomass

Feedstock

- **Catch crop - GAEC Béreyziat**:

Triticale (50% of seed mixture)

Peas (30% of seed mixture)

Vicia (10% of seed mixture)

Fodder radish (10% of seed mixture)

Tested conditions

- Ensiling
- Aerobiosis
- Moisture/Total Solids (TS)
- Storage Duration

Condition	Type	Moisture (%TS)	Duration (days)
TS18%E	Ensiling	18%	3,15,30,90,180
TS23%E	Ensiling	23%	3,15,30,90,180
TS18%A	Aerobiosis	18%	3,15,30,90,180

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Laboratory scale tests

Experimental approach

- Batch tests with different conditions and biomass characterization during storage

Gas analysis:
Production kinetics; composition

Biomass characterization
Before, during and after storage

Chemical analysis

- BMP (*Biochemical methane potential*)
- COD (*Chemical oxygen demand)*
- WSC (water-soluble carbohydrates) and VFA (volatile fatty acids) (HPLC)
- Fibers (Van Soest)
- TS/VS (volatile solids); NH_4-N; pH…

Results

Biomass characterization before and after wilting

- **Absence of readily biodegradable compounds in raw materials**
- **Biomass rich in energy sources, but hardly accessible**
- **Negative influence of wilting on BMP before storage**

Parameter / Biomass	Initial	6h-wilting
TS (%)	18.2	23.4
VS (%)	16.2	21.0
WSC ($\%_{VS}$)	0.15	0.15
VFA ($\%_{VS}$)	4.0	2.1
Cellulose ($\%_{VS}$)	40.2	39.6
Hemicellulose ($\%_{VS}$)	13.2	16.4
Lignin ($\%_{VS}$)	18.2	16.8
pH	7.20	7.23
BMP (mL CH_4/g_{VS})	291 →	251

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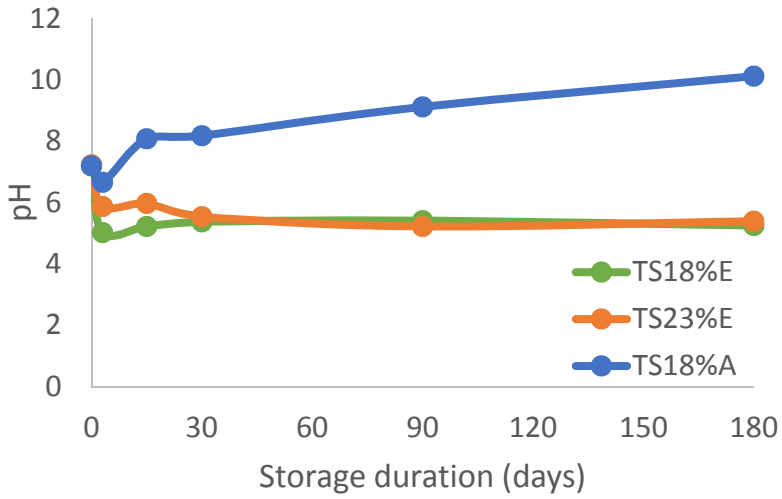
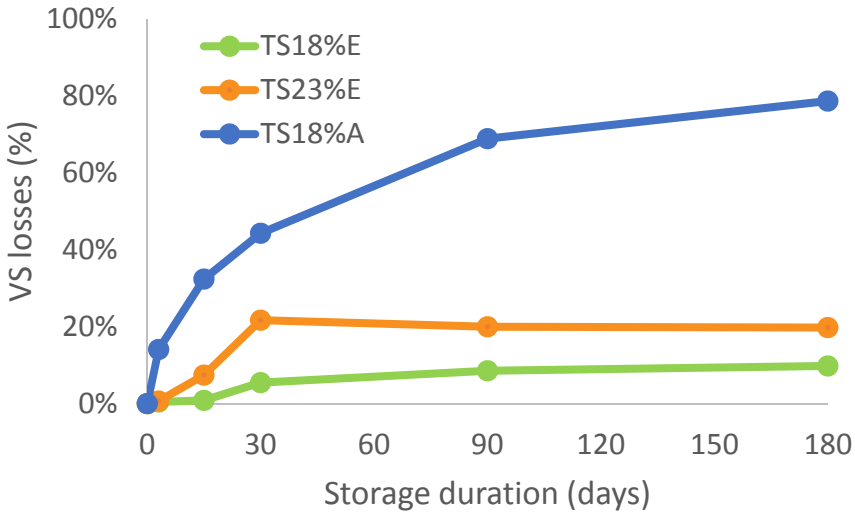
Results

Storage impact on pH



Organic matter losses



- **Silage** acidification leads to **less VS losses**
- The **first month** of storage will define the **success** of ensiling:

Faster acidification → **Less subsequent biodegradation**

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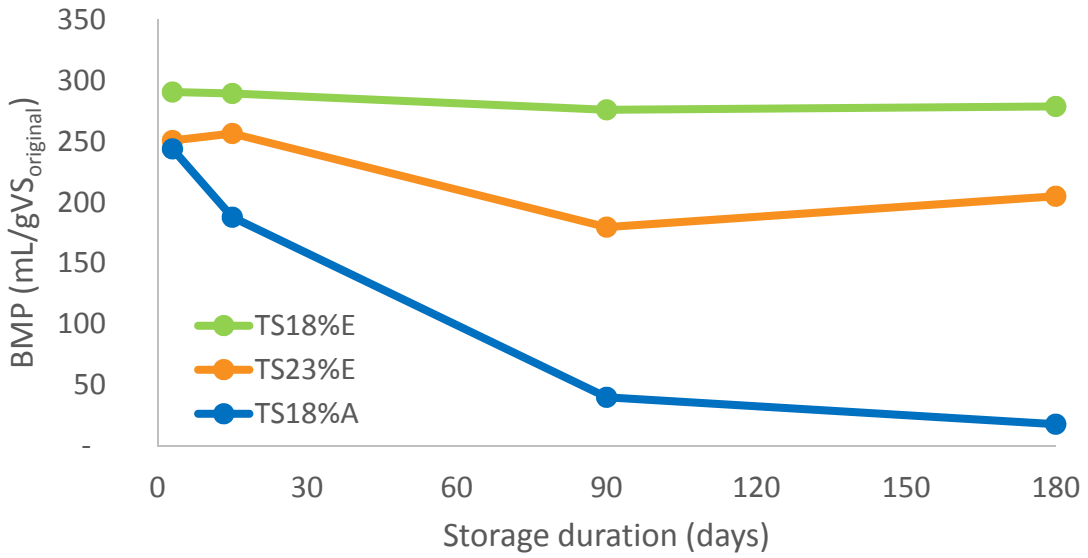
Results

Storage impact on BMP (I)



- **Major advantage** in using **ensiling fresh material** (TS18%E)
- **BMP conserved** even after 6 months for **TS18%E**, so that:

Gains in biochemical accessibility overcome organic matter losses

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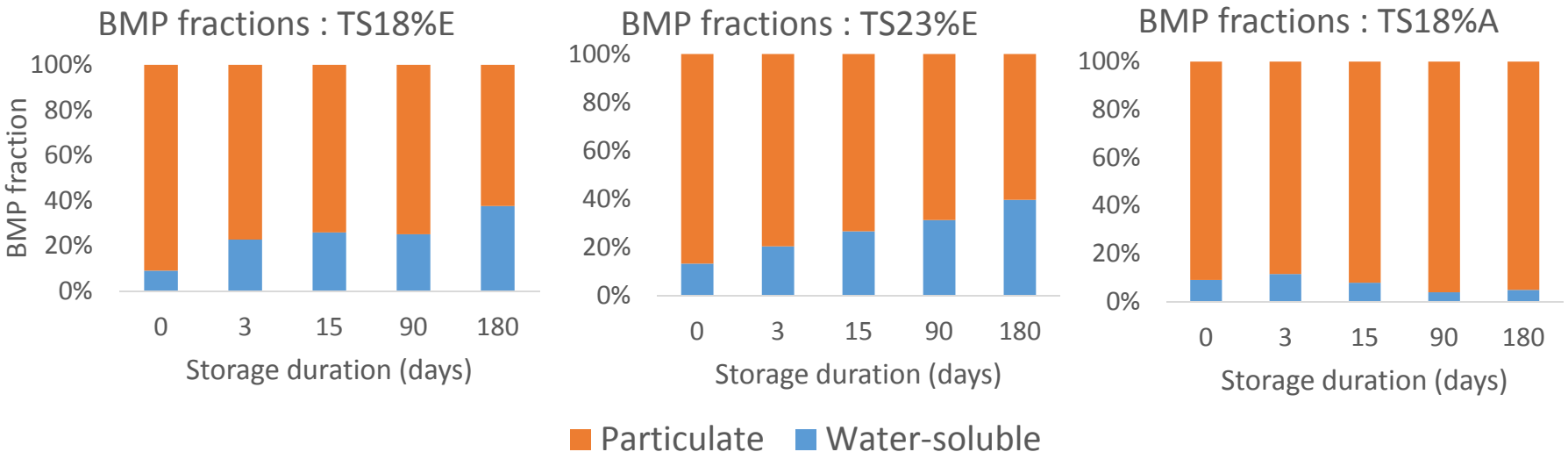
Results

Storage impact on BMP (II)



- **Water-soluble BMP** phase may correspond to **40% of total** one during ensiling

Liquid effluent production may conduct to several energy losses

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Conclusions

➢ **Anaerobiosis**: huge VS and BMP losses if biomass is stored in presence of air.

➢ **Moisture** (23%TS *vs* 18%TS): **Worse silage quality at 23%TS** – as a result of wilting process and structure of biomass.

➢ **Duration**: fresh material (**18%TS**) can be ensiled for 6 months with **negligible losses** of BMP

IF: Effluent production is prevented or recovered !!

FUTURE WORK

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Thank you for your attention!