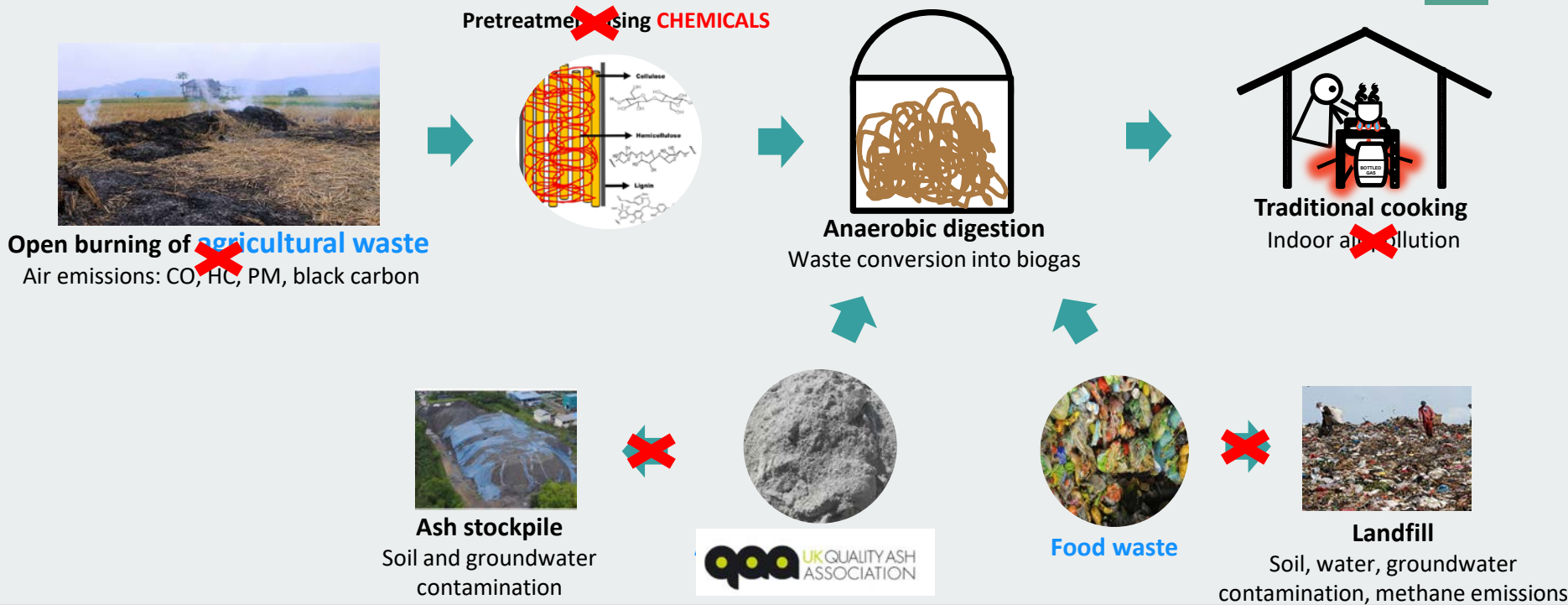


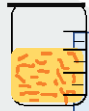
# Pretreatment of lignocellulosic agricultural wastes using coal fly ash to enhance methane production by anaerobic digestion

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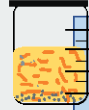


## Pretreatment



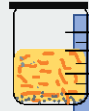
Barley straw pretreated with distilled water

Control



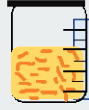
0.25 g coal fly ash/g barley straw with CaO supplementation (equal to alkalinity concentration of 6,000 mg/l  $\text{CaCO}_3$ )

S2



0.5 g coal fly ash/g barley straw with CaO supplementation (equal to alkalinity concentration of 12,000 mg/l  $\text{CaCO}_3$ )

S3



Analogous to S3, without coal fly ash

S5

7 days pretreatment  
Solid to liquid ratio 1:7  
Temp 30°C



## Anaerobic digestion

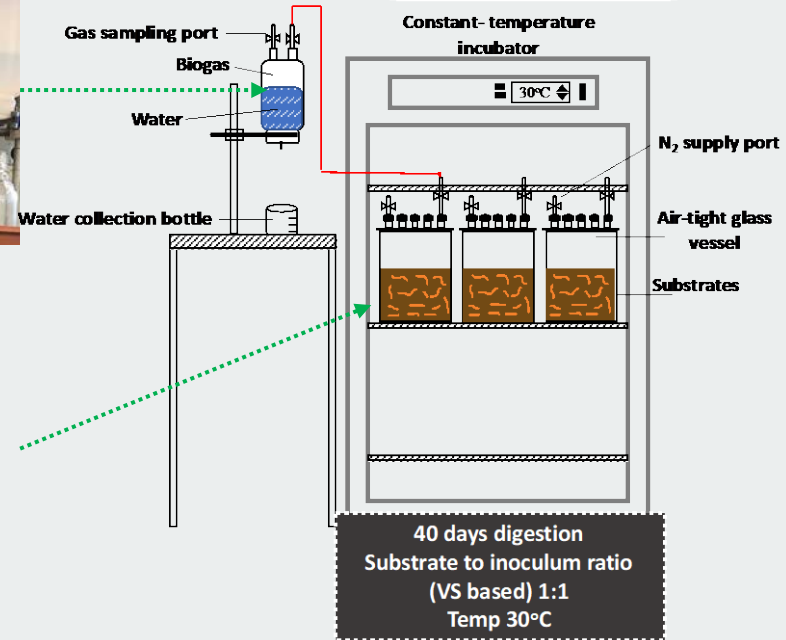
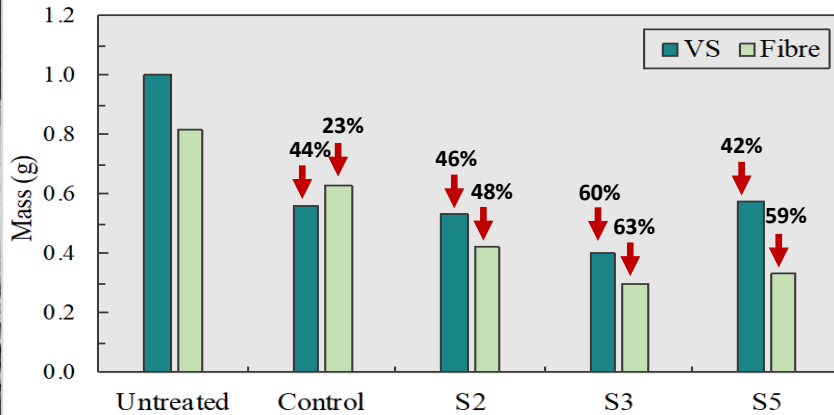
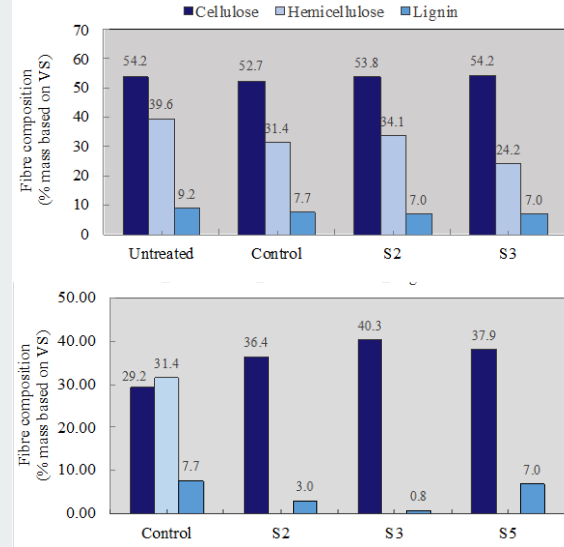


Fig 1. Volatile Solids (VS) and fibre composition from 1 g VS in barley straw after alkaline pretreatment followed by anaerobic digestion



- In all pretreatment conditions, **16%-24% of lignin** and **20.7% -39% of hemicellulose** were solubilized. No significant changes in the cellulose composition were observed
- Significant **reduction in all fibre components in the digested straw** compared to pretreated straw → remaining components in pretreated straw can be easily utilised during AD

Fig 2. Fibre compositions after pretreatment (above) and after anaerobic digestion (below)



- In AD, the **hemicellulose** was converted entirely into soluble fraction, except that in control
- Higher alkaline concentration (S3)** leads to **higher hemicellulose solubilization in pretreatment**

Fig 3. Cumulative experimental biogas yield compared to simulation using Gompertz

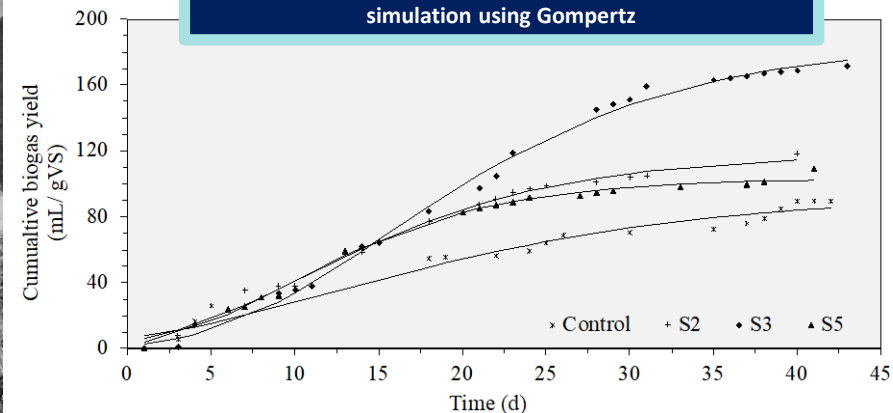
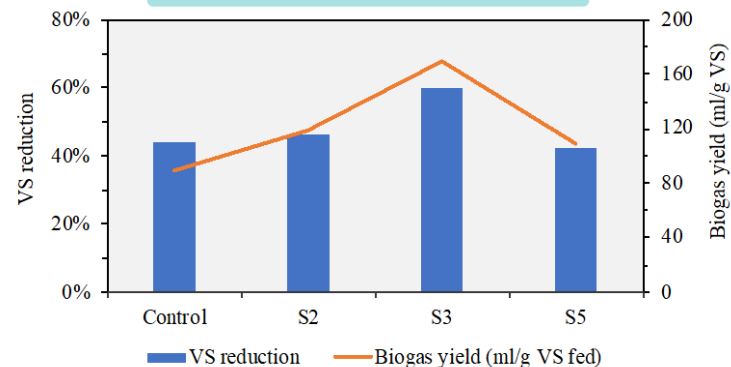


Fig 4. VS reduction vs biogas yield



	Maximum biogas yield (ml biogas/g VS)		R <sup>2</sup>
	Based on experiment	Based on modified Gompertz model (ml biogas/g VS)	
Control	89	94	0.9674
S2	118	118	0.9914
S3	171	187	0.9955
S5	109	104	0.9952

- The biogas yield in S3 is higher than its control (S5) --> there is an interaction between coal fly ash with the biogas yield
- The biogas yield in S2, S3 and S5 is 32.5%, 92%, 22% higher compared to control
- The coefficient of determination (R<sup>2</sup>) are close to 1, showing the experimental cumulative biogas yields are very close to the simulated values
- High alkalinity (11,000 mg/l CaCO<sub>3</sub>) used in the pretreatment did not interfere with the AD process

- **Alkaline pretreatment** using coal fly ash supplemented by CaO **solubilized hemicellulose and lignin** and **made all fibre components easier to digest** in subsequent anaerobic digestion
- **Biogas yield and VS reduction** from the sample with **coal fly ash addition** were **55% and 39% higher** respectively, compared to the sample under the same pretreatment conditions **without** coal fly ash
- **Biogas yield and VS reduction** from the sample with **coal fly ash addition** were **90% and 24% higher** respectively, compared to the sample pretreated with water
- The synergistic effect may be attributed to the **supplementation of trace elements** from coal fly ash

