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Background and Objective

Freshwater consumption and nutrient management remain key challenges in agricultural anaerobic digestion systems. **Liquid digestate recirculation (LDR)** has been proposed as a strategy to **reduce water demand** and **enhance internal nutrient recycling**. However, most previous investigations were short-term or lacked replicated operation under clearly defined steady-state conditions, limiting the robustness of their conclusions.

This study systematically evaluates the effects of LDR on methane yield, process stability, freshwater consumption, and nutrient accumulation during the **co-digestion of wheat straw and cattle manure** under long-term mesophilic operation.

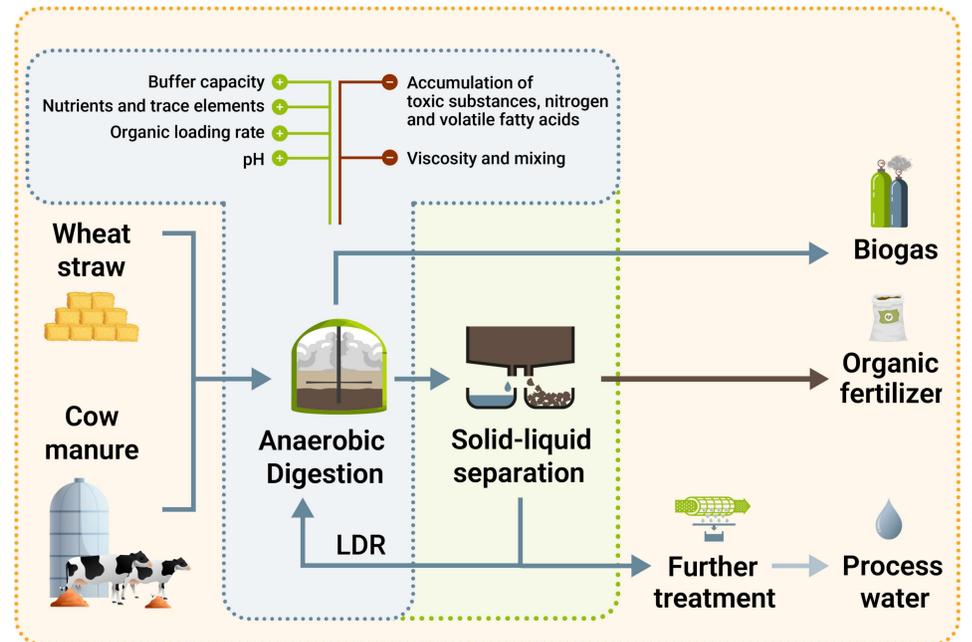


Fig. 1: Process scheme illustrating anaerobic digestion with solid-liquid separation and liquid digestate recirculation (LDR).

Experimental Design

- 6 reactors | 10 L | 39 °C | 248 days
- Wheat straw and cattle manure
- Steady state before treatment
- Control: freshwater dilution (n=3)
- LDR: partial freshwater replacement by digestate (n=3)

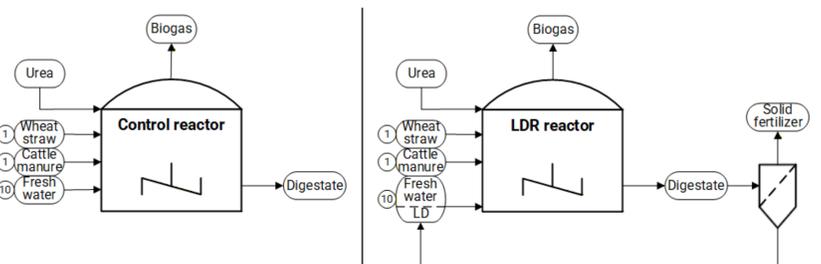


Fig. 2: Experimental configuration of control and LDR reactors.

Key Results

Biogas performance (Fig. 3):

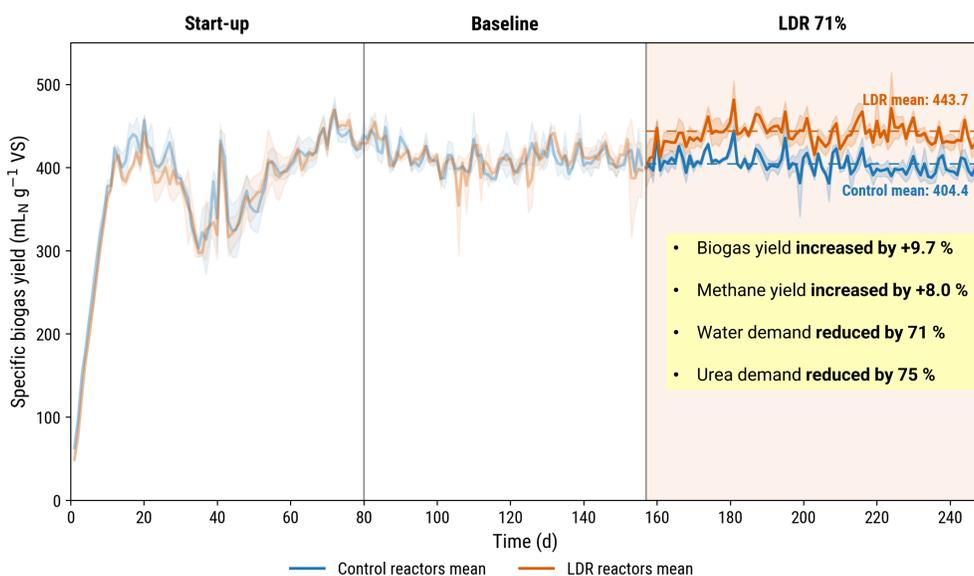


Fig. 3: Specific biogas yield of control and LDR reactors over the 248-day operation period. Vertical dashed lines indicate experimental phases.

Process stability (Fig. 4):

- Key process indicators remained within stable ranges
- No signs of acidification or ammonium inhibition

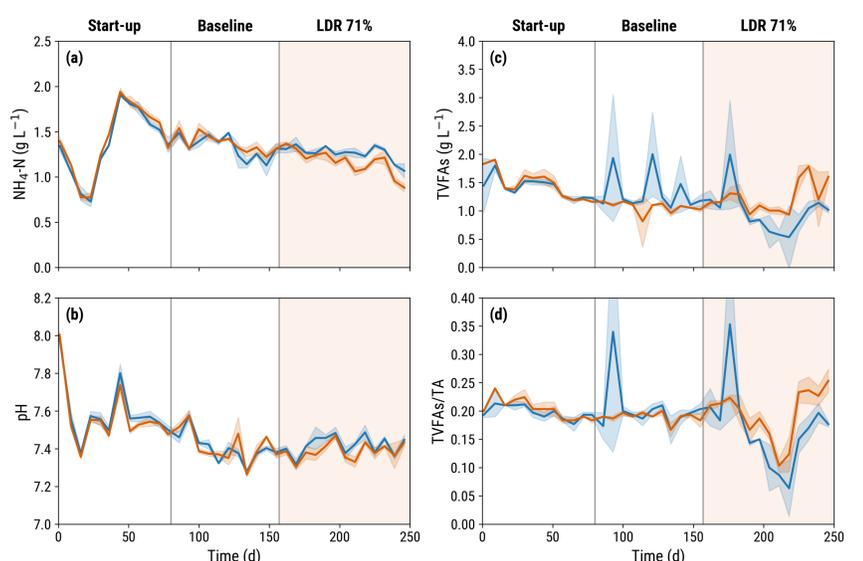


Fig. 4: Temporal evolution of key stability indicators (NH₄-N, pH, total VFAs, TVFAs/TA) in control and LDR reactors.

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