Abstract

On-farm biogas production is typically associated with forage maize as the biomass source. Digesters are designed and operated with the focus of optimising the conditions for this feedstock. Thus, such systems may not be ideally suited to the digestion of grass. Ireland has ca. 3.85 million ha of grassland. Annual excess grass, surplus to livestock requirements, could potentially fuel an anaerobic digestion industry. Biomethane associated with biomass from 1.1 % of grassland in Ireland, could potentially generate over 10 % renewable energy supply in transport. This study aims to identify and optimise technologies for the production of biomethane from grass silage.

Mono-digestion of grass silage and co-digestion with slurry, as would occur on Irish farms, is investigated in laboratory trials. Grass silage was shown to have 7 times greater methane potential than dairy slurry on a fresh weight basis (107 m^3 t^{-1} v 16 m^3 t^{-1}). However, comprehensive trace element profiles indicated that cobalt, iron and nickel are deficient in mono-digestion of grass silage at a high organic loading rate (OLR) of 4.0 kg VS m^{-3} d^{-1}. The addition of a slurry co-substrate was beneficial due to its wealth of essential trace elements.

To stimulate hydrolysis of high lignocellulose grass silage, particle size reduction (physical) and rumen fluid addition (biological) were investigated. In a continuous trial, digestion of grass silage of <1 cm particle size achieved a specific methane yield of 371 L CH_4 kg^{-1} VS when coupled with rumen fluid addition.

The concept of demand driven biogas was also examined in a two-phase digestion system (leaching with UASB). When demand for electricity is low it is recommended to disconnect the UASB from the system and recirculate rumen fluid to increase volatile fatty acid (VFA) and soluble chemical oxygen demand (SCOD) production whilst minimising volatile solids (VS) destruction. At times of high demand for electricity, connection of the UASB increases the destruction of volatiles and associated biogas production.

The above experiments are intended to assess a range of biogas production options from grass silage with a specific focus on maximising methane yields and provide a guideline for feasible design and operation of on-farm digesters in Ireland.