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Business Cooperative Research Centres Programme

Pork CRC
CRC for High Integrity Australian Pork

Project Number & Title
4C-109: Enhanced methane production from pig manure in covered lagoons and digesters

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Aims and Objectives
Manure methane is increasingly used at Australian piggeries to produce heat and generate electricity, with current adoption of biogas covered 13.5% of total Australian pork production. The performance of a covered pond (CAP) or in-vessel anaerobic digester in terms of methane production, is dictated by: design and operation of the CAP or digester; methane potential of the waste(s) being treated; and health of the micro-organisms responsible for anaerobic digestion. This project researched the latter two aspects, with the aim to enhance methane production. A targeted literature review was conducted on co-digestion opportunities and considerations, specifically to boost methane production in the Australian pork sector. A number of experimental studies were carried out to quantify the potential effects of CAP desludging on methane yields, to study the effects of chemical inhibitors/response of microbial communities to try and to identify engineering intervention that could promote inhibition resilience.

Key Findings
There are considerable opportunities for anaerobic co-digestion in the pork industry, where two or more wastes are simultaneously digested to boost methane production. Abroad, a number of carbon-rich wastes are regularly co-digested with animal manures. Co-digestion needs careful management to prevent unsafe organic loading rates. The availability of co-digestion wastes is an on-going challenge and transport costs dictate cost feasibility. A major future incentive would be revenue from gate fees when wastes are diverted away from landfill to produce methane for beneficial use.

Settled sludge eventually displaces active covered pond volume and requires extraction. There are now ways to do this by pumping of sludge via sludge extraction pipes, whilst the CAP remains in full operation. Experiments measured the residual methane potential in sludge samples extracted from covered ponds at Pork CRC demonstration piggeries. The results showed that the sludge was reasonably stable, with over 50% of the organic matter already converted into methane. This was also the case for ponds with very short desludging periods of 1 year. It could be beneficial to decrease desludging frequency to every 2 years to allow more time for conversion of manure into methane. However, some piggeries may instead elect to desludge more frequently to manage water balances during wet/dry seasons and to sustainably apply sludge nutrients to cropland.

Inhibition resilience and adaptation of microbial communities were assessed using inoculum samples from full-scale and pilot scale digesters, and separately by subjecting microbes in continuous digesters to chronic high levels of inhibitor. The results showed that inhibition resilience varied moderately between different inoculum sources, with some microbial communities being more resilient than others. Subjecting microbial communities to chronic inhibitor stress showed clear acclimation. These results were encouraging, because they indicated that microbial communities could adapt to inhibitors. However, no statistical links could be found between intervention strategies and inhibition resilience, so acclimation occurs naturally and unfortunately cannot be greatly encouraged by targeted intervention.

Application to Industry
Overall, there is considerable opportunity for co-digestion in Australia. Future research should explore the effects of temperature and organic loading rate on co-digestion performance. It would be worthwhile to advocate for consistent landfill levies across Australia, because this would be a key driver for future profitability of anaerobic co-digestion. Desludging of covered ponds could be extended to every 2 years to allow further conversion into methane. However, well-operated CAPs would unlikely lose more than 10% of manure methane potential with extraction of sludge. Instead, desludging strategies could be based on pumpability of sludge, water balances during wet/dry seasons and nutrient load management to crop lands. Adaptation of microbial communities to chemical inhibitors is best done gradually. For example, a site where salinity gradually increases because of high effluent recycle rates, low rainfall and high evaporation rates, is unlikely to have issues with salt inhibition until salinity reaches very high levels. This is because enough time is given for the AD microbiology to adapt to the gradually increasing salinity levels.