SUMMARY: Biogas Production Potential of Biomasses Available for Biogas Production in Vietnam

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There are more than one hundred thousand bio-digester in Vietnam of which most is simple- small scale reactors a wide range of different biomasses available on the farms as feedstock for biogas production. However, unstable production and inefficient operation of the biogas plants leads to an unsatisfactory production and use of biogas and also environmental pollution. The study showed that management is inefficient due to lack of the information about needed retention time and about biogas production potential of the used feedstock was recognized to be the main reasons of the problems. Therefore, the aims of this study has been to carry out research on how to optimize biogas production providing a stable and reliable plant operation and high biogas yields.

A core research tool in the study was examination of the Biochemical Methane Potential (BMP) on the laboratory. This BMP is very useful for the determination of biogas gas quality and quantity from a feedstock, which is intended to be used for anaerobic digestion and production of biogas. Although time consuming, it provide a thorough and reliable estimate of the potential gas yield and of digestibility of a specific biomass. In this study the information from BMP tests provides information on potential gas yield from a range of available feedstocks, assisting in feedstock selection and is valuable when making decision about biogas digester plant size and throughputs.

The thesis was comprised of 3 main parts: First part was initiated by surveying livestock manure management in biogas and non-biogas pig farms. The second part was to develop and test BMP methods for measuring biogas potential which can be used in laboratories with limited access to gas chromatography. The last part was to identify BMP of some Vietnamese biomasses and develop a model to predict BMP.

The results indicated that on biogas farms, most of the manure collected was used for bio-digestion. The farmers used the fermented manure (digestate) as a source of nutrients for crops, but on more than 50% of the interviewed biogas farms digestate was discharged to the environment. On non-biogas farms, manure was in the form of slurry or it was separated into a liquid and a dry-matter-rich solid fraction. The solid fraction from separation was used for composting and the liquid fraction usually discharged to the environment. The survey revealed that there is a need to improve methods for transporting the manure to the field, as transportation is the main barrier to recycling the liquid manure fraction. The biogas production on small livestock farms was inefficient due to overloading and a short retention time. Further, during summer periods the biogas owners released redundant gas to atmosphere, which is a procedure make these biogas plants a large source of greenhouse gas. The study demonstrated obviously that biogas technology bring many benefits about energy, hygiene and economy, however if it was not managed in an appropriate way, both biogas and non-biogas farms contributed to GHG emission.

The study also showed that VDI method is the best method to measure BMP and the liquid replacement method was recommended to be an acceptable method to determine methane (CH_4) concentration in the laboratories without GC equipment.

BMP of variety Vietnamese biomasses from livestock manure, slaughterhouse and plant residue was determined. Piglet manure produced the highest methane yield at 443 NL CH_4/kg VS, followed by cow, rabbit, goat and sheep manure at, respectively, 222, 172, 169 and 150 NL CH_4/kg VS. Methane production from duckweed was higher than that from grass and water spinach at 340.6, 220 and 110.6 NL CH_4/kg VS, respectively. The study also showed that there is inhibition of

substrates with high protein and lipid content such as chicken manure, pig slaughterhouse and fish waste. Shoe processing waste is not suitable for biogas production and cassava residue has low BMP if not pre-treated before fermentation. A model to predict BMP based on the lipid, lignin and protein of the biomass was developed with the R-square 0.96%. This model was applied to calculate to predict methane yield of bio-digesters in Vietnam in the combination with previous models.