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Economic Assessment of Biogas Production Potential from Commercial Pig Farms in Cambodia

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INTRODUCTION

Pork is the most eaten meat in Cambodia, accounting 52.8% of annual meat consumption. In 2018, commercial pig farms rose by 30%, but the increase also causes concerns over wastewater management. By law, It is obligatory for all commercial animal farms to construct biogas systems, in order to manage waste and convert it into energy usable for the farms.

Therefore, the study aimed (1) to explore the characteristics of commercial pig farms and wastewater use; (2) to analyze the quality of biogas produced from the covered lagoons in the farms; and (3) to estimate methane production, electricity production, and CO_2 reduction equivalent.

METHOD

- The study was conducted from January to September 2020, targeting 9 commercial fattening farms in 6 provinces, based on the criteria under which the farms were interested in biogas systems. A set of questionnaire was used as a tool for data collection, along with direct observation and group discussion with the farm owners and relevant stakeholders.
- To analyze the biogas quality, a 5000 gas analyser was used and to analyze peak loads in the farms, A Hioki PW3365-20-01/5000 power logger was used. It is capable of measuring three-phase voltage with a high electrical current of up to 5,000 A.

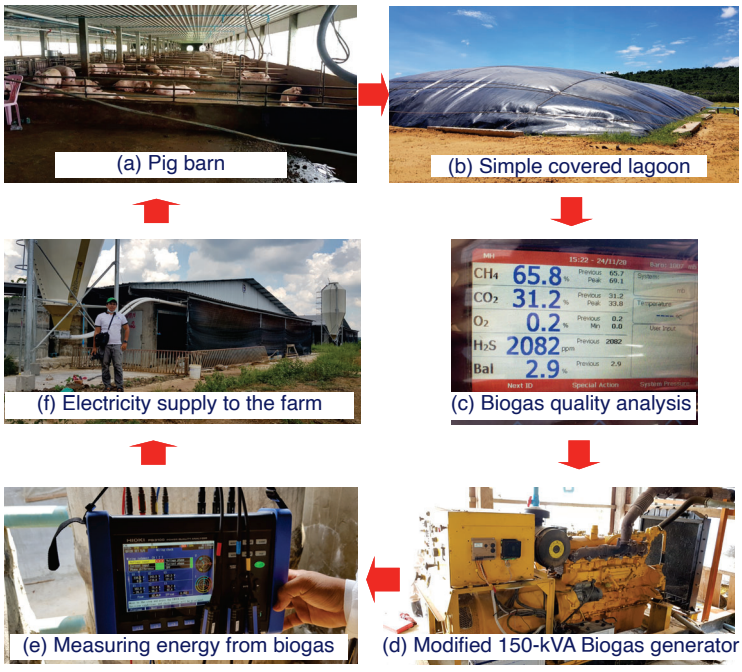

Figure 1 Flow diagram of a typical fattening pig farm from manure *(a)* to the covered lagoon *(b)* that produces biogas for running biogas generators *(c & d)* to generate electricity for the farm *(e & f)*

RESULTS

Table 1 Description of daily wastewater production biogas production

Source	Unit	Average ± SE
Water	$m^3\ d^{-1}$	125.8 ± 14.1
Dung (fresh)	$t\ d^{-1}$	6.3 ± 0.7
Urine	$m^3\ d^{-1}$	10.5 ± 1.2
Evaporation	$m^3\ d^{-1}$	2.8 ± 0.3
Total waste water	*$m^3\ d^{-1}$*	*139.8 ± 15.7*
	$m^3\ d^{-1}\ head^{-1}$	0.033 ± 0.004
DM content	%	0.9
Total DM	$t\ d^{-1}$	1.3
Biogas	*$Nm^3\ d^{-1}$*	*415*
	$Nm^3\ y^{-1}$	137,033
	$Nm^3\ y^{-1}\ head^{-1}$	32.7

Table 2 Biogas quality measured among the farms with covered lagoons

Biogas quality	Unit	Mean ± SE	Min	Max
CH_4	%	59.5 ± 3.0	52.0	64.5
CO_2	%	31.5 ± 2.8	26.9	40.0
O_2	%	1.3 ± 0.7	0.1	3.0
H_2S	ppm	2,256 ± 504	818	3,295

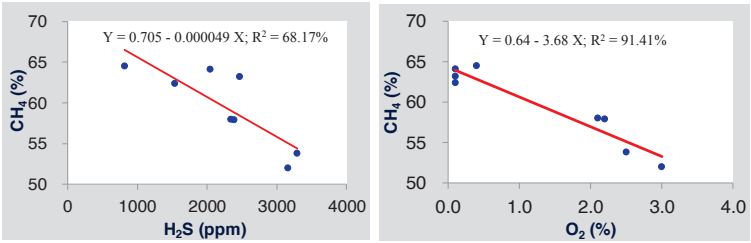

Figure 2 relationship between CH_4 and H_2S (left); CH_4 and O_2 (right)

Table 3 Estimation of annual electricity production and CO_2 reduction

Description	Unit	Value
Potential electricity production	$kWh\ y^{-1}$	178,142
Estimated electricity for farm coverage	$kWh\ y^{-1}$	124,700
Estimated farm demand	$kWh\ y^{-1}$	166,667
Percentage of farm coverage from biogas	%	75
CO_2 reduction	*Unit*	
From CH_4 reduction quivalent	$tCO_2eq\ y^{-1}$	2,751
From grid electricity quivalent	$tCO_2eq\ y^{-1}$	82
Total		*2,832*
CO_2 reduction per head/year	$tCO_2eq\ y^{-1}\ head^{-1}$	0.676

CONCLUSION

- In the studied farms, electricity produced from biogas can meet 75% of annual farm electricity demand and about 2,832 $tCO_2eq\ y^{-1}$ may be reduced per farm.
- A business model should be further considered for successful implementation.

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