Technology Fact Sheet for Mitigation

2.

Technology Name:	Manure-Based Biogas digesters[1]

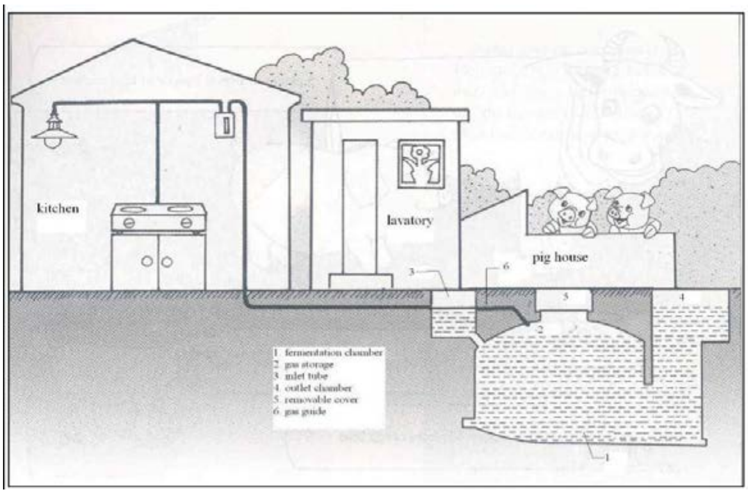
Introduction

Manure-based biogas digesters is animal manure treatment and fermentation system which includes fermentation tanks, manure input and fermentation via anaerobic environment. The methane concentration of biogas is around 60%, so the recovery and utilisation of biogas from digested slurry in a biogas digester will reduce CH4 emissions from the manure. In addition, the biogas can be used to provide electricity, d energy and reduce CO2 emissions from fossil fuel (coal) displaced by biogas.

Technology characteristics

A biogas digester is usually composed of six parts: fermentation chamber, gas storage, inlet tube, outlet chamber, removable or sealed cover, and a gas pipe line (see in Figure 1).

Figure 1Example of a schematic of 'Three in One' combination of household biogas digesters



The mechanics of biogas generation is similar to practice elsewhere which can be described as follows:

- The captured gas is stored in the upper part of the digester tank (gas storage area), which is constructed as an arc ship. The generation of biogas will gradually increase the pressure in the stored area. When the volume of the captured gas is larger than the amount consumed, the pressure in the gas storage will increase and slurry will be pushed into the outlet chamber. If the gas consumed exceeds gas availability, the slurry level drops and the fermented slurry flows back into fermentation chamber.
- The placement of the digester tank (underground fermentation) keeps the temperature in the tank relatively stable ensuring that the slurry can be fermented at adequate temperatures throughout the year without requiring additional heating.

- The bottom of the digester inclines from the material-feeding inlet to the material-outlet, allowing free flow of the slurry.
- The digester has been designed to allow the effluent to be removed without breaking the gas seal, taking the effluent liquid out through the outlet chamber. As pointed out in technology definition biogas fermentation is a process in which certain bacteria decompose organic matter to produce methane. In order to obtain normal biogas fermentation and a fairly high gas yield, it is necessary to ensure the basic conditions required by the methane bacteria are met for them to carry out normal vital activity (including growth, development, multiplication, catabolism etc.).

1) Strict anaerobic environment

Microbes that play a major role in biogas fermentation are all strict anaerobes. In an aerobic environment, the decomposition of organic matter produces CO2, however, in an anaerobic environment, it results in CH4. A strict anaerobic environment is a vital factor in biogas fermentation. Therefore, it is essential to build a well-sealed, air-tight biogas digester (anaerobic digester) to ensure a strictly anaerobic environment for artificial biogas production and effective storage of the gas to prevent leakage or escape.

2) Sufficient and suitable raw materials for fermentation

Sufficient raw materials for biogas fermentation constitute the material basis for biogas production. The nutrients that methane bacteria draw from the raw materials are carbon (in the form of carbohydrates),nitrogen (such as found in protein, nitrite, and ammonium), inorganic salts, etc. Carbon provides energy, and nitrogen is used in the formation of cells. Biogas bacteria require a suitable carbon-nitrogen ratio (C:N).The suitable carbon-nitrogen ratio for rural biogas digesters should be 25~30:1. The carbon-nitrogen ratio changes with different raw materials, and one must bear that fact in mind when choosing a mix of raw materials for the digester.

3) Appropriate dry matter concentration

The appropriate dry matter concentration in the raw materials for biogas fermentation in rural areas should be 7%~9%. Within this range, a low concentration of raw materials may be selected in summer, while in winter a higher value is preferred.

4) Appropriate fermentation temperature

Biogas fermentation rates depend greatly on the temperature of the fermenting liquid in the digester. Temperature directly affects the digestion rate of the raw materials and gas yield. Biogas fermentation takes place within a wide temperature range (XuZengfu, 1981). The higher the temperature, the quicker the digestion of the raw materials will be, and the gas production rate will also become higher. Based on real fermentation conditions, we have identified the following three temperature ranges for fermentation:

- High temperature fermentation: 47°C~55°C
- Medium temperature fermentation: 35°C ~38°C
- Normal temperature fermentation: ambient air temperature of the four seasons. Selecting the

temperature range for bio-gas fermentation depends on the type, sources, and quantities of raw materials; the purposes and requirements of processing organic wastes; and their economic value. Most household biogas digesters are normal temperature fermentation.

5) Appropriate pH Value

The pH value of the fermenting liquid has an important impact on the biological activity of biogas bacteria. Normal biogas fermentation requires the pH value to be between 7 and 8. During the normal process ofbiogas fermentation in a rural digester, the pH value undergoes a naturally balanced process, in which it first drops from a high value to a low value, then rises again until it almost becomes a constant. This process is closely related to the dynamic balance of three periods of biogas fermentation. After feeding the biogas digester, the time that the pH value takes to reach its normal level depends on the temperature and the kinds and amounts of raw materialsthat are fed in.

Country specific applicability and potential

Status of technology in the country

Benefits to development

Economics and mitigation potential

The economic and mitigation potential has not been analyzed and unclear for Lao context. However, according to the practices and findings elsewhere, biogas technology can reduce emissions is efficient if price ranges from US$12-40 per tCO2e or suitable for mitigating GHG emissions if there are adequate manure inputs and price of approximately US$12 per tCO2-e (Wassmann and Pathak, 2007). Overall household biogas digester (8~15 m3) costs between US$500-1,000 though depending on the digester size. It is estimated that an 8m3 household biogas tank can treat the manure from 4 to 6 pigs, yielding 385m3of biogas annually. It can save 847kg of coal based on the calculation of effective heat equivalent. According to the methodology recommended by IPCC in 2006, if a household biogas digester treats the manure of 4 pigs, it can reduce GHG of 1.5~5.0 tonnes CO2e.

Increasing local incomes

It will reduce expenditures for household energy (fuel wood and electricity). It will also increase employment locally for skilled labor during installation, operation, and for the maintenance of biogas digesters.

Improving local environment and public health

It will replace traditional fuel wood-base cooking stoves. Indoor air pollution will be significantly reduced, thus reducing the incidence of respiratory diseases, eye ailments etc., caused by fuel wood burning. Also, through improved manure management, it will reduce ground and surface water contamination. It will also reduce spreading of zoonotic diseases and odor caused by animal manure. Biogas recovery can also diversify the sources of the rural energy supply reducing deforestation.

Climate change mitigation potential
As mentioned, biogas can substantially reduce CH_4 emissions from manure management and CO_2 emissions from energy consumption elsewhere. IPCC (2006) suggested that if a household biogas digester treats the manure of 4 pigs, it can reduce GHG of 1.5~5.0 tonnes CO_2-e. As for Laos case, MoNRE (2012) predicted that if this technology is applied for emissions reduction from 2015 to 2030 for 50 percent to 70 percent of total livestock which raised in farm system such as liquid, paddock and so on, where manure is used for methane recovery, and 30 percent to 50 percent of emissions can be reducible as estimate, the emissions reduction by 2030 will be 194.93 $GgCO_2e$ CH_4 or 12.18 $GgCO_2e$ CH_4 per annum on average.
Barriers
Similar to elsewhere, the development and dissemination of biogas digesters in Laos faced investment and technical barriers **1) Investment Barrier** With the cost of each household biogas digester (8~16 m3) ranges from US$500 to US$1,000 while most rural households have low disposable income and weak financial capacity, so it is difficult for making such a large investment. In addition, the household will continue to pay a biogas digester maintenance cost. By contrast, the current practice of deep-pit treatment method is by far considered the most attractive option for manure treatment given that it requires very limited additional investment and labor input. **2) Technical barrier** The biogas digesters have to be located in many cases in the remote rural areas, where farmers lack ready access to improved technologies and management methods. According to current experiences, the performance of some digesters is unstable, with varying levels of gas production. This is due to the lack of experience among the individual households, limited resources for biogas service support, and insufficient farmer training and maintenance. Expertise is required to ensure that the digesters function properly, so maintenance and management of biogas digesters require adequate support services and trained staff, which is not available in rural areas.

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment Reports For Climate Change Mitigation – Laos. You can access the complete report from the TNA project website http://tech-action.org/**