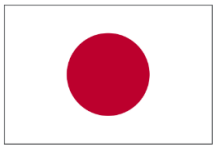


PROJECT ON PROMOTING BIOMASS ENERGY FOR ASEAN REGIONAL AGRICULTURAL AND RURAL DEVELOPMENT COMMUNITIES

REPORT

PROMOTION OF UTILISATION OF BIOGAS FROM MIXED AGRICULTURAL WASTES AS AN ALTERNATIVE SUSTAINABLE ENERGY AT HIGHLAND AREA FOR FARM MANAGEMENT

Implementing Agency: Malaysia Agricultural Research and Development Institute (MARDI), Malaysia

I. INTRODUCTION MODELS

1.1. General Information:

Project name: Promotion of Biomass Energy for Agricultural Communities and Rural Development in ASEAN Region

Implementation model: Promotion of Utilisation of Biogas from Mixed Agricultural Wastes as an Alternative Sustainable Energy at Highland Area for Farm Management

Sponsoring ASEAN Body: ASEAN Technical Working Group on Agricultural Research & Development (ATWGARD); ASEAN Project Management Unit (PMU) Focal Points; ASEAN Secretariat.

Implementing Agency's Name and Address: Malaysia Agricultural Research and Development Institute (MARDI)

Funding Source: Japan- ASEAN Integration Fund (JAIF)

Location of the project model: Cameron Highlands in Pahang, Malaysia

1.2. Introduction

Agriculture is Malaysia's important nation driven and development sector that plays essential role in sustaining food production and security. However, in recent years it is often associated with various environmental impacts e. g inappropriate waste/biomass management, limited access to electricity, high agricultural inputs as fertiliser and water usage, wastewater treatment and greenhouse gas emission. The sector is becoming vulnerable with changes occurring in the society, environment and policy. Sustainable agricultural practices are required to provide one stop solution for balancing agricultural production and environmental exploitation to ensure long term food security.

Energy generation in Malaysia is mostly from natural gas, coal and hydropower. The government is providing opportunities for development of renewable energy. Biomass seems to be the most promising resources for Malaysia

as it provides low cost energy sources while reduce agricultural input's costing and environmental impacts from the agricultural sector. In Malaysia, the agricultural sector produces a significant amount of waste/biomass. According to the United Nations Environment Programme report in 2017, approximately 61 percent of total generated wastes in Malaysia consist of agricultural waste. At current state, in Malaysia, these agricultural wastes are illegally being dumped and burnt to ease farm operations that contribute to environmental depletions. Hence, the wastes may provide sufficient resource for production of renewable energy if treated or converted appropriately in addressing sustainability in the agricultural industry with reduced environmental impacts.

Project was proposed as an initial step to address environmental impacts e. g inappropriate waste/biomass management, limited access to electricity, high agricultural inputs as fertiliser and water usage, wastewater treatment and greenhouse gas emission.

Thus sustainable agricultural practices are required to provide one stop solution for balancing agricultural production and environmental exploitation to ensure long term food security.

Energy generation in Malaysia is mostly from natural gas, coal and hydropower. The government is providing opportunities for development of renewable energy. Biomass seems to be the most promising resources for Malaysia as it provides low cost energy sources while reduce agricultural input's costing and environmental impacts from the agricultural sector.

Technologies for bio-energy are available locally but require improvements and pilot study data to support steady promotion of biomass utilisation as an alternative energy in the agricultural sector. Thus this pilot study proposal is aiming to promote utilisation of agricultural wastes for production of biogas as an alternative sustainable energy for farm management and improve social, economical and environmental aspects. The pilot study is anticipated to develop and enhance sustainable agriculture practices by providing energy, to reduce agricultural input

cost and to mitigate environmental pollution in Malaysia and sharing of detailed information among the ASEAN member states. Furthermore, the study is also expected to assist in the development and reviewing of bio-energy consumption policy for agricultural communities locally and in the ASEAN region

1.3. Objectives

The main objective is to promote sustainable development and utilisation of bio-energy for agriculture sector and strengthen and review national and regional policies for sustainable renewable energy production and consumption.

The specific objectives of the pilot study are as below.

a) To build and conduct pilot study on bio-energy produced of agricultural wastes.

b) To analyse comparison of requirement and consumption between non renewable and bio-energy from agricultural wastes for daily farm operation.

c) To evaluate efficacy of bio-fertilisers produced during production of bioenergy for crop cultivation.

d) To promote utilisation of bio-energy produced to improve productivity and sustainability in the agricultural sector.

e) To share knowledge and review development of bio-energy policy for agricultural communities in the ASEAN region.

II. ACTIVITIES

Cameron Highlands is an extensive agricultural operation area in Malaysia consisting of 4,000 ha of tea plantations, 2,000ha of vegetable farms, 1,000ha of flower farms and 20ha of strawberry farms. Daily turnover for the flower industry is RM2 million, with 80 percent of the flowers heading for the export market; vegetables RM1 million, with 80 percent of the produce going for domestic consumption; and strawberries RM30,000. Bio-energy production and utilisation pilot study have been initiated at MARDI Cameron Highlands in Pahang, Malaysia

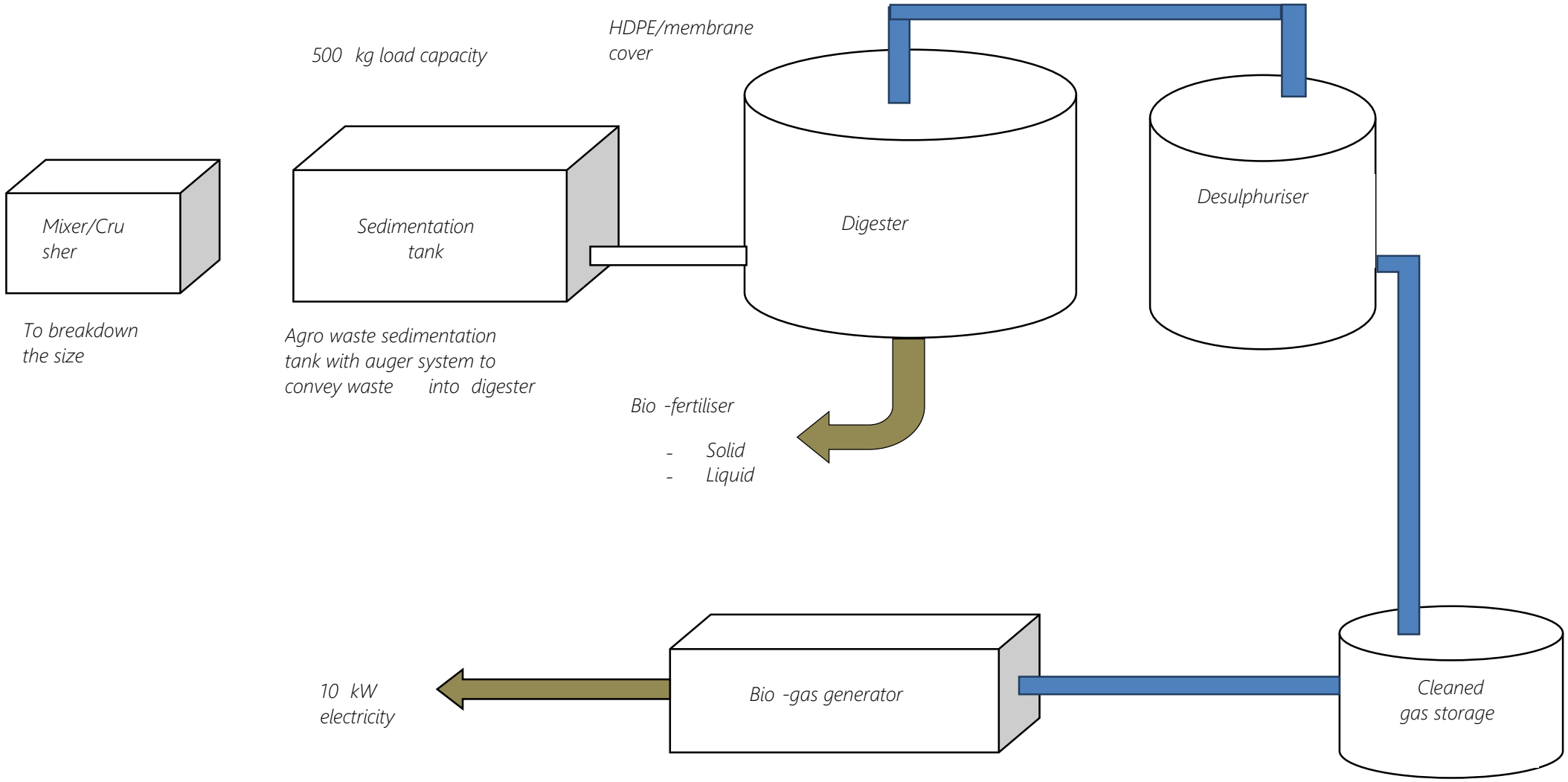
which produces horticultural wastes and vegetable wastes in large amounts on daily basis. These wastes are currently being dumped for disposal causing wastage of resources, environmental pollutions and complaints.

Farms in Cameron Highlands have various operational issues such as limitation to access of energy due to rural location, lack of human resources for farm management, extensive usage of fertilisers and pesticides, water pollution, air pollution and low soil fertility. Thus it is suitable to conduct pilot study here as an initial step of setting an exemplary to the farmers on bioenergy as an alternative to fossil energy and zero waste management. In addition, actual and reliable data of analysis can be obtained promptly with the assistance of employees of MARDI.

Bio-energy (biogas) produced from the pilot study using mixed agriculture wastes here have been converted into electrical energy for utilisation in the farm such as for lighting and crop watering and the by-products from the pilot study such as liquid and solid fertilisers have been test for efficacy to improve soil fertility and crop productions using plot trials. Data obtained of comparing requirement and consumption of fossil energy and bio-energy in the farm management is anticipated to assist in reviewing bio-energy policy. Biofertilisers' efficacy studies will provide information on chemical and phytotoxicity characteristics using 2 leafy and 2 fruity vegetables.

In addition, the display of utilisation of bio-energy pilot study herein can create a great impact among agricultural community and further enhance promotion of bio-energy as MARDI provides complete access to public of various communities for educational visits, training, counselling, consultations and agro-tourism

DIAGRAM OF BIO-ENERGY PILOT STUDY CONCEPT



- The pilot study concept proposed by Malaysia has been conducted as shown in the diagram.
- At present the biogas system shown in the diagram needs to be built at the pilot study location.
- However, instruments required for installation of the design are readily available in the market for purchase.
- Types of waste to be used include animal, horticultural, vegetable and fruit wastes collected within the farm area of selected location. Estimated waste quantity from selected farm is 200 – 300 kg/day.
- Agro-wastes have been mixed and crushed and sent to sediment tank with a 500kg capacity. The semi solid waste have been digested in a digester sealed with high density poly-ethylene sheet or membrane cover for anaerobic process for formation of biogas and bio-fertiliser using selected formulation. The digester is anticipated to have a size of (2 x 2 x 2 m3) made of fibre glass or stainless steel.
- Biogas formed have been filtered using desulphuriser probably H2S scrubber before sent to cleaned gas storage.
- The installation of cleaned gas storage is needed in order to sustain constant gas pressure and supply to the biogas generator besides installation of appropriate valves and gas meters along the gas pipe line.
- Biogas generator used herein is expected to have an engine capacity of 10kW for this study. The current designed capacity can produce 10kW of electric energy from biogas to be used in a target farm for lighting that only requires 79 kW.
- Based on literature review:

1 000 kg waste produces = 20m3 biogas at minimum level

1m^3 biogas produces = 2 kWh of caloric energy using generator (value varies depending on varying parameters)

2kWh is sufficient to power a 100 W light bulb for 20 hours

Hence we estimate 200 kg waste from farm produces = 4 m3 at minimum level

$4m^3$ biogas produces = 8 kWh of caloric energy

However in this pilot study, real data on production of biogas volume and can only be obtained from the experiment due to lack data on subject matter.

- Bio-fertilisers' (solid, liquid) efficacy studies have been conducted to study chemical and phyto-toxicity characteristics using 2 leafy and 2 and 2 fruity vegetables. The activity involves land preparation and irrigation system. Random complete block design with 5 replications have been applied during experimentation. Two leafy (spinach, lettuce) and two fruity (chilli, sweetcorn) vegetables will used for the study in which application of bio-fertilisers tested using various combination of concentrations and compared with chemical fertilisers available. Chemical characteristics as moisture content, pH, EC, total organic carbon, organic matter, total N, heavy metal, macronutrients and microbial details have been obtained. Meanwhile phyto-toxicity analysis using direct assessment technique will provide details on seed germination percentage, plant length, root length and biomass produced.

III. Pre-Evaluation of economic, environmental and social impacts

Economic impacts

a) Change in consumption of fossil fuels: Bio-energy can be produced domestically using agricultural biomass. This could lead to lower fossil fuel imports and consumption and may cause rural population to be less vulnerable to the adverse impacts of supply disruptions.

b) Job creation: Significant proportion of employments can be generated in both construction and operation of the bio-energy facilities and infrastructure in the rural

region, In terms of employment, it have been mostly permanent and ongoing employment since the industry itself is sustainable.

c) Fossil energy price reduction: Reduced demand for fossil energy could also reduce its price while generating economical benefits for the society with adaptation to bio-energy.

d) Energy security and diversity: Fossil fuels are exhaustible resources compared to bio-energy from agricultural feedstock. Thus, bio-energy production and use may become sustainable indefinitely as no additional agricultural production is required and mitigate green house gas emissions from waste. Sustainable bio-energy can provide energy needs with locally available and nationally adaptable solutions that adjust to local resource availability and diversity priorities.

Environmental impacts

a) Reduction of carbon emission: Bio-energy from agricultural wastes can affect carbon emissions in two main ways as it provides energy that can displace fossil energy and it can change the amount of carbon sequestered on land. Bio-energy could yield lower lifecycle green house gas emissions than fossil energy. Second and third generation of bioenergies have significant potential to reduce green house gas emissions because feedstock can be produced using marginal land. Utilisation of waste for bio-energy production eliminates air pollution due to inappropriate disposal of waste.

b) Improve soil quality and fertility: By-products of bio-energy such as liquid and solid fertilisers can be used to nourish nutrients for soil management through natural practices. It helps to maintain soil organic matter for better crop production. At present excessive usage of synthetic fertilisers and pesticides for food production on low fertile lands is often highlighted addressing on food safety for human consumptions.

c) Improve water quality: Excessive usage of chemical fertilisers and pesticides can be prevented and reduce leaching of nutrients to water sources which cause surface and ground water pollutions through utilisation of agricultural wastes for bio-energy and bio-fertiliser productions. Thus water quality in agricultural facilities can be improved to enhance safe food productions.

d) Expansion of agro-biodiversity: Mono-cropping practise can be avoided with availability of varieties of bio-energy feedstock. Planting of a single crop can function as an incubation medium for pests or disease which can then spread into natural habitats and depletion of soil of nutrients completely. In addition, with availability of improved bio-energy technology, specific planting of single crop for bio-energy production may not be required as the system can use any available biomasses.

Social impacts

a) Increase standard of living: Bio-energy industry can create job opportunities which can improve household monetary income and improvise standard of living of rural community. It can provide access to quality living environment, health and education with availability of modern energy services for both agricultural and daily activities.

b) Improve social cohesion and stability: Improved standard of living and acceptation of agricultural activities as source of income can reduce migration effects of population and mitigate rural depopulation besides securing food production for nation and economical development. Hence regional development is achievable with expanding rural diversity and income generation through agricultural practises.

IV. CONCLUSION

Biomass seems to be the most promising resources for Malaysia as it provides low cost energy sources while reduce agricultural input's costing and environmental

impacts from the agricultural sector; According to the United Nations Environment Program report in 2017, approximately 61 percent of total generated wastes in Malaysia consist of agricultural waste. At current state, in Malaysia, these agricultural wastes are illegally being dumped and burnt to ease farm operations that contribute to environmental depletions; Technologies for bio-energy are available locally but require improvements and pilot study data to support steady promotion of biomass utilization as an alternative energy in the agricultural sector.

The model on Promotion of Utilisation of Biogas from Mixed Agricultural Wastes as an Alternative Sustainable Energy at Highland Area for Farm Management also have some direct beneficiaries:

- Pilot model of biogas design set up including generation and connection of electricity to farm appliances

- Farmers in Cameron Highlands in Pahang, Malaysia were trained on how to set-up biogas system and connect electricity to their farm appliances.

ANNEX - ILLUSTRATED PICTURES

Figure 1: Select location for Biogas generator system

Figure 2: Mixed, crushed and sent wastes to sediment tank with a 500kg capacity

Figure 3: Biogas generator system have an engine capacity of 10kW