Biodigester system (Mr. Kim Soben)

Using slurry from biodigester for soil improvement (Cambodia)

biodigester

DESCRIPTION

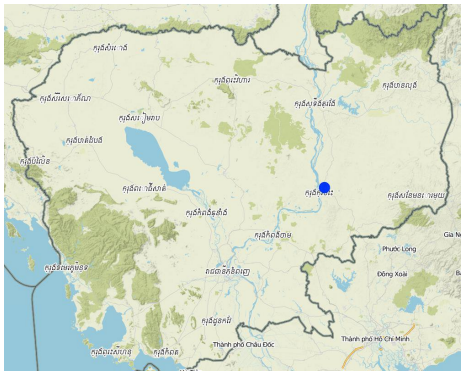
Biodigester slurry sourced from cow manure is used as an important natural fertilizer for the cultivation of crops. It is a form of organic fertilizer that is thoroughly decomposed, does not have an awful smell, or contain living weed seeds, fungi and other viruses. It can also be used immediately after the slurry flows out of the biodigester tank. Such fertilizer helps to improve the soil quality in the long-term due to the rich organic matter that it contains which slowly decomposes to plant nutrients.

There are many kinds of biodigesters and the one used in this technology is a 5000 liter plastic cylinder. It was installed by placing part of the tank into the ground and setting up an inlet-outlet pipe as well as a gas pipe system. The whole installation process takes around a day to complete. In order to produce gas initially the biodigester needs about 120 buckets (around 2000 kg) of fresh cow manure and 120 buckets (1200 liters) of water, which then needs to be kept for one week so that it can produce gas and slurry as fertilizer. After that the farmer has to add one bucket (around 20 kg) of fresh cow manure and one bucket (20 liters) of water every day in order to maintain the continuous production of gas and slurry. As a result, the farmer's family has gas from the biodigester which provides sufficient energy for cooking. In this way they are able to save time which is otherwise spent collecting fuel-wood and it reduces their firewood consumption by around 2190 kg per year. The fresh cow manure for the biodigester should be free from rubbish and not contain small gravel because this blocks the inlet /outlet of the biodigester tank.

In addition, to be able to use the gas for cooking and lighting, the farmer also has the opportunity of using the slurry from the biodigester as fertilizer for all kinds of crops, including bitter gourds, eggplants, mangos, yard long beans, rice, bamboo shoots and other supplementary crops. The slurry from the biodigester can be applied as fertilizer either in a liquid, a semi-dry or a dry form. The slurry can be applied to the crops directly or compost can be made by mixing it with other degradable materials such as woody herb, rice straw and other green leaves. This practice will increase the quantity of the fertilizer because the slurry from bioidigester helps to accelerate the decomposition process and it also produces a higher quality compost.

The slurry from biodigester improves soil aggregates and fertility for a longer period than chemical fertilizers. The slurry contains a lot of nutrients specially nitrogen, phosphorus and potassium that are necessary for plants, and it does not have an awful smell, or contain weed seeds and parasites. The nutrients are in a chemical form which can easily be absorbed by plants, and it contains vitamin B12 which stimulates the growth of earth worms. The use of slurry enables the growth of various microorganisms and besides earth worms, other useful animals such as frogs and soil-insects, thereby maintaining a natural balance of the environment. The fertilizer enhances the growth of crops, builds resistance to disease, and does not affect the soil and human health. For poorer quality soil, the slurry or compost improves both the physical and biological conditions of the soil. It improves the nutrient content including macronutrients and micronutrients, and also helps to keep soil aggregates and moisture.

LOCATION



Location: Rural, Kamboa village, Kouleap commune, Chitrborie district, Kratie province., Cambodia

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 106.08695, 12.54908

Spread of the Technology: applied at specific points/ concentrated on a small area

In a permanently protected area?:

Date of implementation: 2016

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Farmer taking compost produced from the slurry to apply it on crops (Mr. Kim Soben)

Using the slurry compost on eggplant and mango (Mr. Kim Soben)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Land use mixed within the same land unit: Yes - Agroforestry

Cropland

- Annual cropping: vegetables - melon, pumpkin, squash or gourd, vegetables - other, legumes and pulses - beans, rice, eggplant. Cropping system: Vegetables - wheat/barley/oat/upland rice
- Perennial (non-woody) cropping: banana/plantain/abaca, sugar cane
- Tree and shrub cropping: mango, mangosteen, guava

Number of growing seasons per year: 3

Water supply

- [ ] rainfed
- [x] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

physical soil deterioration - Pu: loss of bio-productive function due to other activities

biological degradation - Bs: quality and species composition/ diversity decline, Bl: loss of soil life

SLM group

- integrated crop-livestock management
- energy efficiency technologies

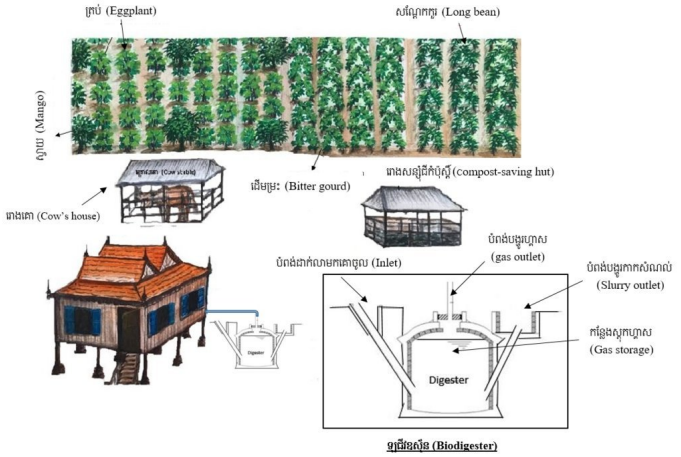
SLM measures

management measures - M6: Waste management (recycling, re-use or reduce)

TECHNICAL DRAWING

Technical specifications

Biodigester tank is made of a plastic tank of 5,000 liter volume. The biodigester structure has three pipes: inlet, gas pipe and outlet. The inlet is for pouring the mixed fresh cow manure into the biodigester tank, while outlet is where the slurry comes out. The pipe is for delivering gas from the biodirester to the end use places. The tank is buried at one-third of the height into the ground. On a daily basis, it needs around 20kg cow manure mixed with 20 litres of water, putting into the tank. There is a hut (3×3 meters sides with 1.6 meters high) for storing the slurry and making compost. The roof is made of zinc at 0,5 meters height above the wall. Bio-digester fertilizers are used on many types of crops in the fields. It can produce around 4 cubic meters of gas, offsetting the use of around 2,190 kg of firewood per year.



Author: Mr. Khoun Sophal

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Biodigester**)
- Currency used for cost calculation: **Riel**
- Exchange rate (to USD): 1 USD = 4000.0 Riel
- Average wage cost of hired labour per day: 25000 riel

Most important factors affecting the costs

The cost of the plastic tank and the enough cows to producing sufficient slurry for the manure production.

Establishment activities

1. Dig soil (Timing/ frequency: May)
2. Put biodigester (Timing/ frequency: May)
3. Prepare pipe system (Timing/ frequency: May)
4. Install (Timing/ frequency: May)
5. Add cow manure (Timing/ frequency: May)

Establishment inputs and costs (per Biodigester)

Specify input	Unit	Quantity	Costs per Unit (Riel)	Total costs per input (Riel)	% of costs borne by land users
Equipment					
Biodigester	set	1.0	4000000.0	4000000.0	20.0
Total costs for establishment of the Technology				**4'000'000.0**	
Total costs for establishment of the Technology in USD				*1'000.0*	

Maintenance activities

1. Clean drainage pipes (Timing/ frequency: every day)
2. Putting cow manure (Timing/ frequency: every day)

Maintenance inputs and costs (per Biodigester)

Specify input	Unit	Quantity	Costs per Unit (Riel)	Total costs per input (Riel)	% of costs borne by land users
Labour					
Cleaning by themself	Hour	30.42	3124.0	95032.08	100.0
Fertilizers and biocides					
Cow manure	Kg	20.0	1200.0	24000.0	100.0
Water	Liter	20.0	200.0	4000.0	100.0
Total costs for maintenance of the Technology				**123'032.08**	
Total costs for maintenance of the Technology in USD				*30.76*	

NATURAL ENVIRONMENT

Average annual rainfall

- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☑ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone

- ☐ humid
- ☑ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate

Average annual rainfall in mm: 1138.2
The average annual rainfall in 2015 is 1138.2 mm, in 2014 is 1696.5 mm, in 2013 is 1661.8 mm.
Name of the meteorological station: Ministry of Water Resources and Meteorology (2015)

Slope

- ☑ flat (0-2%)

Landforms

- ☑ plateau/plains

Altitude

- ☑ 0-100 m a.s.l.

Technology is applied in

- ☐ convex situations

- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Yes
- [x] No

Occurrence of flooding
- [ ] Yes
- [x] No

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial)
- [x] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor ✓	good
education	poor ✓	good
technical assistance	poor	✓ good
employment (e.g. off-farm)	poor	✓ good
markets	poor	✓ good
energy	poor	✓ good
roads and transport	poor	✓ good
drinking water and sanitation	poor	✓ good
financial services	poor	✓ good

IMPACTS

Socio-economic impacts

Crop production

decreased ✓ increased

Quantity before SLM: 150 kg per month
Quantity after SLM: 450 kg per month

crop quality

decreased ✓ increased

Biodigester slurry is a rich-nutrient natural fertilizer and the

produced crop is not chemically contaminated.

animal production

decreased ✓ increased

Quantity before SLM: 10 Cows
Quantity after SLM: 19 cows
As cow manure is needed for the biodigester to produce enough gas and compost, the herd size had to be increased.

risk of production failure

increased ✓ decreased

As the farmer was able to scale up the plant variety by using slurry from biodigester the risk of production shortfall for one crop can be compensated by the other crops.

product diversity

decreased ✓ increased

As the slurry from biodigester matches to all sorts of plants, the farmer was able to scale up the product diversity.

land management

hindered ✓ simplified

Quantity before SLM: Use chemical fertilizer
Quantity after SLM: Use compost fertilizer
Fertilizer now is produced on farm in a very short time and therefore farmer doesn't have to run after manure.

energy generation (e.g. hydro, bio)

decreased ✓ increased

Before the farmer family was forced to look for huge amounts of fire wood (over 1,290 kg per year) in the surrounding area. Now, as side effect of the compost production gas can be produced for cooking.

expenses on agricultural inputs

increased ✓ decreased

No chemical fertilizer has to be bought.

farm income

decreased ✓ increased

Quantity before SLM: 15 %
Quantity after SLM: 45 %
The farmer now has diversified productions from the various crops due to the improved soil quality, thus, the household income increased substatially.

workload

increased ✓ decreased

Stop going to the forest to collect fire wood.

Socio-cultural impacts

food security/ self-sufficiency

reduced ✓ improved

The farmer now have enough and healthy food for the whole year and surplus for selling.

health situation

worsened ✓ improved

Compared to former time, the family is less sick which is closely associated healthier food production and the and the cleaner air during cooking.

SLM/ land degradation knowledge

reduced ✓ improved

The farmer participated in training on compost and vegetable growing including some field visits.

Ecological impacts

evaporation

increased ✓ decreased

Due to the better availability of fertilizer, the farmer grows more crops on his land during the whole year. In cosequence of this, the evaporation is slightly reduced. Also, higher plants such as mango trees provide more shade to the land.

soil moisture

decreased ✓ increased

The increase in organic matter and the better soil cover by plants improved the soil moisture slightly.

soil cover

reduced ✓ improved

During all seasons the soil is now covered by plants.

soil organic matter/ below ground C

decreased ✓ increased

Soil rich in nutrients due to the frequent compost application

plant diversity

decreased ✓ increased

Due to beneficial soil conditions, plant diversity increased.

animal diversity

decreased ✓ increased

Increase in number of frog, worm, and earthworm

beneficial species (predators, earthworms, pollinators)

decreased ✓ increased

More frogs, worms, and earthworms

pest/ disease control

decreased ✓ increased

There are still some insects damaging plant leaves, but

compared to before the number has decreased due to the healthier soil conditions.

Off-site impacts
impact of greenhouse gases

increased ✓ reduced

No burn of firewood for cooking and preservation of forests for carbon sequestration

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns	very negative	very positive ✓
Long-term returns	very negative	very positive ✓

Benefits compared with maintenance costs

Short-term returns	very negative	very positive ✓
Long-term returns	very negative	very positive ✓

No money was needed to repair the biodigester system untill now.

CLIMATE CHANGE

Gradual climate change

annual temperature increase	not well at all	very well ✓	
seasonal temperature increase	not well at all	very well ✓	Season: wet/ rainy season
annual rainfall increase	not well at all	very well ✓	
seasonal rainfall increase	not well at all	very well ✓	Season: wet/ rainy season

Climate-related extremes (disasters)

drought	not well at all	very well ✓
epidemic diseases	not well at all	very well ✓
insect/ worm infestation	not well at all	very well ✓

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☑ 1-10%
- ☐ 11-50%
- ☐ > 50%

Number of households and/ or area covered

Six households have been supported to get the biodigester by the NBP.

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- ☑ 0-10%
- ☐ 11-50%
- ☐ 51-90%
- ☐ 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- ☐ Yes
- ☑ No

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- Manufacture fertilizer by himself
- Can be applied directly to the crop which not results in its putrefy, unlike fresh cow manure which can lead to the putrescence of crops and the growth of a lot of grass.
- Saving of 2190 kg of firewood per year.

Strengths: compiler's or other key resource person's view

- Helps to improve the soil quality.
- Reduces negative environmental effects.
- Reduces daily costs.

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- A biodigester is expensive National biodigester programme to support

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- A biodigester is expensive Need a supporting fund from relevant institutions.
- Need of enough cow manure Promote livestock raising, especially cows.

REFERENCES

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Resource persons
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Saravuth Ly - Official of Chetr Borie Agricultural, Forestry and Fisheries district
Sok Sum - land user
Sivin Sak - Chief of Sambour Agricultural, Forestry and Fisheries district

Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_2137/

Linked SLM data
n.a.

Documentation was faciliated by

Institution
- Royal University of Agriculture (RUA) - Cambodia

Project
- Scaling-up SLM practices by smallholder farmers (IFAD)

Key references

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Links to relevant information which is available online

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