

HOW TO INSTALL A POLYETHYLENE BIOGAS PLANT

By

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Acknowledgements:

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Diagrams: Courtesy.- Aguilar, F.X. et al.(1999). El Biodigestor (Spanish). In: Toward a better use of our natural resources. EARTH University. 28.

1. WHAT IS A BIOGAS PLANT ?

A biogas plant is commonly known as a BIODIGESTER. The biodigester is a technology that takes advantage of excrement from animals and humans in order to transform it into BIOGAS (methane gas) as a source of fuel, and ORGANIC FERTILIZER.

Biogas is produced by bacteria that decomposes animal manure. The residual material is known as effluent and is very high in nutrients, thanks to the bacterial action and absence of oxygen. These factors help to eliminate bad smells and pathogens as well.

A plastic bag, an outgoing biogas valve and a security valve compose a biogas polyethylene plant.

2. BENEFITS OF BIOGAS TECHNIQUE



Fig 1. The biogas plant. Gampaha, Sri Lanka

Biodigesters can be fed with animal and human excrement. For this reason, biogas plants help to diminish illnesses and reduce the population of insects like flies and mosquitoes.

Thanks to biogas production, it is no longer necessary to use firewood to cook. The use of firewood affects the environment because it promotes the destruction of the forest and it also causes respiratory illnesses to people who cook with it. Biogas also saves money, replacing electricity or liquid gas as sources of energy for cooking.

Effluent from the biogas plant can be used as organic fertilizer, and the application of chemical fertilizers can therefore be reduced. This way, farmers save money, and pollution of the atmosphere by chemical inputs is avoided. The same effluent can be used in fish ponds and to produce aquatic plants. Aquatic plants produce enough material to feed animals and/or to make compost.

3. STEPS TO INSTALL A BIODIGESTER FOR A RURAL FAMILY

Step 1: Materials

The recommended biodigester length for a small family is 10 meters. To install a biogas plant of this size, the materials listed below are needed:

- 28 meters of natural polyethylene plastic, 1000 gauges, 1.5 meters width.
- 8 used buckets (~20 L) of the same size or 2 cement pipes, 1 meter length, 12 inches in diameter
- 1 PVC screw (male adapter), 1 inch in diameter
- 1 PVC cap (female adapter) 1 inch in diameter
- 2 meters of transparent plastic hose of 1 ¼ inches in diameter
- 1 PVC "T", 1 inch in diameter.
- 2 - 90° PVC elbows, 1 inch in diameter
- 1 meter of pressure PVC pipe, 1 inch in diameter
- 1 flat PVC cap, 1 inch in diameter
- 2 round plastic or aluminum disks (20-15 centimeters in diameter with a central hole of 1 inch)
- 1 transparent plastic bottle - 1 gallon of capacity
- 3 used tires automobile tubes (rubber belts)
- 8 used plastic fertilizer sacks
- 1 galvanized metallic pipe, ½ inch in diameter 50 centimeters length
- 1 tube of PVC glue
- 1 steel wool
- An automobile or motorcycle as source of exhaust
- 1 plastic hose to take exhaust from the car to the place where the biodigester will be installed



Figure 2. Location where the biogas plant will be installed. Gampaha - Sarvodaya District Center, Sri Lanka.

Step 2: Biodigester location

Once all the materials are obtained, the biodigester location needs to be decided. The biodigester should be close to the animals, and it is also recommended to connect any human latrines to the biogas plant to eliminate another source of pollution. Lastly, the location should be near the kitchen where the biogas will be used.

Next, proceed to dig a grave in the ground. This grave is needed to protect the biodigester from any damage (from wild and domestic animals) and to help to maintain an appropriate atmosphere for the production of biogas.

An inclined gutter should be dug at each end of the grave. It should be the same width as the cement pipes.

It is necessary that the floor of the grave is in no way sloped, or else, the system will not work. Also, the walls should be totally flat and free of stones or roots that can break the bag.

Dimensions for the grave are as follows:

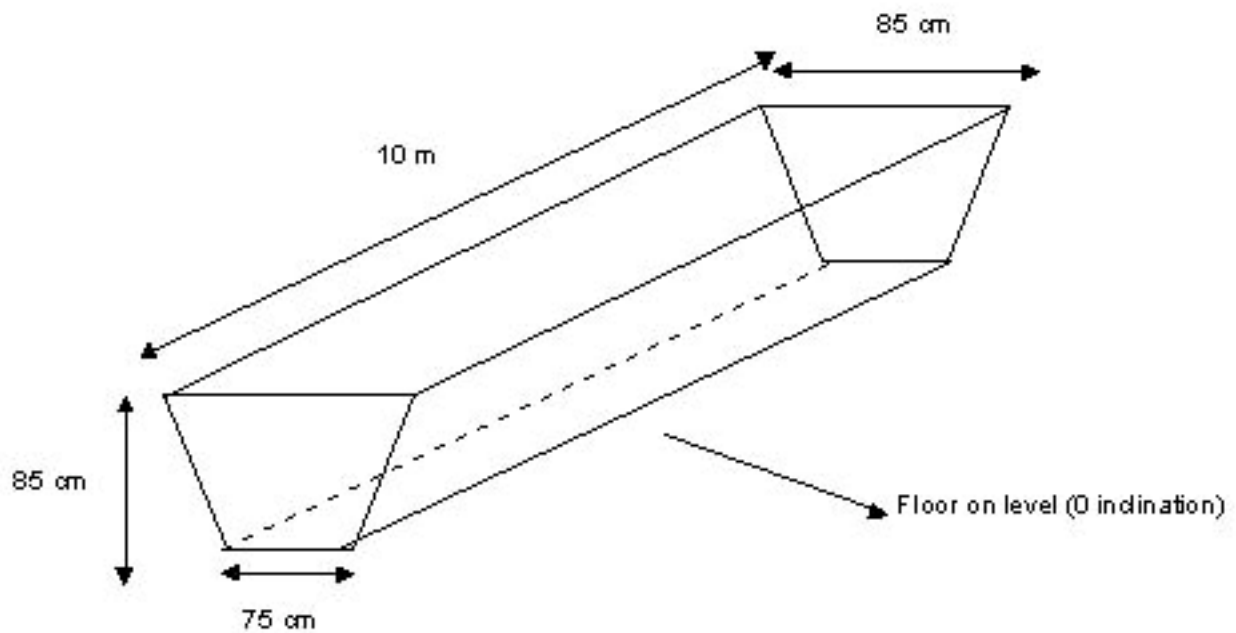


Figure 3. Dimensions of the grave, calculated for a plastic bag 1.5 m width.

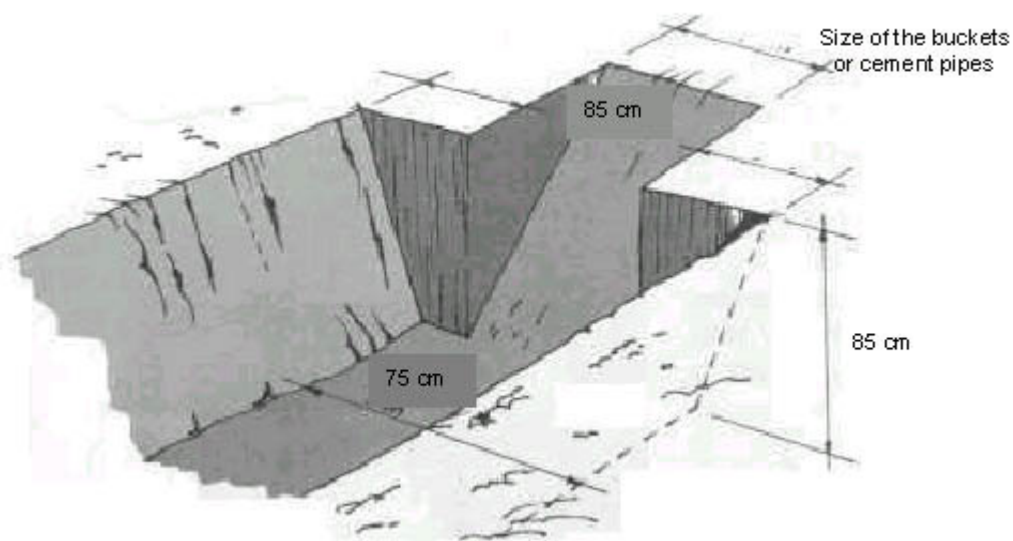


Figure 4. Details of the dug that should be dug at each end of the grave. Source. Botero *et al.*, 1999.

Step 3: Preparing the plastic bag

Extend the 28 m plastic bag on a flat floor that does not have any stones that can break it. It is better if this process is carried out in a hall room of the community centre. Then, fold the plastic in half and cut it in two 14 meters pieces.

Next, a person (with no belt, rings or



Fig. 5. Preparing the plastic bag. A person pulls one plastic bag through the other.

anything that might break the bag) introduces the second bag into the first one by pulling it through the 14 m length of the bag. When the second bag has been pulled through, the system is now a double bag, 14 meters in length. Now, the bag is ready and should be folded and stored in a safe place until the day of installation.

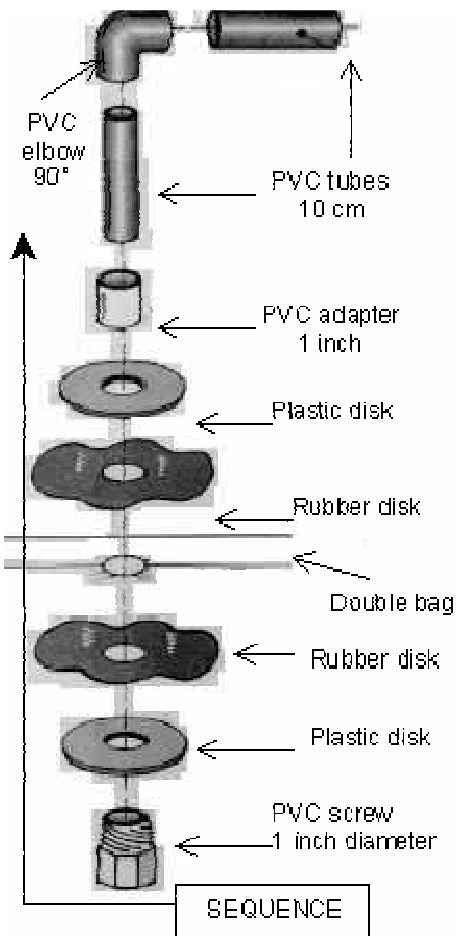


Fig 6. Sequence of the installation of the outgoing biogas valve.

Step 4: Outgoing biogas valve

Four meters from one end of the double bag (nearest to the kitchen), make a small cut ($\frac{3}{4}$ inch) to introduce the 1 inch PVC screw. Between the screw and the double bag, place a plastic disk and a rubber disk (piece of used tire). Then, outside the double bag, place another rubber disk, then a plastic disk and the PVC adapter.

Next, place a 10 cm PVC tube, the PVC elbow and the second 1 inch PVC tube. Finally, place the plastic bag with the outgoing valve in the grave and pass the two ends of the double bag through the 1 meter cement tubes. Instead of cement tubes, you can use plastic buckets. Remove the bottoms of three buckets and connect them together to make a pipe. . You will need 4 buckets at each end (8 buckets total).

Step 5: Security valve

Next, the **security valve** should be placed according to the following:

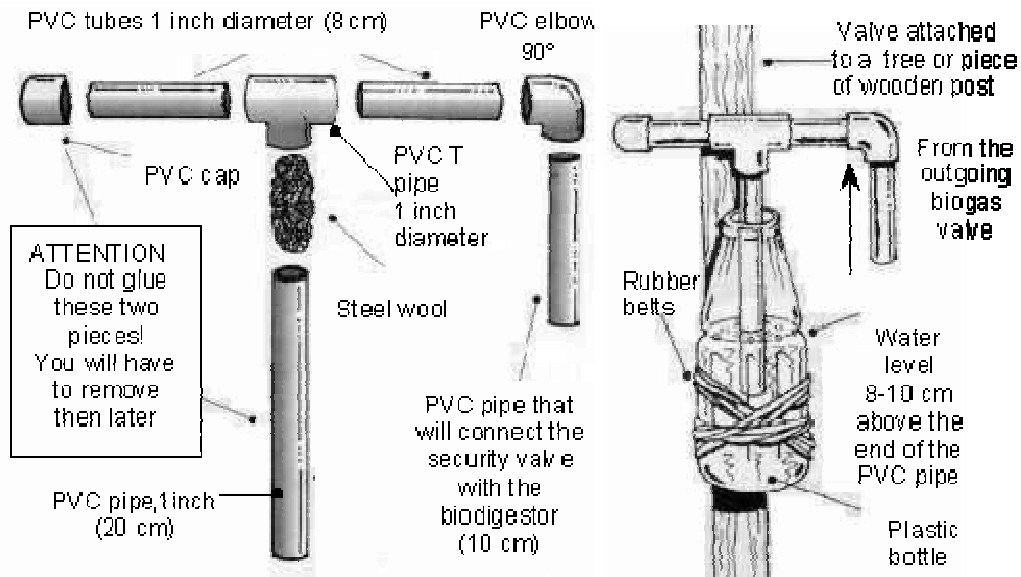


Figure 7. Diagram of the security valve.

Figure 8. The security valve is tied to a wooden post.

ATTENTION: Make sure the **20 cm PVC tube, is not glued to the "T"**. Every **six months**, the **Steel wool needs to be changed**, without dismantling the rest of the system.

Insert the valve into a transparent plastic bottle, full of water, and tie it to a wooden post (next to the exit valve). Make small holes in the plastic bottle to ensure that the 20 cm PVC pipe is 8-10 cm under the water level.

Finally, the outgoing biogas and security valves are connected through the transparent plastic hose.

Step 6: Fill up the biogas plant with exhaust and water

Tie one end of the double bag with rubber belts, and insert a hose into the other end. Connect this hose to the exhaust pipe of a car, making sure it is well attached. Start the engine, and let it run until the bag is full. When the outgoing biogas valve starts to bubble, that indicates that the biogas digester is at its maximum capacity.



Figure 9. Connecting a hose to the exhaust pipe of a car, in order to fill the plastic bag with exhaust.

Next, through the same hose, fill the biodigester with water, until it reaches the level of the buckets, and the gas can no longer escape. This is a critical step, because if it is not carried out correctly, the bell where the biogas will be stored will not form.



Figure 10. Photo of a biogas plant, filled with exhaust and water.

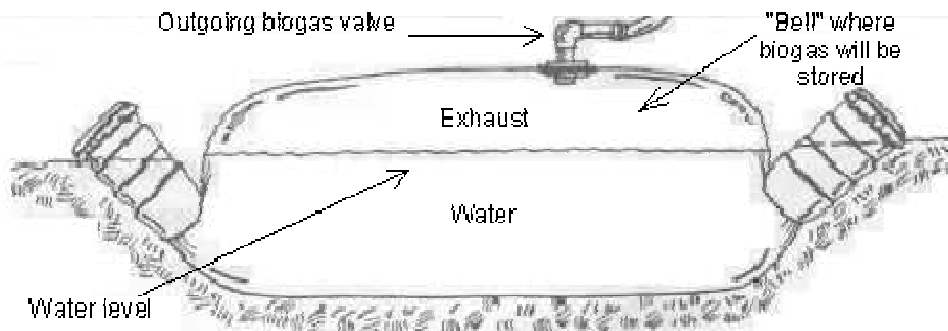


Figure 11. Diagram of a biogas plant, full of exhaust and water.
 Water represents 75% of the total volume of the bag.
 The other 25% is full of exhaust.

At this point, open both ends of the plastic bag. The bell should be formed and biogas will not escape.



Figure 12. When water reaches the level of buckets, both ends are opened. Water level keep gases inside the bag, forming a bell.

Step 7: Management of the biogas plant

Daily, the biogas plant must be fed with 18 kilos of FRESH excrement (from cows, buffaloes, goats, pigs, etc.) blended with 90 kilos of water. This is approximately a mixture of 1 bucket of excrement with five buckets of water. This mixture is needed to replace the water lost during the process and keep a flowing material inside the biodigester.

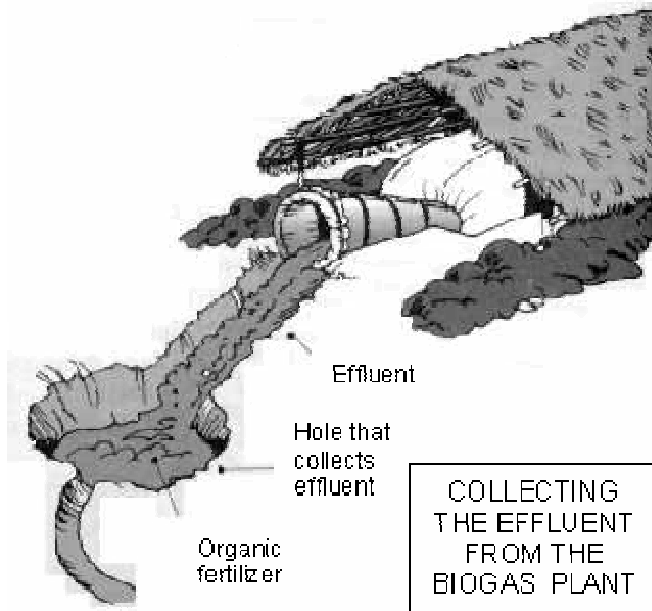
YOU SHOULD **NEVER** CHARGE THE BIOGAS PLANT WITH **CHICKEN MANURE**. This is not appropriate for biogas production.



Figure 13. The biogas plant should be fed every day with fresh manure. Manure is blended with water (1:5) and then through to the biodigester.

Step 8: Protection of the biodigester and use of organic fertilizer

In order to protect the plastic bag from sunlight and animals, a roof and a fence should be built. This will extend the life of the biogas plant (10 years)



Dig a hole next to the end of the biogas plant to collect the effluent which can be used as fertilizer (see figure). This fertilizer can be utilized for orchards or to produce aquatic plants for animal consumption or composting, as well as in ponds for breeding fishes.

Fig 14. The effluents from the biodigester can be used directly as organic fertilizer or to produce aquatic plants, that then can be used to feed pigs or produce compost.

Step 9: Install the burner

30 days after the installation of the biogas plant, remove the PVC cap from the security valve and connect the end of the PVC pipe to the burner. All connections should be made with plastic or PVC pipe, because the biogas is corrosive. Only the pipe that will be used to burn the biogas is galvanized iron.



Figure 15. Biogas is brought to the kitchen using PVC connections, due to its corrosive action. Only the last tube is a iron galvanized pipe. A biogas plant can produce enough fuel to fulfill the requirements of a rural family.

Through the application of biogas technology the quality of life can be improved, save money and increase productivity of the farm and the same time, while protecting our natural resources. This simple and cheap technology can be applied everywhere in the Tropics.

4. REFERENCES

BOTERO, R.; AGUILAR, F.; PRESTON, T. 1999. The biodigester. In Toward a better use of our natural resources. EARTH, Guácimo, C.R. 28 p.

BOTERO, R.; AGUILAR, F. X.; FERNÁNDEZ, J.; RUÍZ, P. 1997-1998. How to install a low cost biodigester. EARTH, Guácimo, C.R. Program of Community Development [videocassette] 16 min.

BOTERO, R.; PRESTON, T.R. 1987 Low-cost biodigester for production of fuel and fertilizer from manure . Cali, Colombia. 30 p.

DEUSTCHE GESELLSCHAFT FÜR TECHNISCHE ZUSAMMERNARBEIT. 1998 Biogas Basics. Information and Advisory Service on Appropriate Technology, Eschborn, Germany.
<<http://gate.gtz.de/biogas/basics/basics.htm>>.

FAO & (CIPAV) FUNDACIÓN CENTRO PARA LA INVESTIGACIÓN EN SISTEMAS SOSTENIBLES DE PRODUCCIÓN AGROPECUARIA. 1995. Plastic biodigester generator of biogas and organic fertilizer. Cali, Colombia. 18 p.

PRESTON, T. R.; RODRIGUEZ , L.J. 1999. Manual for the installation of low cost biodigester. Fundación Universidad para la Agricultura Tropical. Vietnam. Cd-rom

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Biodigester installation manual

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Introduction

Biodigesters can play a pivotal role in integrated farming systems by reducing health risks, facilitating control of pollution and at the same time adding value to livestock excreta through production of biogas and improved nutrient status of the effluent as fertilizer for ponds and crop land. Energy is also a fundamental factor for economic development, but normally the energetic models are based on "non-renewable" resources. In addition to energy sources from humans and work animals there are many kinds of renewable energy such as: hydraulic energy, wind energy, solar radiation or biomass (through pyrolysis and gasification). During the course of this century the world energy consumption per inhabitant has increased sixteen-fold. Today the industrial countries, with 32% of the world population, consume 82% of the planet's energy. On average, a person from an industrialized country consumes 20 times more energy than a person in Africa. It is clear that the "economic development model" is what drives energy consumption.

In many developing countries there is a serious shortage of fuel and the energy crisis is a daily reality for most families. Cooking is one of the most energy-consuming activities, yet is often inefficient. The open fire is still very common. Today the devastation of forests in developing countries is frequently mentioned in the mass media. Deforestation has many causes. Poor people are migrating and inhabiting, cultivating and using new forest areas. In some cases they use "slash and burn" methods and this is another factor rapidly depleting the forests. War has been another important cause of deforestation. However, the daily consumption of fuel must not be underestimated when considering causes of deforestation. It is not unusual for a family to have to spend the greater part of their day gathering fuel for their home. At times dozens of kilometres need to be covered to find fuel (Nystrom 1988). Many developing countries, such as Colombia, Ethiopia, Tanzania, Vietnam, Cambodia, have promoted the low-cost biodigester technology aiming at reducing the production cost by using local materials and simplifying installation and operation (Botero and Preston 1987; Solarte 1995; Chater 1986; Sarwatt et al 1995; Soeurn 1994; Khan 1996). The model used was a continuous-flow flexible tube biodigester based on the "red mud PVC" (Taiwan) bag design as described by Pound et al (1981) and later simplified by Preston and co-workers first in Ethiopia (Preston unpubl.), Colombia (Botero and Preston 1987) and later in Vietnam (Bui Xuan An et al 1994). More than 7000 polyethylene biodigesters have been installed in Vietnam, mainly paid for by farmers (Bui Xuan An and Preston 1995).

There are many designs of biogas plants which are available but the most common are the floating canopy (Indian) and fixed dome (Chinese) models. The poor acceptability of many of these digesters has been due mainly to: (a) high cost of the digesters; (b) difficulty in installing them; and (c) difficulty in procuring spare parts for replacement as these are not always locally available. The polyethylene tubular biodigester technology is a cheap and simple way to produce gas for small-scale farmers. It is appealing to rural people because of the low cost of the installation and therefore of the gas, and the improvement in the environment that the installation allows. It can be applied in rural or urban areas, both in low and hilly lands.

Pollution

The deterioration of soil fertility through loss of nutrients and organic matter, erosion and salinity, and the pollution of the environment - of air, soil and water - are negative consequences of modern agricultural practices in the industrialized countries where the

divorce of livestock and crop production has become the norm. Traditionally, livestock were a balanced - indeed an essential - component of farming systems but the development of the chemical industry in the 19th century, and the major impetus it received from the discovery of oil, created opportunities for the low-cost supply of plant nutrients in inorganic form and led to the rapid displacement of organic manures derived from livestock excreta. The increasing global awareness that resources are finite, and that the livelihood of future generations depends upon the maintenance of renewable natural resources, is now a major stimulus for initiatives that will lead to the more efficient use of these same resources. In industry, recycling of processed raw materials at the end of their useful life is now seen as a means of lowering costs of production and reducing the pollution caused by accumulation of these materials in the environment.

The accumulation of livestock excreta, chiefly from poultry kept in deep litter, was seen as an opportunity to recycle this material as a feed for ruminant livestock (Muller 1980), and there were even attempts to do likewise with the excreta from intensively-fed pigs (Buitrago J, personal communication) and cattle (Anthony 1971). However, in all these cases the nutritional value of the manure was mainly a reflection of the spillage of feed which is almost inevitable when intensive systems of self-feeding are practiced. The high risk of disease from recycling wastes through livestock, highlighted by the recent outbreaks of BSE, is now seen as a major deterrent to these practices.

The process of fermentation in biodigesters results in transformation of organically bound carbon into gaseous carbon dioxide and methane. The anaerobic environment and extended retention time also inhibit the growth of most pathogenic organisms and prevent the survival of intestinal parasites. It is therefore to be expected that both the chemical and biological parameters of livestock excreta will be improved by passage through biodigesters



Photo 1. Washing the pig pen



Photo 2. The waste water running out of the pen



Photo 3. Pollution



Photo 4. Production of methane (and pollution of the air)

Deciding on the location of the biodigester and excavating the soil to make the trench

The first step in installing the biodigester is to identify the most appropriate location. In general this should be close to the source of the livestock pen where the waste is produced. It is a distinct advantage if the washings from the pen pass by gravity directly to the inlet of the biodigester. It is relatively easy to transport the gas by pipeline but difficult and tedious to do this with liquid wastes.

Once the site is selected the next step is to determine the size of the biodigester. As a general rule the excreta produced by 10 fattening pigs will require a biodigester of 4 m³ liquid capacity. The standard diameters of polyethylene tubular film are 80, 125 and 200 cm. For a small number of animals, it is advisable to use a diameter of 80cm which gives a cross-section area of

$$0.4*0.4*\pi=0.50\text{m}^2$$

On average 80% of the total volume in the tube corresponds to the liquid fraction, thus to provide a liquid volume of 4 m³ will require a biodigester with a length of:

$$4/0.80/0.5=10\text{m}$$

The recommended dimensions of the trench which will hold a biodigester of the above dimensions are:

Width at the top 90cm; depth 90cm; width at the bottom 70cm; length 10m.

Having decided on the size of the biodigester the upper extremities of the trench should be defined by a string attached to four posts

When digging the trench it is important to observe the following:

- The sides and the floor should be smooth with no protruding stones or roots which could damage the plastic film
- The floor should have a slope of about 2.5% from the inlet to the exit (this would be 25cm for a biodigester of 10m length)
- The soil that is excavated should be moved away from the edges of the trench so that movement around the biodigester during or after installation, or subsequent heavy rains, do not cause soil to fall onto the plastic



Photo 5. Excavating the soil

Preparing the plastic tube

The polyethylene comes from the factory in rolls which weigh about 50 kg. If the diameter is 80cm then the length of the roll will be about 100m (the weight of 1m is about 0.5kg). The rolls should be protected, especially the edges, and should be stored and manipulated in a horizontal position. Putting a steel rod (or bamboo pole) through the centre of the roll facilitates the extraction of the required length of tube. If the biodigester trench is 10m long then an additional 75cm should be added to each end of the plastic tube to allow for wrapping the ends over the inlet pipes. Thus the length to be cut will be 11.5m.

Two lengths are required as one will be put inside the other to give added strength. When the second length of tube is inserted inside the first length, care should be taken to ensure that the two films fit snugly together and there are no folds or creases.



Photo 6. Putting a steel rod (or bamboo pole) through the centre of the roll facilitates the extraction of the required length of tube



Photo 7. Cutting the second piece of plastic



Photo 8. Bundling one plastic tube in preparation for putting it inside the other

Photo 9. Starting to put one plastic tube inside the other to give added strength



Photo 10. Putting one plastic inside the other to give added strength

Materials required for the biodigester

- Transparent polyethylene tubular film, the diameter of which varies according to the capacities of the machines installed in the factories, but is usually in the range of 80 to 200cm (equivalent to a circumference of 2.5 to 6.3m). The calibre (thickness) should be in the range of 800 to 1,000 (200 to 250 microns). The length of the tube is determined by the size of the biodigester. The most appropriate material is that which is used for greenhouses as this

usually contains an ultraviolet (UV) filter which helps to prolong the life of the plastic when fully exposed to the sun (see Photo 69).

- 2 ceramic tubes of 75 to 100cm length and 15cm internal diameter.
- Plastic (PVC) hosepipe of 12.5mm internal diameter (the length depends on the distance to the kitchen).
- 2 PVC adapters (male and female) of 12.5mm internal diameter.
- 2 rubber washers (from car inner tube) of 7cm diameter and 1mm thickness with a 12.5 mm diameter central hole.
- 2 rigid plastic (perspex) washers of 10 cm diameter and a central hole of 12.5mm. Although perspex is best, these washers can be cut from different sources such as old plastic buckets and other materials made from strong plastic.
- 2 m of PVC pipe of 12.5mm internal diameter.
- 4 used inner tubes (from bicycle, motor cycle or motor car) cut into bands 5 cm wide.
- 1 transparent plastic bottle.
- 1 PVC elbow of 12.5mm internal diameter..
- 3 PVC "T" pieces of 12.5mm internal diameter.
- 1 tube of PVC cement.



Photo 11. Materials for installing a plastic biodigester

Fixing the gas outlet

The components of the gas outlet and the order in which they are placed in the plastic tube are indicated below

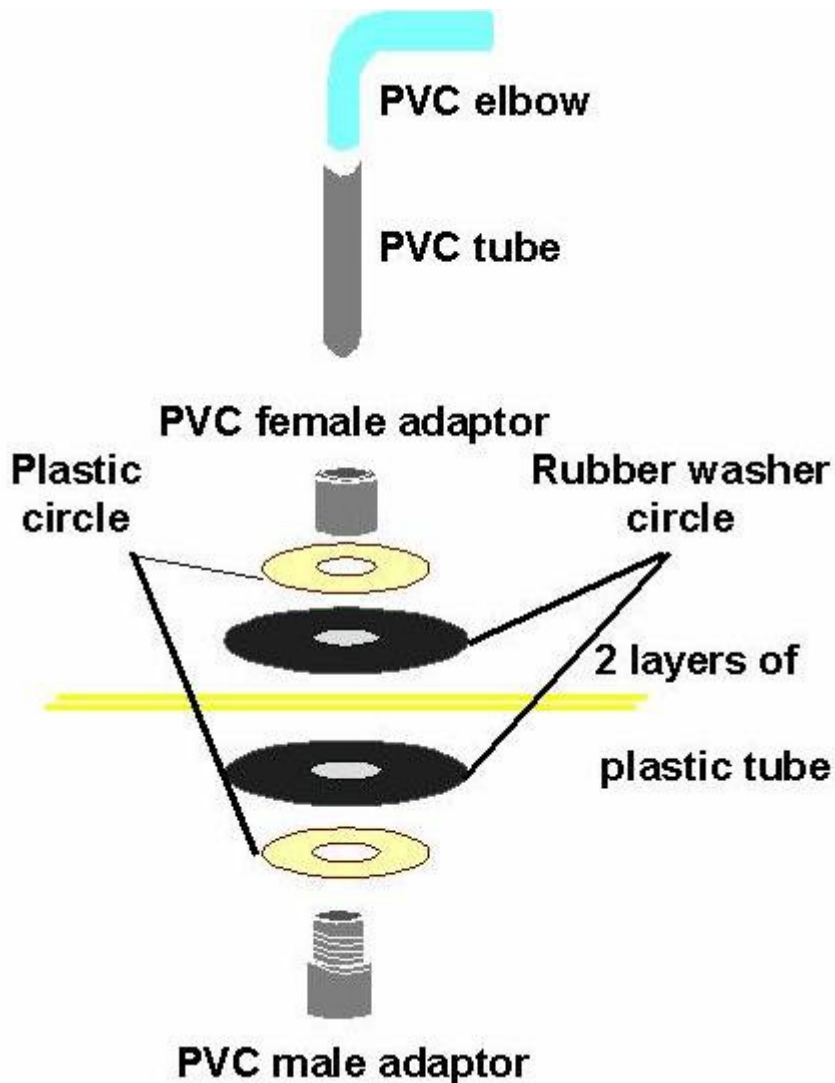


Figure 1. Materials for the gas outlet and the order of assembling them

The first step is to mark the place where the gas outlet will be placed. This should be 1.5m from the end of the plastic tube and in the centre of what will be the top of the biodigester.

The size of the hole is determined by the external diameter of the PVC male adapter.

The rubber washer circles are cut from a length of "used" motor cycle or car inner tube, using the plastic (Perspex) circles as a guide.

The components are then assembled to ensure the male and female adapters fit together smoothly.

The male adapter, complete with plastic circle and above this the rubber circle, is inserted from within the plastic tube. The female adapter, with the rubber and plastic circles attached, is screwed tightly on the protruding male adapter.

The installation of the gas outlet is now complete.



Photo 12. Measuring the distance



Photo 13. Marking the place to cut the plastic



Photo 14. Holding the plastic



Photo 15. Cutting the plastic



Photo 16. Preparing the materials for the gas outlet



Photo 17. Tightening the gas outlet (without using glue)

Fixing the inlet pipe

Rubber bands 5cm wide are cut from "used" inner tubes (from bicycle, motor cycle or motor car).

A polypropylene sack (or one of similar material) is placed on the ground below the work area to avoid damage to the plastic tube.

The ceramic pipe is inserted to one half of its length in the interior of the plastic tube and the plastic tube is folded around it. The join is secured by wrapping the rubber bands around the pipe beginning 25 cm from the edge of the plastic and working towards the exposed part of the ceramic pipe, each band overlapping the previous one, and finishing on the ceramic pipe so that the edges of the plastic tube are completely covered.



Photo 18. Placing the pipe



Photo 19. Starting to fold up the plastic in the middle



Photo 20. Finishing one side



Photo 21. Ready to tie



Photo 22. Cutting the rubber bands

Photo 23. Wrapping the rubber bands around plastic tube where it overlaps the pipe



Photo 24. Completing the wrapping of the plastic over the inlet pipe

Filling the plastic tube with air

The inlet tube is closed with a square of plastic film (or a plastic bag) and a rubber band. The exit of the female adapter is closed with a small square of plastic film and a rubber band.

The polyethylene tube is filled with air before being located in the trench. From the open end, air is forced into the tube in waves formed by flapping the end of the tube in a forward propelling movement of the arms. The tube is then tied with a rubber band about 3m from the end so that the air does not escape. This is to facilitate fitting the exit ceramic tube which is put in place using the same procedure as for the inlet pipe.



Photo 25. Covering the entrance of the inlet pipe with a plastic bag



Photo 26. Covering the gas outlet with a plastic bag



Photo 27. Holding the plastic



Photo 28. Pumping air



Photo 29. Pumping air until the tube is full



Photo 30. Tying the tube but leaving enough plastic to insert the outlet pipe

Final stages in preparing the plastic tube

The second ceramic pipe is fitted to the exit of the plastic tube using the same procedure as for the inlet.

It is very important that the edges of the plastic are completely covered by the rubber bands which are applied each overlapping the previous one, and ending on the ceramic tube.

When the ceramic tube is fixed a square of plastic sheet, held in place with rubber bands, is used to seal the tube. The restraining rubber band, previously attached to prevent escape of air when the exit ceramic tube was inserted, is now removed. The bag will appear to deflate a little as air enters the final section previously closed by the rubber band. The final step in completely filling the bag with air is done by attaching a length (4m) of plastic tube (same material as used for the biodigester) to the ceramic exit pipe, filling this with air by the flapping procedure, and then removing the plastic sheet to allow this air to enter the main

bag. The process can be repeated until the biodigester bag is completely full with air. The square of plastic, held in place with a rubber band, is again put in place to seal the exit pipe. The inflated tube is then carried to the trench taking care that it does not come in contact with any object which might puncture it.

It is lowered into the trench in such a way that the gas outlet is at the top of the tube.

A support is prepared to hold the gas exit line

The gas line (13mm internal diameter PVC tube) is secured using PVC cement.

The bag is filled with water until the inlet and outlet pipes are sealed (covered with water) from the inside. The air inside the bag is now trapped in the upper part. Filling with water is suspended and the plastic bags over the exit and entry pipes can be removed.



Photo 31. Placing the outlet pipe

(following the same procedure as for the **Photo 32.** Attaching a plastic tube of 3 m length inlet pipe)



Photo 33. Tying the 3 m length of plastic tube to the exit pipe **Photo 34.** Pumping air (look at the position of the hands)



Photo 35. Untying the plastic bag



Photo 36. Forcing the air from the 3m tube to the main tube



Photo 37. Forcing the air into the main tube until it is full



Photo 38. The biodigester is full of air



Photo 39. Carrying the biodigester



Photo 40. Placing the digester in the trench



Photo 41. Connecting the PVC pipe to the gas outlet



Photo 42. A support is prepared to hold the gas exit line



Photo 43. Connecting a plastic hose (or rigid PVC tube) to the PVC gas outlet



Photo 44. Adding water when a pump is available

The water trap (gas escape valve)

A "T" is prepared from three pieces of PVC pipe, two short pieces and a longer one which will fit into a "used" plastic bottle.

A 3*3cm hole is cut in the upper part of the bottle, just below the neck, through which water will be added to form the gas seal.

Small holes are made either side of the neck to take a length of thin wire which will be used to attach the bottle to some support structure.

The PVC "T" is inserted in the bottle and water is added to a depth of 4-5 cm above the lower point of the "T"

Small holes are punched into the sides of the bottle at a point 2 cm above the lower end of the "T". This ensures that if the gas pressure inside the system exceeds 2cm water column the gas can escape to relieve the pressure.

The "water trap" is now suspended in a convenient place so that the water level can be easily observed and replenished when necessary

A flexible plastic pipe is attached to the gas outlet and joined to one arm of the "T". The other arm links with another plastic pipe which goes to the kitchen.



Photo 45. Materials to prepare the trap (PVC "T" and PVC pipe, old plastic bottle, knife and water)



Photo 46. Cutting a hole to add the water



Photo 47. The PVC pipe is inserted into the bottle and a little hole is made to fix the water level



Photo 48. Connecting a plastic hose to the PVC pipe of the gas outlet



Photo 49. Suspending the water trap



Photo 50. Joining the other end of the PVC "T" to the plastic hose that goes to the reservoir bag

The gas reservoir

This is a large plastic bag (4m length) of the same polyethylene tube used for the biodigester.

One end is closed using rubber bands from "used" car or motor cycle inner tubes.

A "T" made from rigid PVC pipe is fitted at the other end.

The reservoir is then located in a convenient place (for example, suspended in the roof space of the pig pen) close to the kitchen.

The arms of the "T" are connected to the gas line; the inlet to the biodigester and the outlet to the stove in the kitchen.



Photo 51. Closing one end of the 3m plastic tube



Photo 52. Fastening the closed end of the plastic tube with a rubber band



Photo 53. One end of the tube is closed



Photo 54. Placing the PVC "T" at the other end of the 3m plastic tube (one of the end of the "T" is joined to the hose coming from the digester and the other to the stove)



Photo 55. Tying with rubber band



Photo 56. Finishing wrapping the rubber band to ensure the connection is gas-tight



Photo 57. The finished reservoir bag



Photo 58. Suspending the reservoir bag in the roof space



Photo 59. The reservoir bag full of biogas

Taking the gas to the kitchen

With the reservoir in place, the gas line attached to the outlet arm of the "T" is fixed to the burners.

A strap is placed around the middle section of the reservoir. By pulling on the strap, and tying it to some fixed object or hanging a heavy stone or a brick, the pressure of the gas delivered to the burners can be increased. This is usually necessary when cooking proceeds over an extended period of time.

The time that elapses before gas is produced depends on the composition and quantity of the manure that is put into the biodigester. In certain farm households the washings from the pig pens may already be in an advanced state of fermentation when they are introduced into the biodigester. The farm family would thus be able to begin cooking with biogas only 5 days after the installation. With fresh unfermented manure the time lag is between 21 and 28 days.



Photo 60. Connecting the reservoir bag to the stove in the kitchen



Photo 61. Cooking with biogas



Photo 62. A string around the bag is used to increase the pressure

Photo 63. It is the women who benefit most from the installation of a biodigester

Linking the waste outlets of the pig pens with the biodigester

Channels are made with bricks and cement to link the waste outlets from the pig pens with the inlet of the biodigester.



Photo 64. A channel is made with bricks to lead the waste from the pig pen to the inlet of the biodigester



Photo 65. The channel is connected to the biodigester

The completed installation of the channels

With the channels in place the washing of the pens automatically forces the slurry into the biodigester



Photo 66. Channel completed

Photo 67. The finished installation

Protecting the digester



Photo 68. Fencing around the area where the biodigester is located

Photo 69. Roofing can protect the biodigester

The completed biodigester

What was once a polluted area is now dry soil.

There are no bad odours as twice daily the pig excreta is washed directly into the biodigester.

The farm family no longer need to buy liquid gas for cooking. The savings will help the cost of the biodigester in less than 12 months



Photo 70. Before placing the biodigester



Photo 71. After placing the digester



Photo 72. Before placing the biodigester

Photo 73. After placing the biodigester



Photo 74. The complete system

What to do if one day there is not gas to cook?

The biodigester needs maintenance. It has to be fed every day with manure and water. But if one day there is not enough gas to cook, you should check:

	Check	No	Yes	Cause	Solution
1.	Are there enough animals to supply manure for the biodigester?	X		The animals were sold The animals are very small	Join the toilet to your biodigester, the whole family can contribute to the gas production. Temporarily it is possible to add some readily fermentable materials such as cassava waste, damaged cassava roots, molasses or any similar carbohydrate source. If this

					done it is wise to also 30-40 g urea every day.
2.	Is it the water enough for the biodigester?	X			Add water
3.	Is there a smell of gas?		X	A loose connection. A damaged tap in the kitchen. A hole in the plastic.	Check all the connections, starting with the taps in the kitchen up to the gas outlet from the biodigester. Repair with sticking plaster or tape.
4.	Not enough gas is produced		X	A loose connection, a broken section of pipe or a pipe doubled over impeding the gas flow?	Cut a new piece of hose pipe to replace the damaged one.
5.	Is there enough water in the trap bottle?	X		Evaporation caused the water level to fall below the tip of the gas tube.	Check it periodically and add water
6.	Can you see a lot of gas in the biodigester but nothing or very little in the reservoir bag?		X	Water on the pipe gas line.	Check it frequently. There are two ways to solve the problem: 1. Open the joins and take out the water as it can be accumulated. 2. Make a hole in the PVC pipe, take the water out and stick it again with tape 3. Fit drain taps at the lowest points in the line.
7.	Do you want to cook faster?		X	Not enough pressure inside the reservoir.	Tighten the string around the reservoir.
8.	In the morning you find the reservoir bag with little gas?		X	You forgot to loosen the string around the reservoir after finishing cooking the night before.	Place the reservoir bag in the ceiling of the kitchen or in a place close by to facilitate the control of it. Check the reservoir bag after finishing the activities in the kitchen.
9	The biodigester has a hole through both layers?		X	An animal fell down	If the hole is not large it can be sealed by inserting another male and female adapter with washers big enough to cover the hole, and sealing the exit of the adapter. If the hole is large, replace the plastic tubes and reinstall the system.

					Protect the digester with a fence
10.	Can you see that the first layer of plastic is broken?		X	Crystallization of the plastic that does not have contact with water	Try to set the digester in such was that most of the plastic surface is in contact with the water. It means that the inlet and outlet pipes are high enough to keep the bag almost full but of course leaving enough space for the gas to flow to the gas outlet. The solution is NOT to put 3 or 4 layers of plastic
11.	Is there a lot of soil in the trench of the biodigester?		X	Usually it is more serious problem. It can happen when the biodigester is placed on very sandy soil or on low land so that the rain washes a lot of soil into the trench.	Avoid this by choosing a good place to set the digester. Make channels to lead away the rain water. Cover the upper walls of the trench with bricks or with a mixture of cement and soil. Make a wall in front of the biodigester inlet.
12.	Is the slurry inside the biodigester very hard?		X		It can be caused by # 11 or by too high a content of manure in the input slurry. It is more of a problem when cattle manure is used. Experience with the plastic biodigesters indicates that the plastic has to be changed after about 2 to 4 years mainly because of this problem.



Photo 75. In Cambodia the latrine is always linked to the plastic biodigester



Photo 76. Hose pipe bent down (#4)
Cut the damaged hose and join it
again



Photo 77. Adding water to the trap (#
5)



Photo 78. Accumulation of water.
Open the joins and take out the water
as it can be accumulated (# 6-1)



Photo 79. Make a hole in the PVC pipe, take the water out and stick it again with tape or a rubber band (# 6-2)



Photo 80. Increasing the pressure in the reservoir bag. (# 7)



Photo 81. The outer plastic layer damaged (after 3 years..!). The inner one is still gas-tight.

Replacing the digester



Photo 82. Cutting the plastic to take out the contents



Photo 83. Hard layer of manure due to accumulation of soil in the trench and time (3 years). The plastic was in good condition



Photo 84. After removing all the content of the digester



Photo 85. Pulling the plastic to one side of the trench



Photo 86. Taking out the gas outlet to be reused

Photo 87. taking out the rubber bands and inlet and outlet pipes to be reused



Photo 88. Starting to fix the trench

And try to fix the previous mistakes



Photo 89. A small wall of brick to avoid the soil entering and rain water entering the biogas digester.



Photo 90. A mixture of soil and cement to cover the upper part of the walls of the trench



Photo 91. Make a system to capture the sand in the inlet box



Photo 92. Make a system so the rain water is led away.

Uses of biogas in different systems

At the family level the main use of the biogas is for cooking (#93-94). Because of the low pressure (less than 3 cm water column) it is not possible to use the gas for lighting

In the ecological farm of UTA (many animals and ten biodigesters) there is enough biogas to supply the laboratory (#95-96)

The "Pozo Verde" farm in Jamundi, Cauca Valley, Colombia, there are 100 sows (1,000 pigs in total), 100 Crossbred (Holstein*Zebu) cattle and 20 buffaloes. The two biodigesters each have a liquid volume of 100 m³ (#97). There is enough gas to power a diesel generator in dual mode (#98) and to heat 20 "creep" areas of the piglets. The heater for the piglets is an inverted plough disc with a "U" tube underneath where the gas is burned (#99).



Photo 93. Reservoir bag placed vertically in the kitchen in Cambodia



Photo 94. In the small-holder farm the gas is enough to cook for the whole family and when there is a large population of livestock it will be enough to cook for the pigs also (Vietnamese tradition)



Photo 95. Reservoir bags storing biogas in the the laboratory of UTA



Photo 96. Using the biogas to digest samples for Nitrogen analysis



Photo 97. The use of plastic biodigesters to recycle the manure from a unit with 100 sows (1000 pigs in total) in Pozo Verde farm, Jamundi, Colombia

Photo 98. A large reservoir bag provides biogas for a diesel generator in the integrated farm of Pozo Verde, Colombia



Photo 99. The use of biogas to heat the piglets in Pozo Verde farm, Jamundi, Colombia

Photos by Lylian Rodríguez

References

Anthony W B 1971 Feeding value of cattle manure for cattle. Journal Animal Science. 30:274

Botero R and Preston T R 1986 Low-cost biodigester for production of fuel and fertilizer from manure (spanish). Mimeograph. CIPAV, Cali, Colombia, pp1-20.

Bui Xuan An, Ngo an Man, Duong Nguyen Khang, Nguyen Duc Anh and Preston T R 1994 Installation and performance of low-cost polyethylene tube biodigesters on small-scale farms in Vietnam. In: Proceedings of National Seminar- workshop "Sustainable Livestock Production On Local Feed Resources" (Editors: T R Preston, Le Viet Ly, Luu Trong Hieu and Brian Ogle) Ho Chi Minh City, November 22 - 27, 1993 pp: 81-90

Bui Xuan An and Preston T R 1995 Low-cost polyethylene tube biodigesters on small scale farms in Vietnam. Electronic Proceedings 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p. 11.

Bui Xuan An, Preston T R and Dolberg F 1997 The introduction of low-cost polyethylene tube biodigesters on small scale farms in Vietnam. Livestock Research for Rural Development (9) 2: <http://www.cipav.org.co/lrrd/lrrd9/2/an92>

Bui Xuan An, Rodriguez Lylian, Sarwatt S V, Preston T R and Dolberg F 1997 Installation and performance of low-cost polyethylene tube biodigesters on small-scale farms. World Animal Review (88) 1:38-47

Chater S 1986 New biogas digester for African small holders. ILCA Newsletter 1986, 5:4.

Dolberg F 1993 Transfer of sustainable technologies in Vietnam. Development of Sustainable Livestock Technologies for Ecologically Fragile Zones in The Tropics. SIDA MSc course in sustainable livestock production systems. Report.

Khan S R 1996 Low cost biodigesters. Programme for Research on Poverty Alleviation, Grameen Trust Report, Feb-1996.

Marchaim U 1992 Biogas processes for sustainable development. FAO Agricultural Services Bulletin 95 pp: 232

Muller Z 1980 Feed from animal wastes: state of knowledge. FAO Animal Production and Health Paper. No. 18. FAO; Rome

Nystrom Maria 1988 Kitchen and stove: the selection of technology and design. Lund University, Sweden pp: 136

Pound B, Bordas F and Preston T R 1981 Characteristics of production and function of a 15 cubic metre Red-Mud PVC biogas digester. Tropical Animal Production 6:146-153
(<http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/FRG/Welcme.htm>)

Rodríguez Lylian, Preston T R and Dolberg F 1996 Participatory Rural Development: "Experiences in Binh Dien and Xuan Loc villages in Central Vietnam". Livestock Research for Rural Development Volume 8, Number 2: 1-39

Sarwatt S V, Lekule F P and Preston T R 1995 Biodigesters as means for introducing appropriate technologies to poor farmers in Tanzania. Electronic Proceedings. 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p.6.

Soeum Than 1994 Low cost biodigesters in Cambodia. In: Proceedings of National Seminar-workshop "Sustainable Livestock Production On Local Feed Resources" (Editors: T R Preston, Le Viet Ly, Luu Trong Hieu and Brian Ogle) Ho Chi Minh City, November 22 - 27, 1993 pp: 81-90

Solarte A 1995 Sustainable livestock systems based on local resources: CIPAVs experiences. Electronic Proc. 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p.2

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Biodigester installation manual

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Follow the links

Introduction **Fout! Bladwijzer niet gedefinieerd.**

Pollution

Deciding on the location of the biodigester and excavating the soil to make the trench **Fout!**

Bladwijzer niet gedefinieerd.

Preparing the plastic tube

Materials required for the biodigester **Fout! Bladwijzer niet gedefinieerd.**

Introduction

Biodigesters can play a pivotal role in integrated farming systems by reducing health risks, facilitating control of pollution and at the same time adding value to livestock excreta through production of biogas and improved nutrient status of the effluent as fertilizer for ponds and crop land. Energy is also a fundamental factor for economic development, but normally the energetic models are based on "non-renewable" resources. In addition to energy sources from humans and work animals there are many kinds of renewable energy such as: hydraulic energy, wind energy, solar radiation or biomass (through pyrolysis and gasification). During the course of this century the world energy consumption per inhabitant has increased sixteen-fold. Today the industrial countries, with 32% of the world population, consume 82% of the planet's energy. On average, a person from an industrialized country consumes 20 times more energy than a person in Africa. It is clear that the "economic development model" is what drives energy consumption.

In many developing countries there is a serious shortage of fuel and the energy crisis is a daily reality for most families. Cooking is one of the most energy-consuming activities, yet is often inefficient. The open fire is still very common. Today the devastation of forests in developing countries is frequently mentioned in the mass media. Deforestation has many causes. Poor people are migrating and inhabiting, cultivating and using new forest areas. In some cases they use "slash and burn" methods and this is another factor rapidly depleting

the forests. War has been another important cause of deforestation. However, the daily consumption of fuel must not be underestimated when considering causes of deforestation. It is not unusual for a family to have to spend the greater part of their day gathering fuel for their home. At times dozens of kilometres need to be covered to find fuel (Nystrom 1988). Many developing countries, such as Colombia, Ethiopia, Tanzania, Vietnam, Cambodia, have promoted the low-cost biodigester technology aiming at reducing the production cost by using local materials and simplifying installation and operation (Botero and Preston 1987; Solarte 1995; Chater 1986; Sarwatt et al 1995; Soeurn 1994; Khan 1996). The model used was a continuous-flow flexible tube biodigester based on the "red mud PVC" (Taiwan) bag design as described by Pound et al (1981) and later simplified by Preston and co-workers first in Ethiopia (Preston unpubl.), Colombia (Botero and Preston 1987) and later in Vietnam (Bui Xuan An et al 1994). More than 7000 polyethylene biodigesters have been installed in Vietnam, mainly paid for by farmers (Bui Xuan An and Preston 1995).

There are many designs of biogas plants which are available but the most common are the floating canopy (Indian) and fixed dome (Chinese) models. The poor acceptability of many of these digesters has been due mainly to: (a) high cost of the digesters; (b) difficulty in installing them; and (c) difficulty in procuring spare parts for replacement as these are not always locally available. The polyethylene tubular biodigester technology is a cheap and simple way to produce gas for small-scale farmers. It is appealing to rural people because of the low cost of the installation and therefore of the gas, and the improvement in the environment that the installation allows. It can be applied in rural or urban areas, both in low and hilly lands.

Pollution

The deterioration of soil fertility through loss of nutrients and organic matter, erosion and salinity, and the pollution of the environment - of air, soil and water - are negative consequences of modern agricultural practices in the industrialized countries where the divorce of livestock and crop production has become the norm. Traditionally, livestock were a balanced - indeed an essential - component of farming systems but the development of the chemical industry in the 19th century, and the major impetus it received from the discovery of oil, created opportunities for the low-cost supply of plant nutrients in inorganic form and led to the rapid displacement of organic manures derived from livestock excreta.

The increasing global awareness that resources are finite, and that the livelihood of future generations depends upon the maintenance of renewable natural resources, is now a major stimulus for initiatives that will lead to the more efficient use of these same resources. In industry, recycling of processed raw materials at the end of their useful life is now seen as a means of lowering costs of production and reducing the pollution caused by accumulation of these materials in the environment.

The accumulation of livestock excreta, chiefly from poultry kept in deep litter, was seen as an opportunity to recycle this material as a feed for ruminant livestock (Muller 1980), and there were even attempts to do likewise with the excreta from intensively-fed pigs (Buitrago J, personal communication) and cattle (Anthony 1971). However, in all these cases the nutritional value of the manure was mainly a reflection of the spillage of feed which is almost inevitable when intensive systems of self-feeding are practiced. The high risk of disease from recycling wastes through livestock, highlighted by the recent outbreaks of BSE, is now seen as a major deterrent to these practices.

The process of fermentation in biodigesters results in transformation of organically bound carbon into gaseous carbon dioxide and methane. The anaerobic environment and extended retention time also inhibit the growth of most pathogenic organisms and prevent the survival of intestinal parasites. It is therefore to be expected that both the chemical and biological parameters of livestock excreta will be improved by passage through biodigesters



Photo 1. Washing the pig pen



Photo 2. The waste water running out of the pen



Photo 3. Pollution



Photo 4. Production of methane (and pollution of the air)

Deciding on the location of the biodigester and excavating the soil to make the trench

The first step in installing the biodigester is to identify the most appropriate location. In general this should be close to the source of the livestock pen where the waste is produced. It is a distinct advantage if the washings from the pen pass by gravity directly to the inlet of the biodigester. It is relatively easy to transport the gas by pipeline but difficult and tedious to do this with liquid wastes.

Once the site is selected the next step is to determine the size of the biodigester. As a general rule the excreta produced by 10 fattening pigs will require a biodigester of 4 m³ liquid capacity. The standard diameters of polyethylene tubular film are 80, 125 and 200 cm. For a small number of animals, it is advisable to use a diameter of 80cm which gives a cross-section area of

$$0.4*0.4*\pi=0.50\text{m}^2$$

On average 80% of the total volume in the tube corresponds to the liquid fraction, thus to provide a liquid volume of 4 m³ will require a biodigester with a length of:

$$4/0.80/0.5=10\text{m}$$

The recommended dimensions of the trench which will hold a biodigester of the above dimensions are:

Width at the top 90cm; depth 90cm; width at the bottom 70cm; length 10m.

Having decided on the size of the biodigester the upper extremities of the trench should be defined by a string attached to four posts

When digging the trench it is important to observe the following:

- The sides and the floor should be smooth with no protruding stones or roots which could damage the plastic film
- The floor should have a slope of about 2.5% from the inlet to the exit (this would be 25cm for a biodigester of 10m length)
- The soil that is excavated should be moved away from the edges of the trench so that movement around the biodigester during or after installation, or subsequent heavy rains, do not cause soil to fall onto the plastic



Photo 5. Excavating the soil

Preparing the plastic tube

The polyethylene comes from the factory in rolls which weigh about 50 kg. If the diameter is 80cm then the length of the roll will be about 100m (the weight of 1m is about 0.5kg). The rolls should be protected, especially the edges, and should be stored and manipulated in a horizontal position. Putting a steel rod (or bamboo pole) through the centre of the roll facilitates the extraction of the required length of tube. If the biodigester trench is 10m long then an additional 75cm should be added to each end of the plastic tube to allow for wrapping the ends over the inlet pipes. Thus the length to be cut will be 11.5m.

Two lengths are required as one will be put inside the other to give added strength. When the second length of tube is inserted inside the first length, care should be taken to ensure that the two films fit snugly together and there are no folds or creases.



Photo 6. Putting a steel rod (or bamboo pole) through the centre of the roll facilitates the extraction of the required length of tube



Photo 7. Cutting the second piece of plastic



Photo 8. Bundling one plastic tube in preparation for putting it inside the other

Photo 9. Starting to put one plastic tube inside the other to give added strength



Photo 10. Putting one plastic inside the other to give added strength

Materials required for the biodigester

- Transparent polyethylene tubular film, the diameter of which varies according to the capacities of the machines installed in the factories, but is usually in the range of 80 to 200cm (equivalent to a circumference of 2.5 to 6.3m). The calibre (thickness) should be in the range of 800 to 1,000 (200 to 250 microns). The length of the tube is determined by the size of the biodigester. The most appropriate material is that which is used for greenhouses as this

usually contains an ultraviolet (UV) filter which helps to prolong the life of the plastic when fully exposed to the sun (see Photo 69).

- 2 ceramic tubes of 75 to 100cm length and 15cm internal diameter.
- Plastic (PVC) hosepipe of 12.5mm internal diameter (the length depends on the distance to the kitchen).
- 2 PVC adapters (male and female) of 12.5mm internal diameter.
- 2 rubber washers (from car inner tube) of 7cm diameter and 1mm thickness with a 12.5 mm diameter central hole.
- 2 rigid plastic (perspex) washers of 10 cm diameter and a central hole of 12.5mm. Although perspex is best, these washers can be cut from different sources such as old plastic buckets and other materials made from strong plastic.
- 2 m of PVC pipe of 12.5mm internal diameter.
- 4 used inner tubes (from bicycle, motor cycle or motor car) cut into bands 5 cm wide.
- 1 transparent plastic bottle.
- 1 PVC elbow of 12.5mm internal diameter..
- 3 PVC "T" pieces of 12.5mm internal diameter.
- 1 tube of PVC cement.



Photo 11. Materials for installing a plastic biodigester

Fixing the gas outlet

The components of the gas outlet and the order in which they are placed in the plastic tube are indicated below

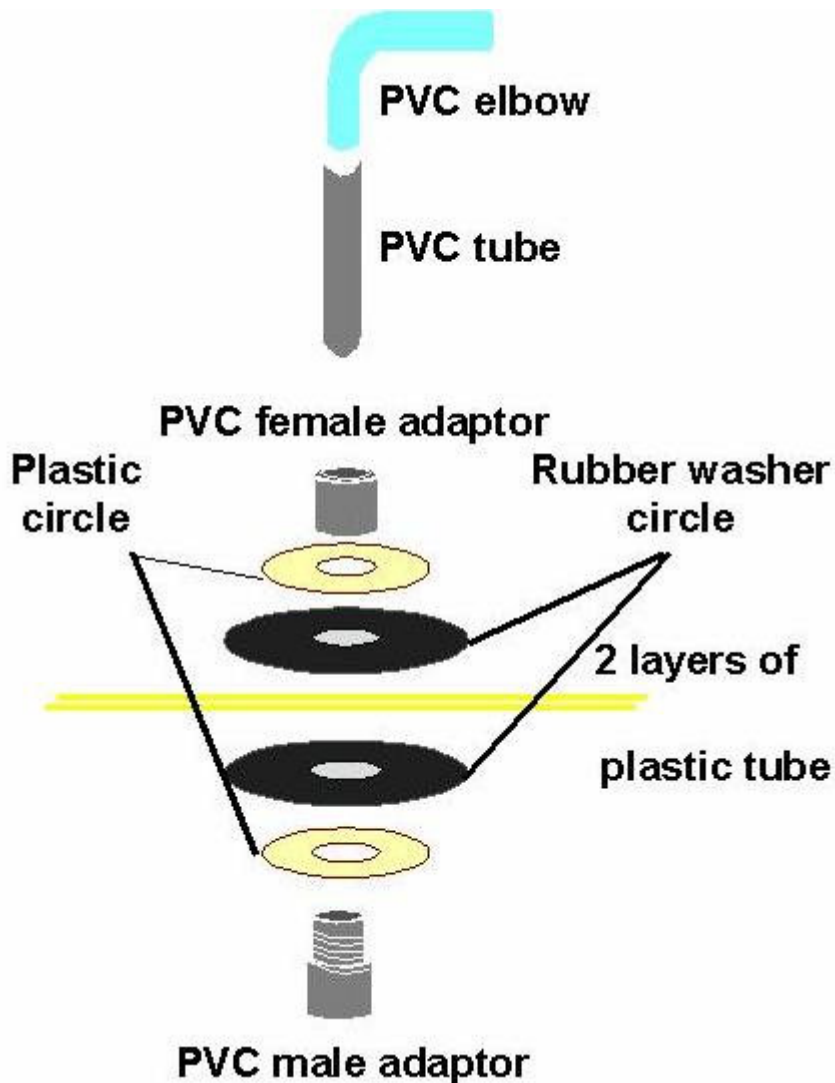


Figure 1. Materials for the gas outlet and the order of assembling them

The first step is to mark the place where the gas outlet will be placed. This should be 1.5m from the end of the plastic tube and in the centre of what will be the top of the biodigester.

The size of the hole is determined by the external diameter of the PVC male adapter.

The rubber washer circles are cut from a length of "used" motor cycle or car inner tube, using the plastic (Perspex) circles as a guide.

The components are then assembled to ensure the male and female adapters fit together smoothly.

The male adapter, complete with plastic circle and above this the rubber circle, is inserted from within the plastic tube. The female adapter, with the rubber and plastic circles attached, is screwed tightly on the protruding male adapter.

The installation of the gas outlet is now complete.



Photo 12. Measuring the distance



Photo 13. Marking the place to cut the plastic



Photo 14. Holding the plastic



Photo 15. Cutting the plastic



Photo 16. Preparing the materials for the gas outlet



Photo 17. Tightening the gas outlet (without using glue)

Fixing the inlet pipe

Rubber bands 5cm wide are cut from "used" inner tubes (from bicycle, motor cycle or motor car).

A polypropylene sack (or one of similar material) is placed on the ground below the work area to avoid damage to the plastic tube.

The ceramic pipe is inserted to one half of its length in the interior of the plastic tube and the plastic tube is folded around it. The join is secured by wrapping the rubber bands around the pipe beginning 25 cm from the edge of the plastic and working towards the exposed part of the ceramic pipe, each band overlapping the previous one, and finishing on the ceramic pipe so that the edges of the plastic tube are completely covered.



Photo 18. Placing the pipe



Photo 19. Starting to fold up the plastic in the middle



Photo 20. Finishing one side



Photo 21. Ready to tie



Photo 22. Cutting the rubber bands

Photo 23. Wrapping the rubber bands around plastic tube where it overlaps the pipe



Photo 24. Completing the wrapping of the plastic over the inlet pipe

Filling the plastic tube with air

The inlet tube is closed with a square of plastic film (or a plastic bag) and a rubber band. The exit of the female adapter is closed with a small square of plastic film and a rubber band.

The polyethylene tube is filled with air before being located in the trench. From the open end, air is forced into the tube in waves formed by flapping the end of the tube in a forward propelling movement of the arms. The tube is then tied with a rubber band about 3m from the end so that the air does not escape. This is to facilitate fitting the exit ceramic tube which is put in place using the same procedure as for the inlet pipe.



Photo 25. Covering the entrance of the inlet pipe with a plastic bag



Photo 26. Covering the gas outlet with a plastic bag



Photo 27. Holding the plastic



Photo 28. Pumping air



Photo 29. Pumping air until the tube is full



Photo 30. Tying the tube but leaving enough plastic to insert the outlet pipe

Final stages in preparing the plastic tube

The second ceramic pipe is fitted to the exit of the plastic tube using the same procedure as for the inlet.

It is very important that the edges of the plastic are completely covered by the rubber bands which are applied each overlapping the previous one, and ending on the ceramic tube.

When the ceramic tube is fixed a square of plastic sheet, held in place with rubber bands, is used to seal the tube. The restraining rubber band, previously attached to prevent escape of air when the exit ceramic tube was inserted, is now removed. The bag will appear to deflate a little as air enters the final section previously closed by the rubber band. The final step in completely filling the bag with air is done by attaching a length (4m) of plastic tube (same material as used for the biodigester) to the ceramic exit pipe, filling this with air by the flapping procedure, and then removing the plastic sheet to allow this air to enter the main

bag. The process can be repeated until the biodigester bag is completely full with air. The square of plastic, held in place with a rubber band, is again put in place to seal the exit pipe. The inflated tube is then carried to the trench taking care that it does not come in contact with any object which might puncture it.

It is lowered into the trench in such a way that the gas outlet is at the top of the tube.

A support is prepared to hold the gas exit line

The gas line (13mm internal diameter PVC tube) is secured using PVC cement.

The bag is filled with water until the inlet and outlet pipes are sealed (covered with water) from the inside. The air inside the bag is now trapped in the upper part. Filling with water is suspended and the plastic bags over the exit and entry pipes can be removed.



Photo 31. Placing the outlet pipe

(following the same procedure as for the **Photo 32.** Attaching a plastic tube of 3 m length inlet pipe)



Photo 33. Tying the 3 m length of plastic **Photo 34.** Pumping air (look at the position of the tube to the exit pipe hands)



Photo 35. Untying the plastic bag



Photo 36. Forcing the air from the 3m tube to the main tube



Photo 37. Forcing the air into the main tube until it is full



Photo 38. The biodigester is full of air



Photo 39. Carrying the biodigester



Photo 40. Placing the digester in the trench



Photo 41. Connecting the PVC pipe to the gas outlet



Photo 42. A support is prepared to hold the gas exit line



Photo 43. Connecting a plastic hose (or rigid PVC tube) to the PVC gas outlet



Photo 44. Adding water when a pump is available

The water trap (gas escape valve)

A "T" is prepared from three pieces of PVC pipe, two short pieces and a longer one which will fit into a "used" plastic bottle.

A 3*3cm hole is cut in the upper part of the bottle, just below the neck, through which water will be added to form the gas seal.

Small holes are made either side of the neck to take a length of thin wire which will be used to attach the bottle to some support structure.

The PVC "T" is inserted in the bottle and water is added to a depth of 4-5 cm above the lower point of the "T"

Small holes are punched into the sides of the bottle at a point 2 cm above the lower end of the "T". This ensures that if the gas pressure inside the system exceeds 2cm water column the gas can escape to relieve the pressure.

The "water trap" is now suspended in a convenient place so that the water level can be easily observed and replenished when necessary

A flexible plastic pipe is attached to the gas outlet and joined to one arm of the "T". The other arm links with another plastic pipe which goes to the kitchen.



Photo 45. Materials to prepare the trap (PVC "T" and PVC pipe, old plastic bottle, knife and water)



Photo 46. Cutting a hole to add the water



Photo 47. The PVC pipe is inserted into the bottle and a little hole is made to fix the water level



Photo 48. Connecting a plastic hose to the PVC pipe of the gas outlet



Photo 49. Suspending the water trap



Photo 50. Joining the other end of the PVC "T" to the plastic hose that goes to the reservoir bag

The gas reservoir

This is a large plastic bag (4m length) of the same polyethylene tube used for the biodigester.

One end is closed using rubber bands from "used" car or motor cycle inner tubes.

A "T" made from rigid PVC pipe is fitted at the other end.

The reservoir is then located in a convenient place (for example, suspended in the roof space of the pig pen) close to the kitchen.

The arms of the "T" are connected to the gas line; the inlet to the biodigester and the outlet to the stove in the kitchen.



Photo 51. Closing one end of the 3m plastic tube



Photo 52. Fastening the closed end of the plastic tube with a rubber band



Photo 53. One end of the tube is closed



Photo 54. Placing the PVC "T" at the other end of the 3m plastic tube (one of the end of the "T" is joined to the hose coming from the digester and the other to the stove)



Photo 55. Tying with rubber band



Photo 56. Finishing wrapping the rubber band to ensure the connection is gas-tight



Photo 57. The finished reservoir bag



Photo 58. Suspending the reservoir bag in the roof space



Photo 59. The reservoir bag full of biogas

Taking the gas to the kitchen

With the reservoir in place, the gas line attached to the outlet arm of the "T" is fixed to the burners.

A strap is placed around the middle section of the reservoir. By pulling on the strap, and tying it to some fixed object or hanging a heavy stone or a brick, the pressure of the gas delivered to the burners can be increased. This is usually necessary when cooking proceeds over an extended period of time.

The time that elapses before gas is produced depends on the composition and quantity of the manure that is put into the biodigester. In certain farm households the washings from the pig pens may already be in an advanced state of fermentation when they are introduced into the biodigester. The farm family would thus be able to begin cooking with biogas only 5 days after the installation. With fresh unfermented manure the time lag is between 21 and 28 days.



Photo 60. Connecting the reservoir bag to the stove in the kitchen



Photo 61. Cooking with biogas



Photo 62. A string around the bag is used to increase the pressure

Photo 63. It is the women who benefit most from the installation of a biodigester

Linking the waste outlets of the pig pens with the biodigester

Channels are made with bricks and cement to link the waste outlets from the pig pens with the inlet of the biodigester.



Photo 64. A channel is made with bricks to lead the waste from the pig pen to the inlet of the biodigester



Photo 65. The channel is connected to the biodigester

The completed installation of the channels

With the channels in place the washing of the pens automatically forces the slurry into the biodigester



Photo 66. Channel completed

Photo 67. The finished installation

Protecting the digester



Photo 68. Fencing around the area where the biodigester is located

Photo 69. Roofing can protect the biodigester

The completed biodigester

What was once a polluted area is now dry soil.

There are no bad odours as twice daily the pig excreta is washed directly into the biodigester.

The farm family no longer need to buy liquid gas for cooking. The savings will help the cost of the biodigester in less than 12 months



Photo 70. Before placing the biodigester



Photo 71. After placing the digester



Photo 72. Before placing the biodigester

Photo 73. After placing the biodigester



Photo 74. The complete system

What to do if one day there is not gas to cook?

The biodigester needs maintenance. It has to be fed every day with manure and water. But if one day there is not enough gas to cook, you should check:

	Check	No	Yes	Cause	Solution
1.	Are there enough animals to supply manure for the biodigester?	X		The animals were sold The animals are very small	Join the toilet to your biodigester, the whole family can contribute to the gas production. Temporarily it is possible to add some readily fermentable materials such as cassava waste, damaged cassava roots, molasses or any similar carbohydrate source. If this

					done it is wise to also 30-40 g urea every day.
2.	Is it the water enough for the biodigester?	X			Add water
3.	Is there a smell of gas?		X	A loose connection. A damaged tap in the kitchen. A hole in the plastic.	Check all the connections, starting with the taps in the kitchen up to the gas outlet from the biodigester. Repair with sticking plaster or tape.
4.	Not enough gas is produced		X	A loose connection, a broken section of pipe or a pipe doubled over impeding the gas flow?	Cut a new piece of hose pipe to replace the damaged one.
5.	Is there enough water in the trap bottle?	X		Evaporation caused the water level to fall below the tip of the gas tube.	Check it periodically and add water
6.	Can you see a lot of gas in the biodigester but nothing or very little in the reservoir bag?		X	Water on the pipe gas line.	Check it frequently. There are two ways to solve the problem: 1. Open the joins and take out the water as it can be accumulated. 2. Make a hole in the PVC pipe, take the water out and stick it again with tape 3. Fit drain taps at the lowest points in the line.
7.	Do you want to cook faster?		X	Not enough pressure inside the reservoir.	Tighten the string around the reservoir.
8.	In the morning you find the reservoir bag with little gas?		X	You forgot to loosen the string around the reservoir after finishing cooking the night before.	Place the reservoir bag in the ceiling of the kitchen or in a place close by to facilitate the control of it. Check the reservoir bag after finishing the activities in the kitchen.
9	The biodigester has a hole through both layers?		X	An animal fell down	If the hole is not large it can be sealed by inserting another male and female adapter with washers big enough to cover the hole, and sealing the exit of the adapter. If the hole is large, replace the plastic tubes and reinstall the system.

					Protect the digester with a fence
10.	Can you see that the first layer of plastic is broken?		X	Crystallization of the plastic that does not have contact with water	Try to set the digester in such was that most of the plastic surface is in contact with the water. It means that the inlet and outlet pipes are high enough to keep the bag almost full but of course leaving enough space for the gas to flow to the gas outlet. The solution is NOT to put 3 or 4 layers of plastic
11.	Is there a lot of soil in the trench of the biodigester?		X	Usually it is more serious problem. It can happen when the biodigester is placed on very sandy soil or on low land so that the rain washes a lot of soil into the trench.	Avoid this by choosing a good place to set the digester. Make channels to lead away the rain water. Cover the upper walls of the trench with bricks or with a mixture of cement and soil. Make a wall in front of the biodigester inlet.
12.	Is the slurry inside the biodigester very hard?		X		It can be caused by # 11 or by too high a content of manure in the input slurry. It is more of a problem when cattle manure is used. Experience with the plastic biodigesters indicates that the plastic has to be changed after about 2 to 4 years mainly because of this problem.



Photo 75. In Cambodia the latrine is always linked to the plastic biodigester



Photo 76. Hose pipe bent down (#4)
Cut the damaged hose and join it
again



Photo 77. Adding water to the trap (#
5)



Photo 78. Accumulation of water.
Open the joins and take out the water
as it can be accumulated (# 6-1)



Photo 79. Make a hole in the PVC pipe, take the water out and stick it again with tape or a rubber band (# 6-2)



Photo 80. Increasing the pressure in the reservoir bag. (# 7)



Photo 81. The outer plastic layer damaged (after 3 years..!). The inner one is still gas-tight.

Replacing the digester



Photo 82. Cutting the plastic to take out the contents



Photo 83. Hard layer of manure due to accumulation of soil in the trench and time (3 years). The plastic was in good condition



Photo 84. After removing all the content of the digester



Photo 85. Pulling the plastic to one side of the trench



Photo 86. Taking out the gas outlet to be reused

Photo 87. taking out the rubber bands and inlet and outlet pipes to be reused



Photo 88. Starting to fix the trench

And try to fix the previous mistakes



Photo 89. A small wall of brick to avoid the soil entering and rain water entering the biogas digester.



Photo 90. A mixture of soil and cement to cover the upper part of the walls of the trench



Photo 91. Make a system to capture the sand in the inlet box



Photo 92. Make a system so the rain water is led away.

Uses of biogas in different systems

At the family level the main use of the biogas is for cooking (#93-94). Because of the low pressure (less than 3 cm water column) it is not possible to use the gas for lighting

In the ecological farm of UTA (many animals and ten biodigesters) there is enough biogas to supply the laboratory (#95-96)

The "Pozo Verde" farm in Jamundi, Cauca Valley, Colombia, there are 100 sows (1,000 pigs in total), 100 Crossbred (Holstein*Zebu) cattle and 20 buffaloes. The two biodigesters each have a liquid volume of 100 m³ (#97). There is enough gas to power a diesel generator in dual mode (#98) and to heat 20 "creep" areas of the piglets. The heater for the piglets is an inverted plough disc with a "U" tube underneath where the gas is burned (#99).



Photo 93. Reservoir bag placed vertically in the kitchen in Cambodia



Photo 94. In the small-holder farm the gas is enough to cook for the whole family and when there is a large population of livestock it will be enough to cook for the pigs also (Vietnamese tradition)



Photo 95. Reservoir bags storing biogas in the the laboratory of UTA



Photo 96. Using the biogas to digest samples for Nitrogen analysis



Photo 97. The use of plastic biodigesters to recycle the manure from a unit with 100 sows (1000 pigs in total) in Pozo Verde farm, Jamundi, Colombia

Photo 98. A large reservoir bag provides biogas for a diesel generator in the integrated farm of Pozo Verde, Colombia



Photo 99. The use of biogas to heat the piglets in Pozo Verde farm, Jamundi, Colombia

Photos by Lylian Rodríguez

References

Anthony W B 1971 Feeding value of cattle manure for cattle. *Journal Animal Science*. 30:274

Botero R and Preston T R 1986 Low-cost biodigester for production of fuel and fertilizer from manure (spanish). Mimeograph. CIPAV, Cali, Colombia, pp1-20.

Bui Xuan An, Ngo an Man, Duong Nguyen Khang, Nguyen Duc Anh and Preston T R 1994 Installation and performance of low-cost polyethylene tube biodigesters on small-scale farms in Vietnam. In: *Proceedings of National Seminar- workshop "Sustainable Livestock Production On Local Feed Resources"* (Editors: T R Preston, Le Viet Ly, Luu Trong Hieu and Brian Ogle) Ho Chi Minh City, November 22 - 27, 1993 pp: 81-90

Bui Xuan An and Preston T R 1995 Low-cost polyethylene tube biodigesters on small scale farms in Vietnam. Electronic Proceedings 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p. 11.

Bui Xuan An, Preston T R and Dolberg F 1997 The introduction of low-cost polyethylene tube biodigesters on small scale farms in Vietnam. Livestock Research for Rural Development (9) 2: <http://www.cipav.org.co/lrrd/lrrd9/2/an92>

Bui Xuan An, Rodriguez Lylian, Sarwatt S V, Preston T R and Dolberg F 1997 Installation and performance of low-cost polyethylene tube biodigesters on small-scale farms. World Animal Review (88) 1:38-47

Chater S 1986 New biogas digester for African small holders. ILCA Newsletter 1986, 5:4.

Dolberg F 1993 Transfer of sustainable technologies in Vietnam. Development of Sustainable Livestock Technologies for Ecologically Fragile Zones in The Tropics. SIDA MSc course in sustainable livestock production systems. Report.

Khan S R 1996 Low cost biodigesters. Programme for Research on Poverty Alleviation, Grameen Trust Report, Feb-1996.

Marchaim U 1992 Biogas processes for sustainable development. FAO Agricultural Services Bulletin 95 pp: 232

Muller Z 1980 Feed from animal wastes: state of knowledge. FAO Animal Production and Health Paper. No. 18. FAO; Rome

Nystrom Maria 1988 Kitchen and stove: the selection of technology and design. Lund University, Sweden pp: 136

Pound B, Bordas F and Preston T R 1981 Characteristics of production and function of a 15 cubic metre Red-Mud PVC biogas digester. Tropical Animal Production 6:146-153
(<http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/FRG/Welcome.htm>)

Rodríguez Lylian, Preston T R and Dolberg F 1996 Participatory Rural Development: "Experiences in Binh Dien and Xuan Loc villages in Central Vietnam". Livestock Research for Rural Development Volume 8, Number 2: 1-39

Sarwatt S V, Lekule F P and Preston T R 1995 Biodigesters as means for introducing appropriate technologies to poor farmers in Tanzania. Electronic Proceedings. 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p.6.

Soeum Than 1994 Low cost biodigesters in Cambodia. In: Proceedings of National Seminar-workshop "Sustainable Livestock Production On Local Feed Resources" (Editors: T R Preston, Le Viet Ly, Luu Trong Hieu and Brian Ogle) Ho Chi Minh City, November 22 - 27, 1993 pp: 81-90

Solarte A 1995 Sustainable livestock systems based on local resources: CIPAVs experiences. Electronic Proc. 2nd Intl. Conference on Increasing Animal Production with Local Resources, Zhanjiang, China, p.2

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