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what it is
how it is made
how to use it

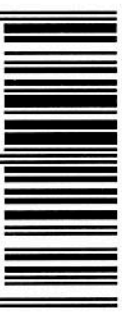
Biogas 2

building a better
biogas unit



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Food and Agriculture Organization of the United Nations
Better Farming Series

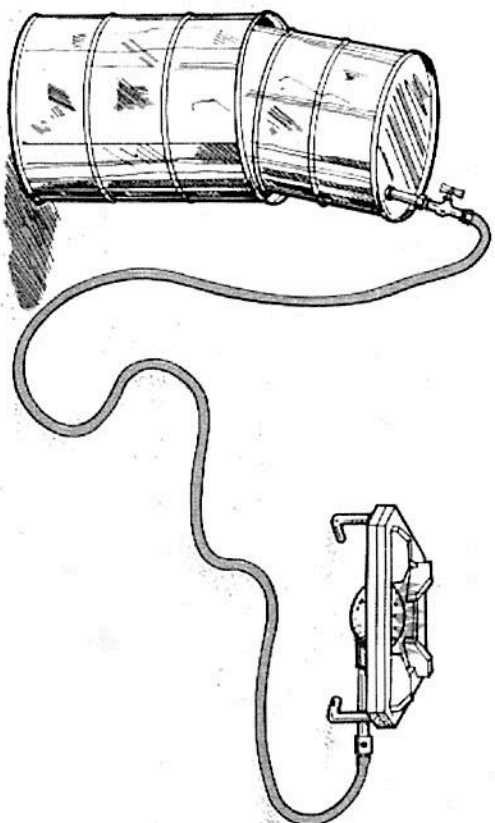
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biogas

what it is
how it is made
how to use it



Biogas

**What it is
How it is made
How to use it**

PREFACE

The first twenty-six volumes in FAO's Better Farming Series were based on the *Cours d'apprentissage agricole* prepared in the Ivory Coast by the *Institut africain de développement économique et social* for use by extension workers. Later volumes, beginning with No. 27, have been prepared by FAO for use in agricultural development at the farm and family level. The approach has deliberately been a general one, the intention being to constitute basic prototype outlines to be modified or expanded in each area according to local conditions of agriculture.

Many of the booklets deal with specific crops and techniques, while others are intended to give the farmer more general information which can help him to understand *why* he does what he does, so that he will be able to do it better.

Adaptations of the series, or of individual volumes in it, have been published in Amharic, Arabic, Bengali, Creole, Hindi, Igala, Indonesian, Kiswahili, Malagasy, Siswati and Turkish, an indication of the success and usefulness of this series.

Requests for permission to issue this manual in other languages and to adapt it according to local climatic and ecological conditions are welcomed. They should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

Translated, modified, printed and made available on the Internet and elsewhere by the People of Africa Biogas Centre. This document may be photocopied and distributed for the purposes of instruction, education and the assistance of the many who need better and clean energy.

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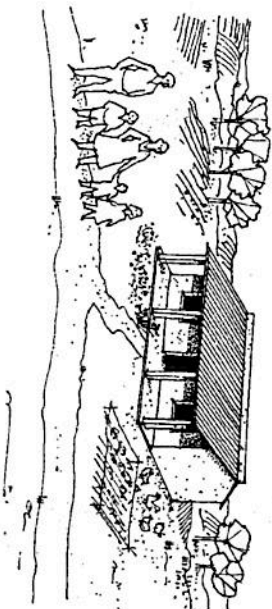
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OUTLINE OF COURSE

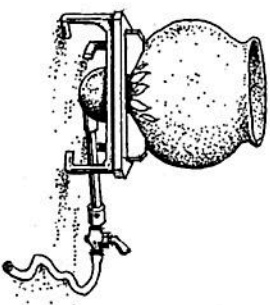
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INTRODUCTION

1. Farmers and their families always look for ways to make their lives better.



2. One way farm families can make their lives better is to make their own fuel gas which they can use for cooking.



3. Today many farmers are making fuel gas at home. They make it from animal manure or from plant materials or from a mixture of both.
4. Fuel gas made in this way has a lot of methane in it. Methane burns very well.

- Where you live methane gas may be called by a different name. One of the most common names for this kind of gas, when it is made at home, is **biogas**. We will use the name **biogas** in this booklet.

Biogas

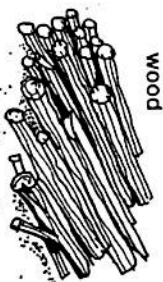
- If you make your own biogas you will not have to use so much of the more expensive fuels such as kerosene and charcoal or firewood, which may be hard to find where you live.



kerosene



charcoal



wood

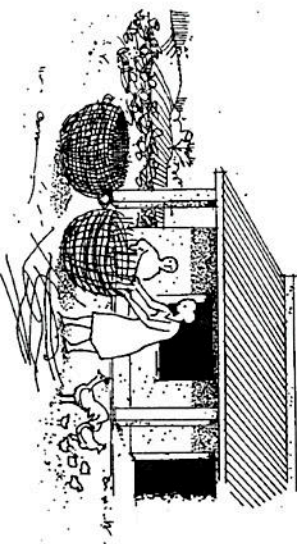
- Using biogas can help you to save time and work when you cook your meals.

4

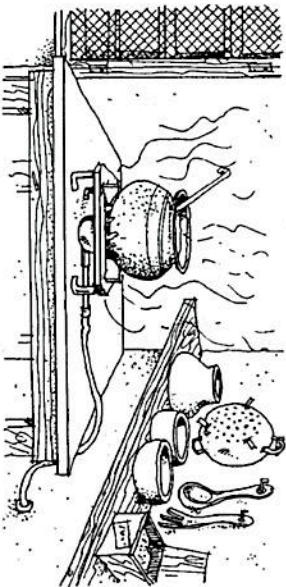
- You can use the time you save to do other things around your home and farm, such as care for a bigger garden



or work at a money-making home craft.

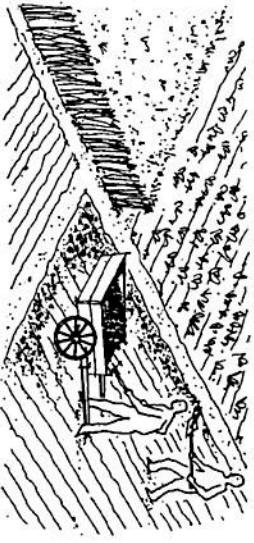


- Biogas is a clean-burning fuel. It does not give off smoke as does charcoal or firewood. By using biogas for cooking you can keep your cooking area and your food cleaner.



5

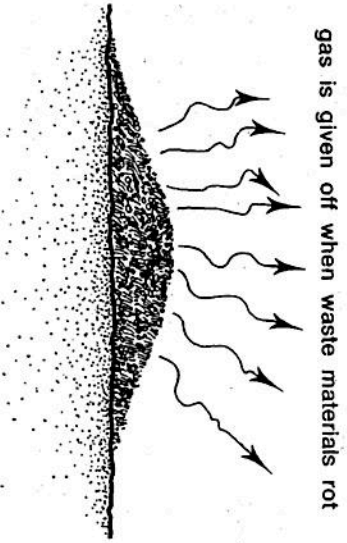
10. After all gas has been made the material that is left is a very rich fertilizer that you can use on your fields.



11. This booklet was written to help you to learn some of the things that you need to know before you begin to make biogas. You will also learn how to make your own biogas.

How is biogas made?

12. When animal manure or plant materials rot they give off gas. You collect this gas as it is made when you make biogas.



gas is given off when waste materials rot

6

13. In this booklet you will learn how to mix water with animal manure or plant materials, how to put this mixture into a container where it will rot and give off gas, and how to collect the gas in another container which is airtight. We will call these containers the **biogas unit**.

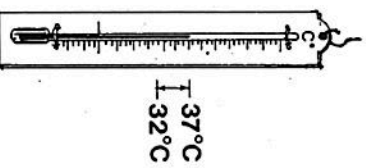
14. It is not easy to build a biogas unit. When you begin you will have to spend a lot of time and work very hard. It may also cost you money.

15. You must be sure that building a biogas unit will be a good way to use your time and money.

16. You will need a good place to put your biogas unit. Items 26 to 30 will tell you where to put it.

17. If you live where it is too hot or too cold, you may find it hard to keep a biogas unit working.

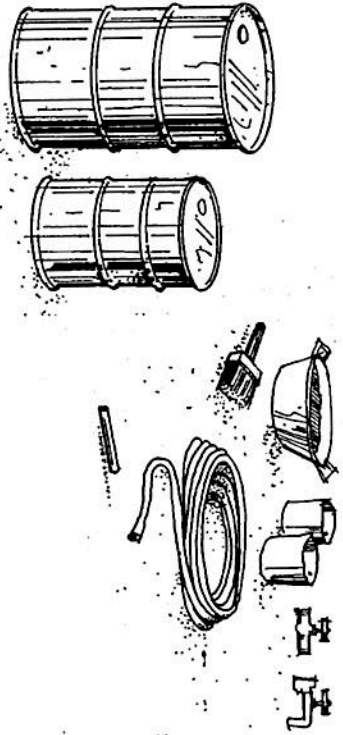
18. **Biogas is produced best at a temperature between 32 and 37°C.** When the temperature is below 15°C almost no gas is made. Items 31 to 34 will tell you some ways which will help you to keep your biogas unit at the right temperature.



37°C
32°C

7

19. You will need oil drums, pipe, valves, a gas line and sealing materials to build a biogas unit.

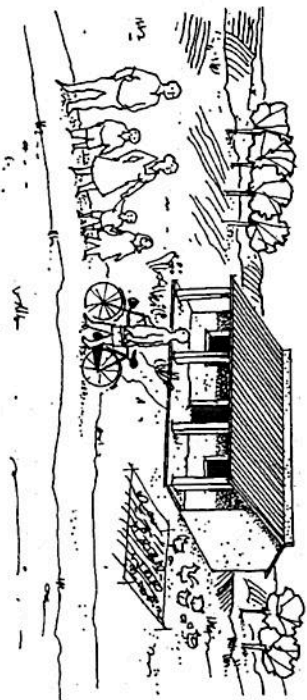


You will need a good supply of animal manure or plant material.



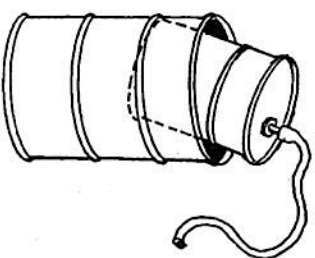
20. If there is a biogas unit near where you live, you should go to visit it. Talk to those who have built it and are running it to see how it works.

21. When you are thinking about building a biogas unit, you may be able to get advice from your extension officer.



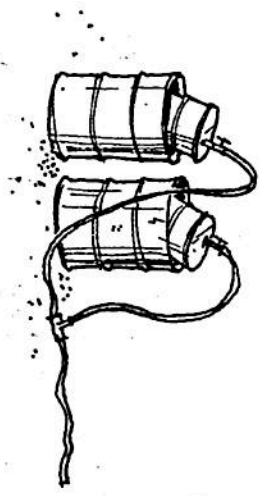
How big should your biogas unit be?

22. Begin by building a small unit. Items 35 to 57 will tell you how. With a small biogas unit, you will need less animal manure and plant materials. A small unit will cost less to build and it will be easier to run.



23. When you have learned how to run your biogas unit and have made and used your own gas, you may decide that you need more gas.

24. You can get more gas by building one or more biogas units just like your first one. Items 126 to 130 will tell you how to run several biogas units together.

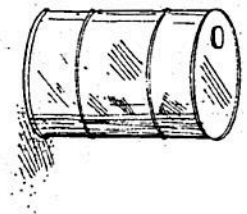
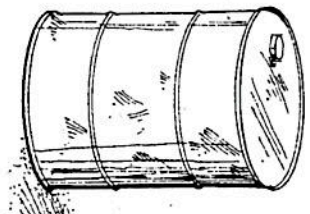


HOW TO BUILD A SMALL BIOGAS UNIT

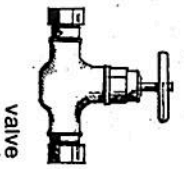
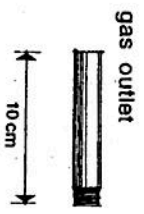
25. You can build a small biogas unit from two oil drums.

You will need

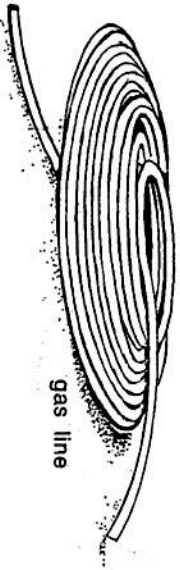
- an oil drum of about 200 litres, to hold the waste
- an oil drum of about 120 litres, to collect the gas



- a piece of pipe about 10 centimetres long and about 2 centimetres in diameter, for the gas outlet
- a valve to fit the gas outlet

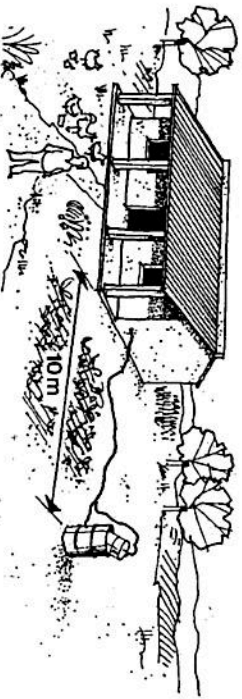


- at least 10 metres of rubber or plastic tube about 2 centimetres in diameter, for the gas line



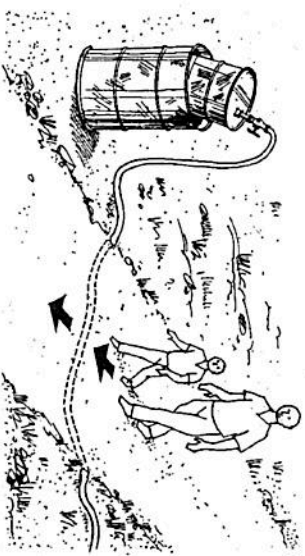
Where to put your biogas unit

26. Be careful not to put your biogas unit too close to your home or your cooking area or your water supply.
27. A biogas unit should be at least **10 metres** from your home so that when you put waste into your unit it will not be too close to where you and your family live and cook your meals.

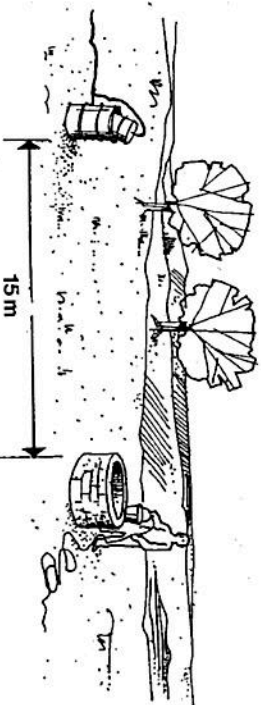


28. Do not put your biogas unit too far from where you cook or you will need a long gas line. Gas lines are hard to find and may cost a lot of money.

29. If your gas line is moved or damaged, it may leak when gas is made. If your gas line crosses a path, bury it a little underground to protect it from being moved or damaged.

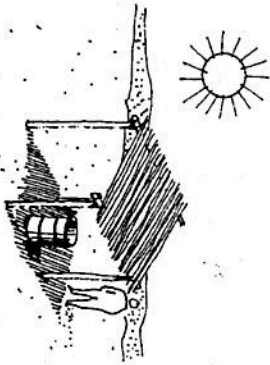
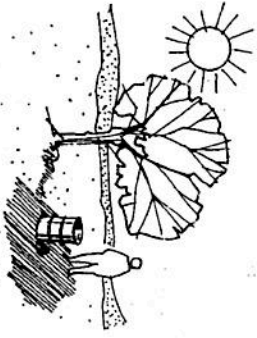


30. A biogas unit should be at least **15 metres** from your water supply, so that the waste in your unit will not make your water dirty and unhealthy to drink or use.

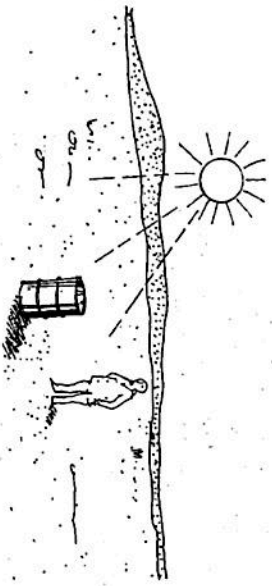


31. You have already been told that you will get most gas if the temperature of your unit is between 32 and 37°C.

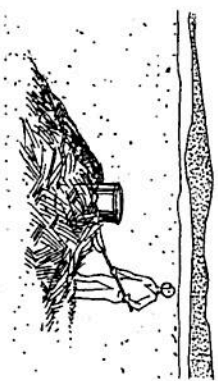
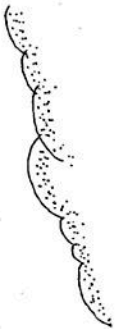
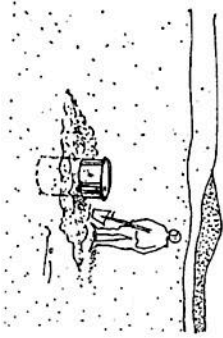
32. If you live in a very hot place, put your unit out of the sun, in the shade or under trees to keep it from getting too hot.



33. If you live in a place that is not very warm, put your unit in the sun to keep it warm.



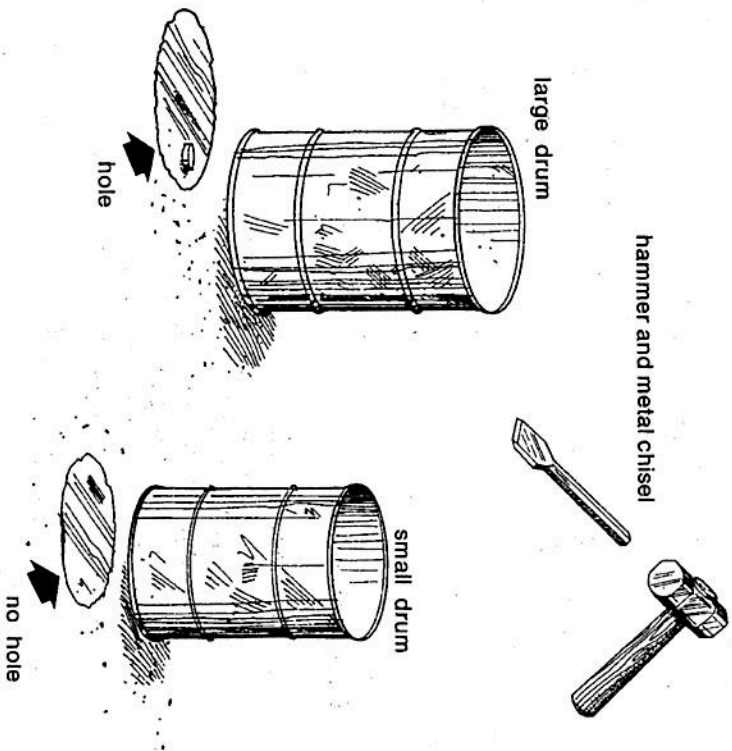
34. If you live in a cold place, put the unit underground or cover it with earth or straw to keep it warm.



Building the unit

35. The bottom part of the unit, which holds the waste mixture, is made from the bigger drum. The top part of the unit, which holds the gas, is made from the smaller drum which you put inside the bigger drum.
36. Most drums have a hole in the top. You will not need a hole in the top of the bigger drum but you will need a hole in the top of the smaller drum for the gas outlet.

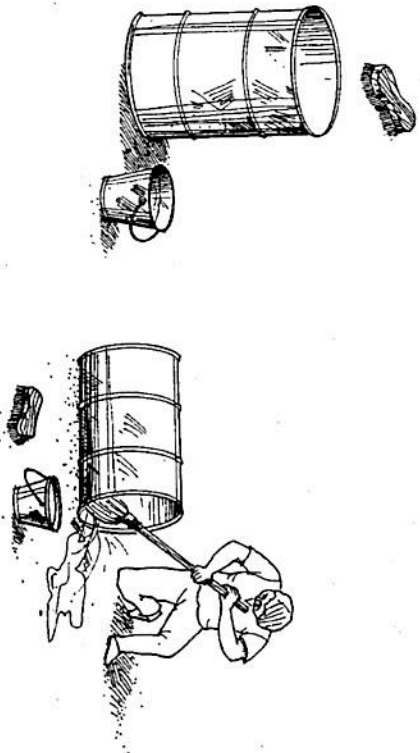
37. Cut out one end from each drum. You can do this using a hammer and metal chisel. Cut the end of the bigger drum that has a hole in it. Cut the end of the smaller drum that does not have a hole in it.



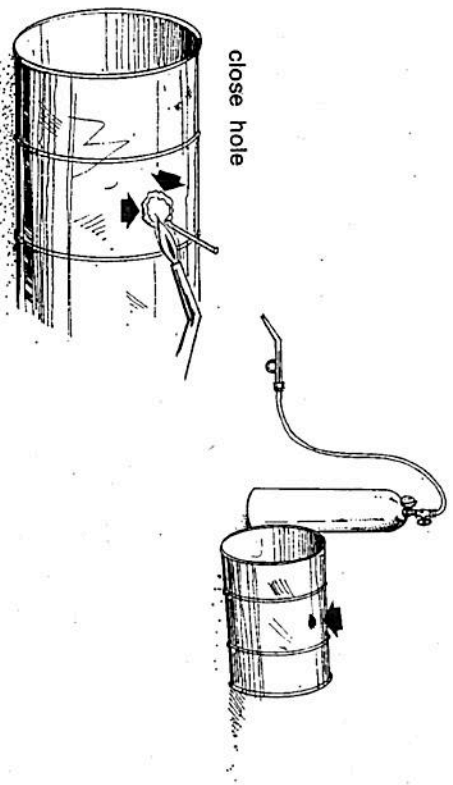
38. If the small drum does not have a hole in the top, you will have to cut one (see Item 45).

16

39. Now clean both drums well inside and outside to remove oil and grease.



40. If either drum has a hole in the side, close it tightly. This can be done with a metal plug or by welding a piece of metal in the hole as shown in the drawings.

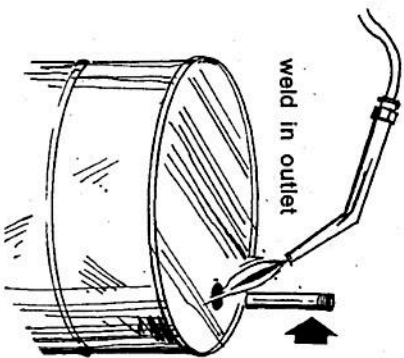
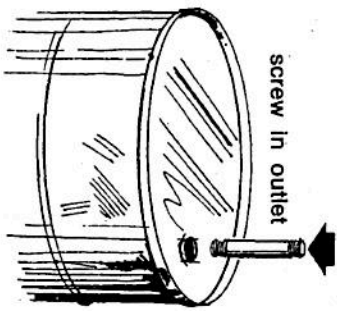


17

41. Now you are ready to put the gas outlet in the top of the small drum.

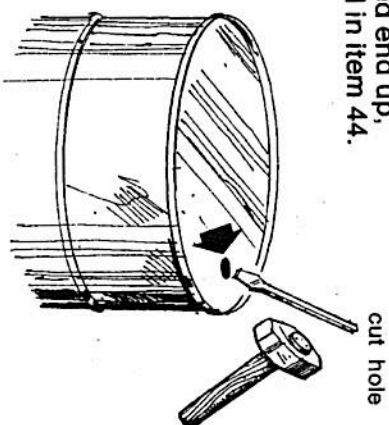
42. The gas outlet is made from a short piece of pipe about 10 centimetres long and about 2 centimetres in diameter.

43. If there is a threaded hole in the top of the small drum, use a gas outlet which is threaded on both ends and screw it tightly into the hole.



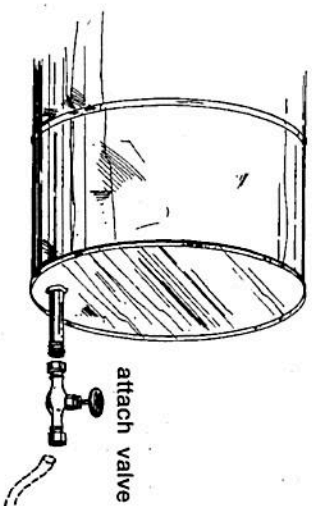
44. If the hole in the top of the small drum is not threaded, use a gas outlet which is threaded on one end and weld it into the hole with the threaded end up.

45. If there is no hole in the top of the small drum, cut one about 2 centimetres in diameter and using a gas outlet which is threaded on one end weld it into the hole with the threaded end up, as you were told in item 44.

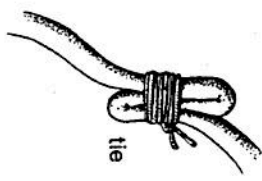
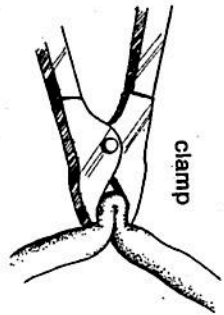


46. Now you are ready to attach a valve to the top of the gas outlet. You can use valves like the ones shown in the drawing.

47. The valve you use must be airtight so that it will not leak gas and you must be sure to screw it tightly to the gas outlet.



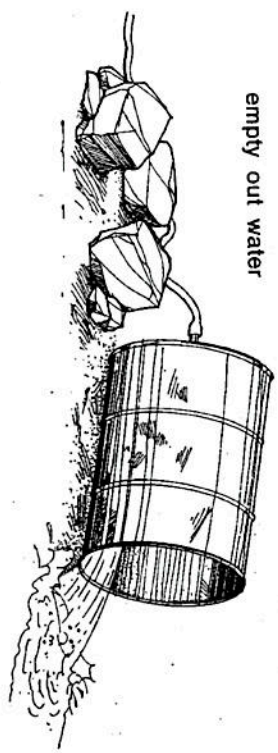
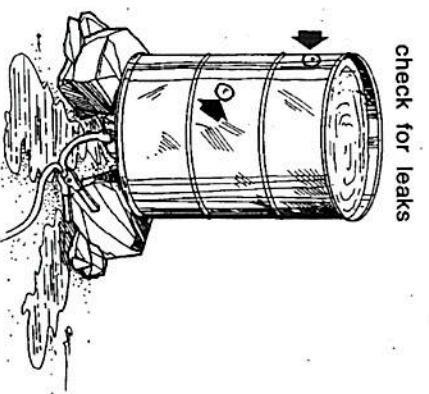
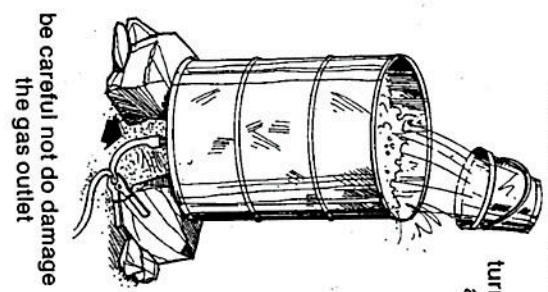
48. If you do not have a valve, attach the rubber or plastic tube you are using for the gas line directly to the gas outlet. To close the gas line, you can fold it once and clamp it shut or you can fold it twice and tie it tightly with cord as shown in the drawings.



Testing for leaks

49. Now you are ready to test the small drum for leaks. To hold gas it must be airtight.
50. To check for leaks, close the valve or if you have no valve clamp or tie the gas line tightly as you were told in item 48.
51. Turn the small drum over and place it above the ground on stones or pieces of wood, but be careful not to damage the gas outlet or the valve or to loosen the clamp or to loosen the gas line. Now fill the small drum with water.

52. If you see water leaking from the drum, the gas outlet, the valve or the tied gas line, mark the place of each leak. Then empty out the water, being careful not to damage the gas outlet, and let the drum dry.



be careful not to damage the gas outlet

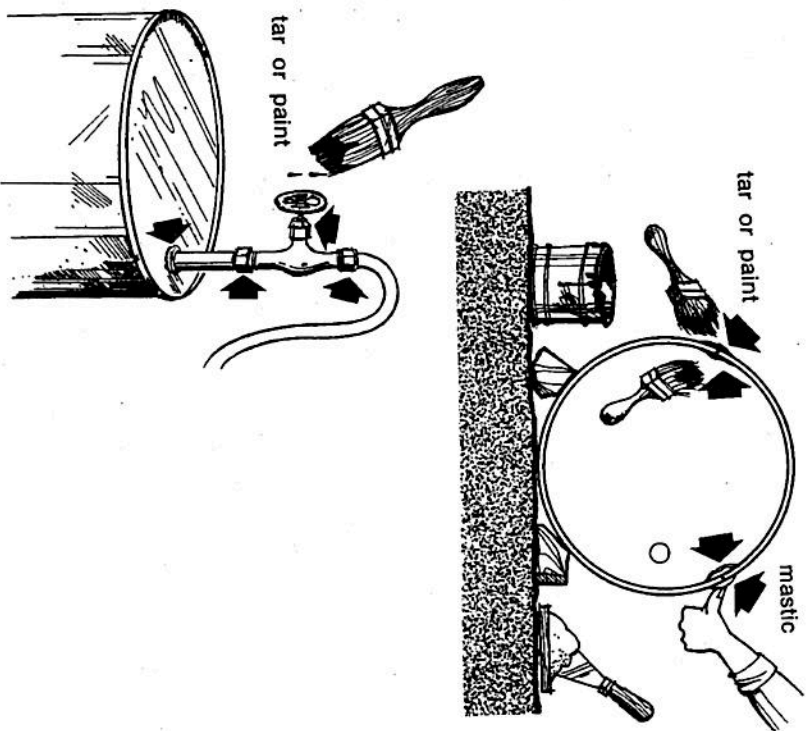
empty out water

turn the small drum over and fill it with water

check for leaks

53. Seal the leaks by coating them with tar, mastic or paint on the inside and the outside of the drum.

54. If there are leaks around the gas outlet or valve, tighten the outlet or valve again and coat the joints with tar, mastic or paint.



55. When the sealing is dry, fill the drum with water again to be sure that the leaks are well sealed. If water still leaks, start over again.

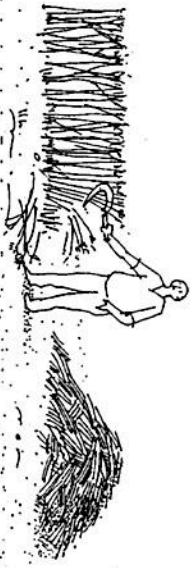
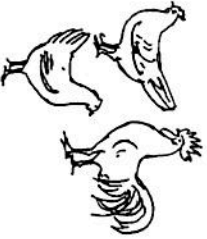
56. When the small drum is well sealed and no longer leaks, your biogas unit is ready to use.

57. **It is very important to seal all leaks carefully.**

WASTE MATERIALS

What waste materials to use

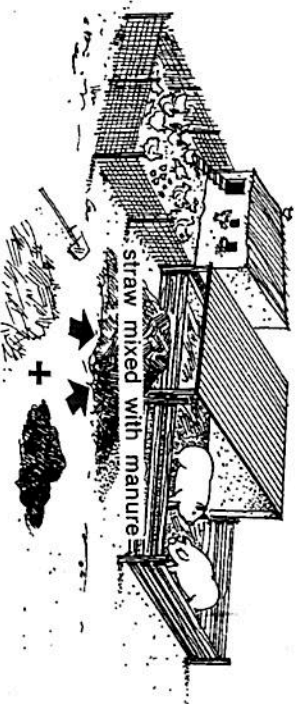
58. Animal manure from cows, pigs and chickens, and crop and plant wastes are good materials for making biogas.



59. You can use animal manure alone or plant materials alone or you can use both mixed together.

60. Straw which is mixed with manure, which you may have where you keep your pigs or chickens, is usually a good mixture of animal manure and plant material for making biogas.

Be careful to chop it fine before you use it.



61. When you first begin, it is best to use only animal manure or a mixture of animal manure and very little plant material. Later when you have learned more about how your biogas unit works, you can use more plant materials.

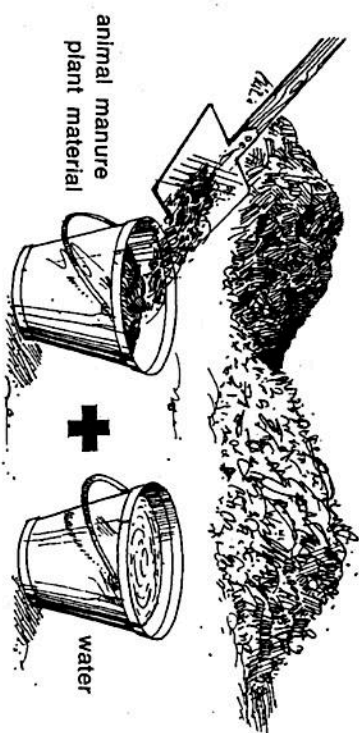
62. When you do begin to use plant materials, remember that dry plant materials must be chopped or shredded very fine and fresh plant materials must be left outside to rot for 10 days or more before you put them into a biogas unit.

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				



How to use them

63. Whether you are going to use animal manure or plant materials in your biogas unit, you must mix them with water. Use one bucket of water with every bucket of animal manure or plant material.

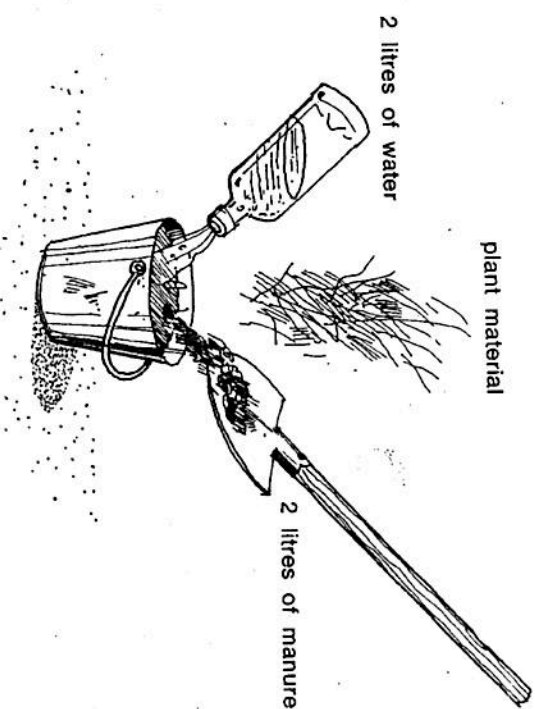


64. Plant materials which are not mixed well may not make gas later. When you mix plant materials with water, they pack together.
65. If you are using plant materials, break them apart and stir them well so that they will be well mixed.
66. Mix the animal manure or the plant material with water until the waste mixture is easy to pour. The waste mixture will work best if it is like a thin paste.

26

Making a starter

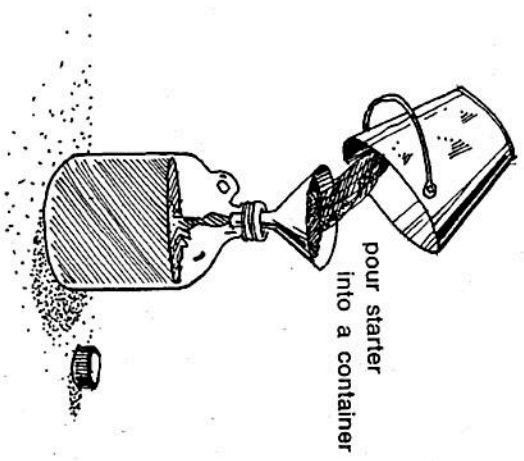
67. About two months before you are ready to use your biogas unit for the first time, put 2 litres of animal manure and 2 litres of water in a bucket and mix well. You can also add some finely chopped plant material such as grass.



68. We call this mixture a **starter**. A starter helps the biogas unit to make gas sooner.

27

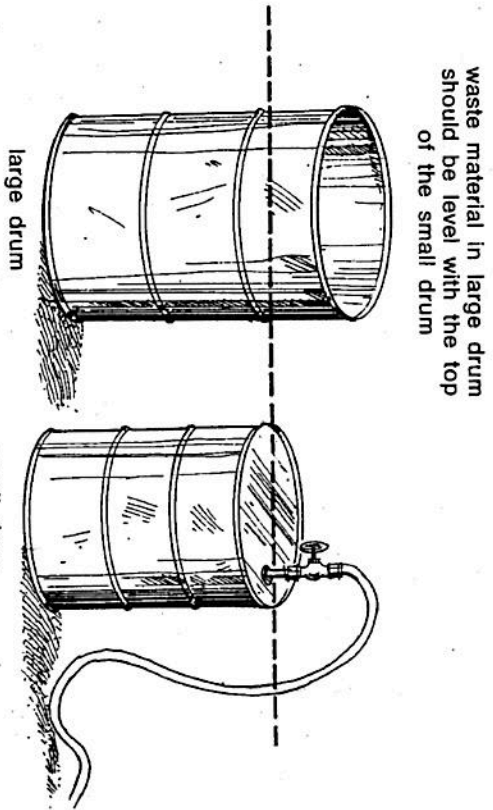
69. Pour the starter mixture into a container which holds a little more than 4 litres. You can use a bottle or a jug but do not close it, leave it open.



70. Keep the starter warm and shake the container three or four times each week to mix the contents. In about two months it will be ready to use.

Putting waste into your biogas unit

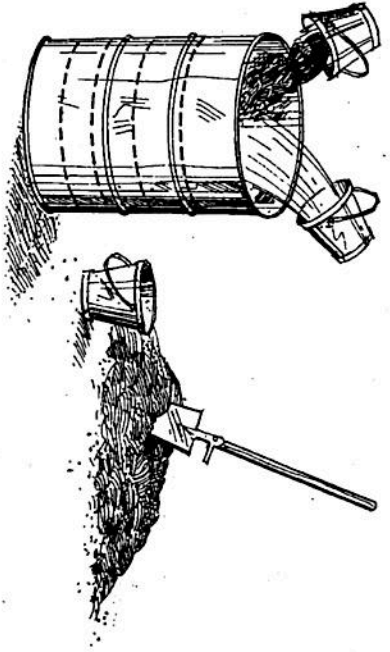
71. Now you are ready to put the waste into your biogas unit. Put the large drum open end up where you want the unit to be. Put the small drum next to it with the gas outlet up.



waste material in large drum should be level with the top of the small drum

72. Now put the waste and water you are going to use into the large drum. Put 3 buckets of waste and 3 buckets of water into the large drum and stir it well.

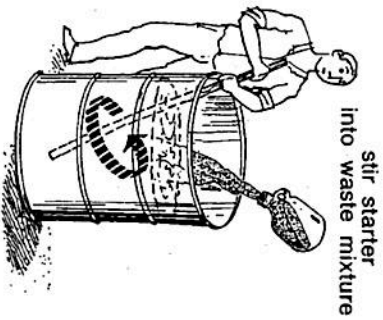
3 buckets of water and 3 buckets of waste
at a time



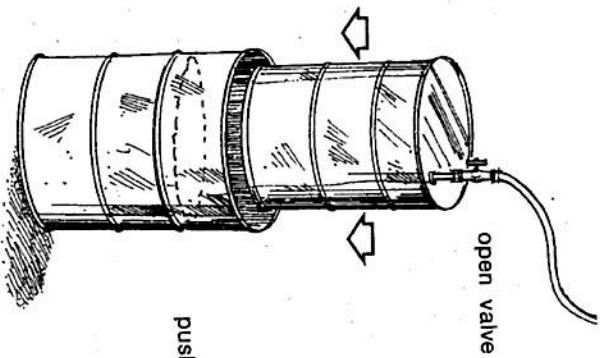
73. Now put another 3 buckets
of waste and 3 buckets of water
into the large drum
and stir all of the waste mixture again.

74. Put more waste and water into the large drum,
stirring well each time,
until the waste mixture in the large drum
is level with the top of the small drum.
The drawing on page 29 will show you how.

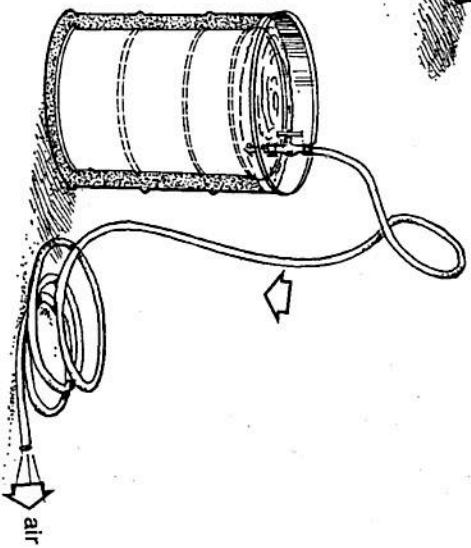
75. Stir the starter
you have made,
(see Items 67 to 70)
into the waste mixture
in the large drum.
The starter
which has already
begun to work
will help you
to make gas sooner.



76. Now open the valve or clamp
or untie the gas line
of the small drum
to let out the air.
Push the small drum down
into the waste mixture
until it touches the bottom
of the large drum.



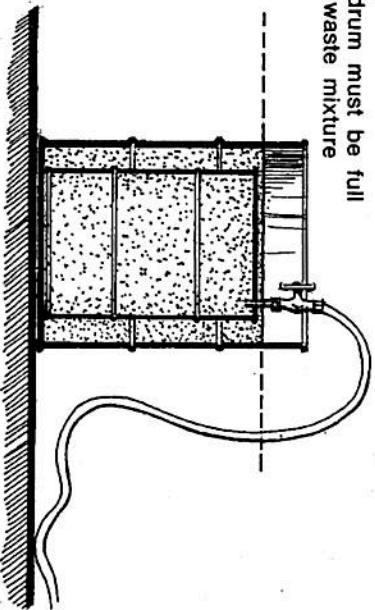
push small drum down



77. The small drum must be full of waste mixture. It must be full to the top so that there will be no air in it.

78. You can be sure that the small drum is full to the top if you can see that the waste mixture inside the large drum rises a little above the top edge of the small drum when it has been pushed down.

small drum must be full of waste mixture

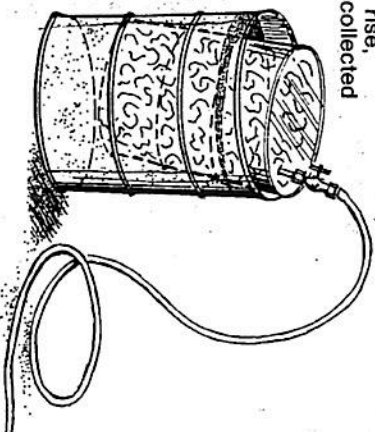


79. If it does not rise above the top edge of the small drum, take the small drum out and put a little more waste and water into the large drum. Then put the small drum back and push it down into the waste again.

80. When you are sure that the small drum is full of waste mixture to the top, close the valve or clamp or tie the gas line so that you will keep out air and begin to collect gas.

81. You can tell that the waste mixture in your simple biogas unit has begun to rot and make gas when the small drum begins to rise. This means that gas is being collected.

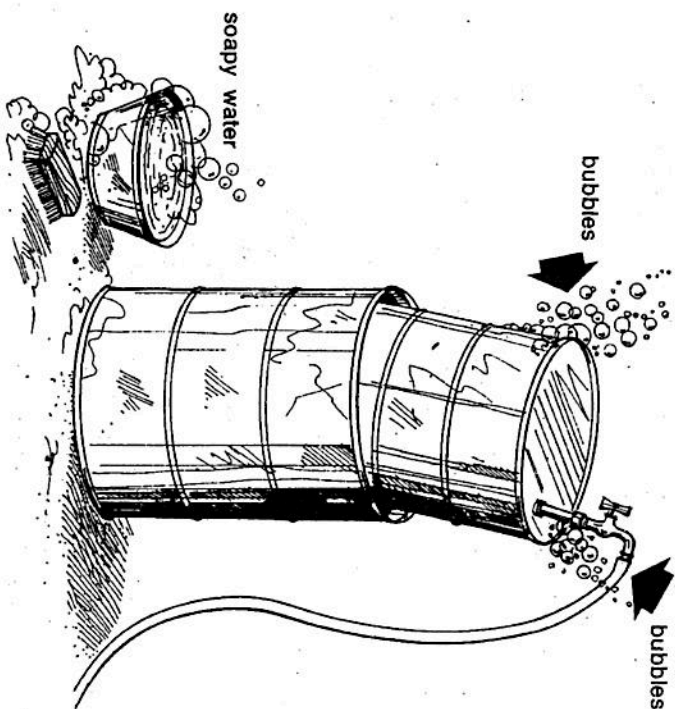
when the small drum begins to rise, gas is being collected



82. If you find that gas is leaking from the small drum after the biogas unit has begun to work, seal the leaks with tar, mastic or paint. If the gas is leaking around the gas outlet or valve, tighten the outlet or valve again and coat the joints with tar, mastic or paint.

83.

A good way to check for leaks after the biogas unit has begun to work is to put soapy water on the small drum and on the joints of all the parts and lines. If you see bubbles anywhere, you will know that there is a leak. Seal the leaks as you were told in items 53 and 54.



34

TIME

84.

It may take up to three weeks or even a month for the waste in your biogas unit to start making gas. After that, gas will be made for about eight weeks.

85.

During these eight weeks, half of the gas will be made in the first two or three weeks and the rest in the last five or six weeks.

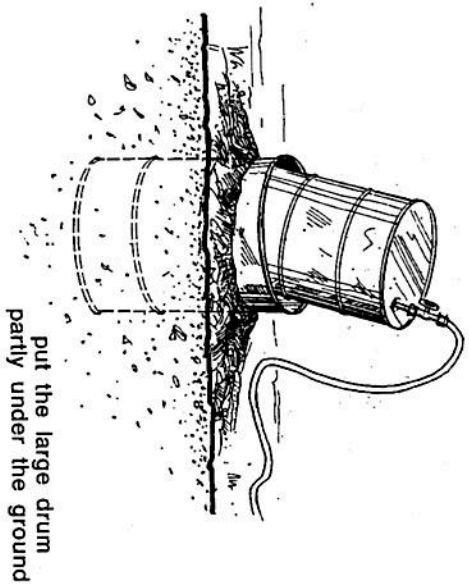
86.

If you find that not much gas is being made in the last weeks, empty the unit and start again.

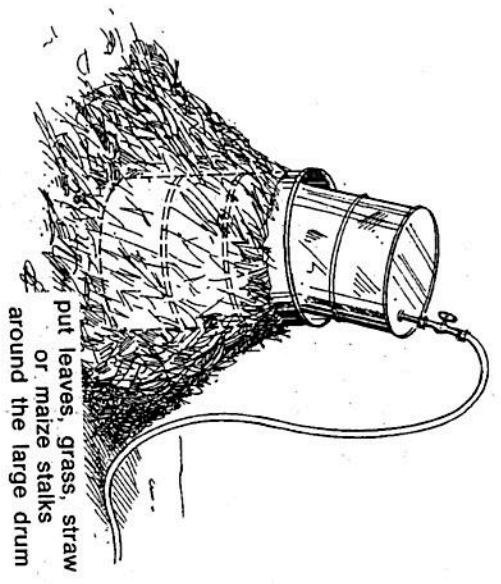
35

COLD WEATHER PROTECTION

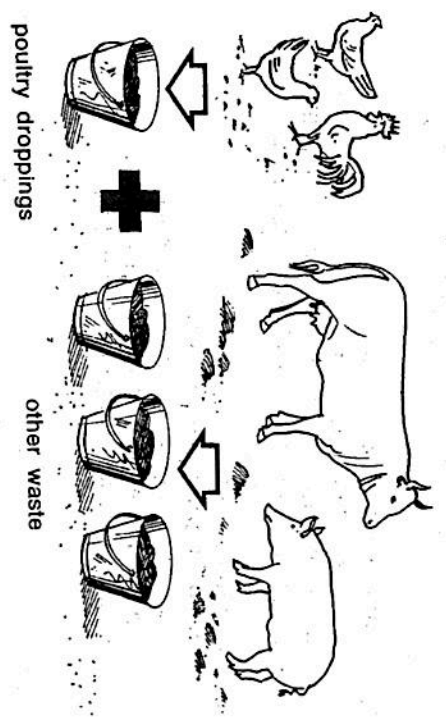
87. If the temperature where you are often falls below 15°C, you will have to keep the waste mixture in your biogas unit warm.
88. If you put your biogas unit under the ground or partly under the ground, this will help to keep the waste warm.



89. You can keep the waste mixture in your biogas unit warm by putting leaves, grass, straw or maize stalks around the large drum.

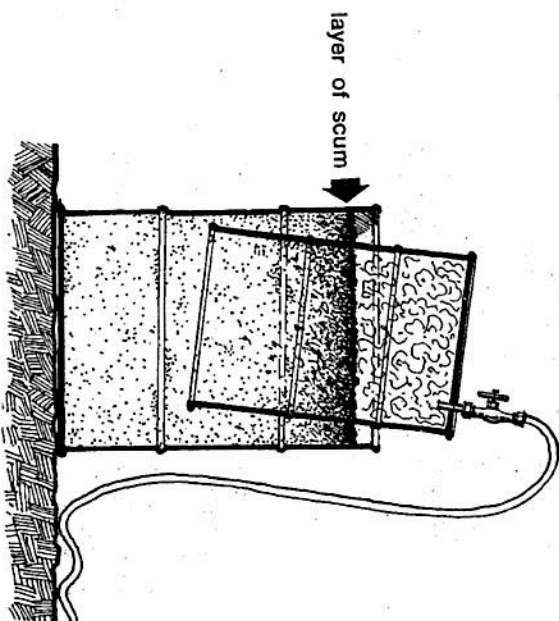


90. You can also keep it warm by adding a bucket or two of poultry droppings mixed with other waste to the waste already in the large drum. Use one part of poultry droppings to three parts of other waste.



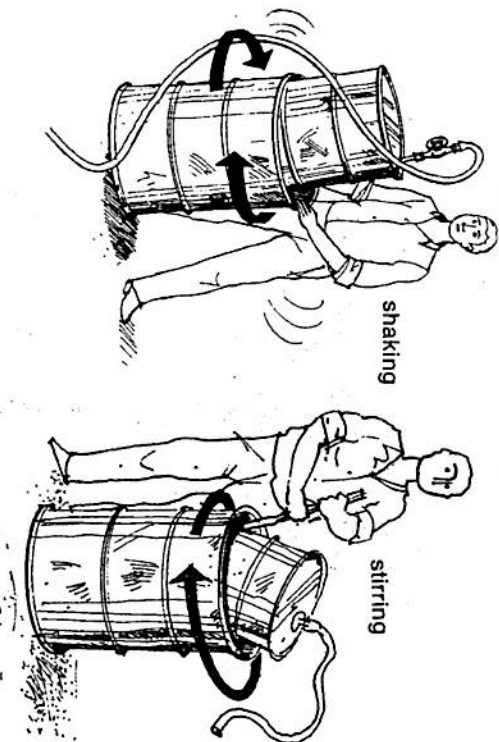
STIRRING THE WASTE MIXTURE

91. Sometimes a layer of scum may form on top of the waste mixture in your biogas unit. If this happens, less gas will be made and the small drum may not rise.



92. If the waste is well mixed before it is put into the unit, there will be less chance for scum to form and your biogas unit will make gas well.
93. If you use plant materials, scum is more likely to form than if you use only animal manure. You will need to stir the waste mixture in your biogas unit from time to time.

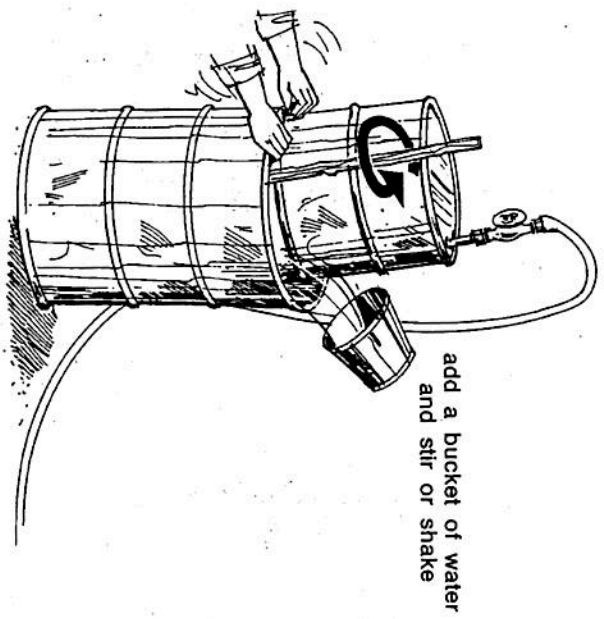
94. You can break up a scum layer by stirring or shaking the waste mixture after it is in the unit. You must do this without opening the small drum and letting out the gas or letting in the air.



95. During warm weather, the waste mixture in your biogas unit may become too thick and little gas will be made.

96.

If this happens, add a bucket of water to the unit and stir the waste to thin it. If after a few days no gas is being made and the waste is still too thick, add another half-bucket of water and try again.



97.

If a lot of very hard scum forms on top of the waste mixture and no gas is being made, take out all the waste mixture, clean the unit and start again. Do not throw the waste mixture away, use it for fertilizer.

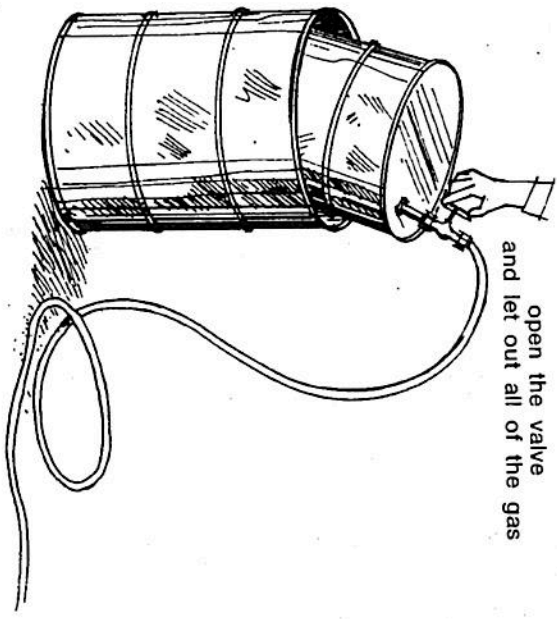
WHEN THE GAS IS MADE

98.

Do not burn the first gas that is made. It may have air in it and could explode.

99.

A few days after the small drum has begun to rise, open the valve or clamp or untie the gas line and let out all of the gas that has been collected.

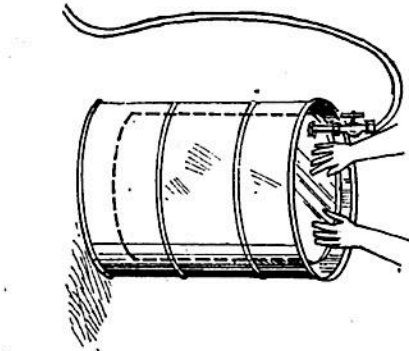


100.

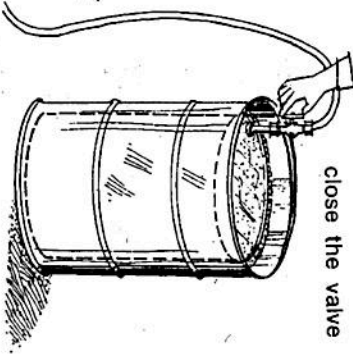
While you are letting the gas out, be very careful not to have fire near the biogas unit.

101. To let the gas out, push the small drum back down into the waste mixture in the large drum. This will force all gas and air out of your biogas unit. Then, close the valve or clamp or tie the gas line and your biogas unit will begin to collect gas again.

push the small drum down



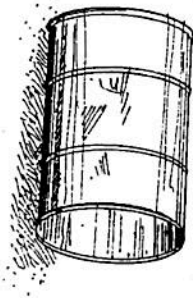
close the valve



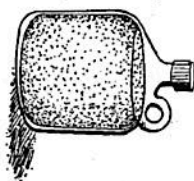
102. If you have done this carefully, the next gas that is made will have no air in it and it will be safe to burn. You can burn all the biogas that is made after this. Do not open the unit again until all the gas has been made.

103. After all the gas has been made, take the unit apart and empty out the fertilizer. Keep about 4 litres of the fertilizer to be used as a starter for the next time.

take the unit apart



keep 4 litres of fertilizer to be used as a starter



104. Clean the unit and check for leaks.

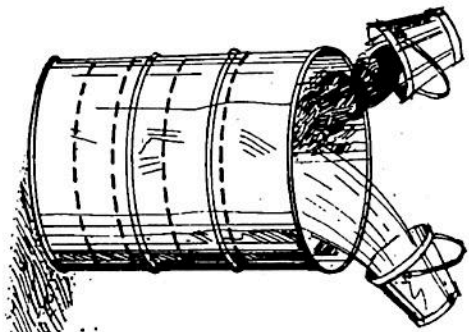
clean and check for leaks



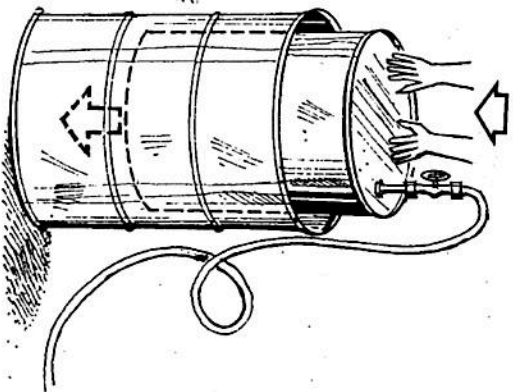
105. Now fill the unit

with new waste material
and add the starter.
Close the unit tightly
and it will begin to make gas again.

fill with new waste material



close the unit tightly
and push the small drum down



106. Remember,
every time you start again,
do not burn
the first gas that is made.

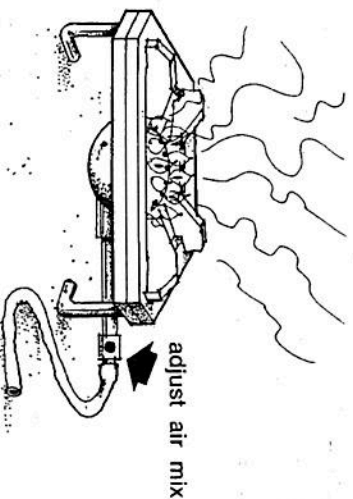
USING YOUR BIOGAS

107. The best way to use the biogas

that you make
with your small biogas unit
is for cooking.
When your unit is working well,
it will make enough gas every day
to cook your evening meal.

108. You can use biogas

with almost any ordinary gas-burner,
if you adjust the burner
so that the right amount of air
is mixed with the biogas.

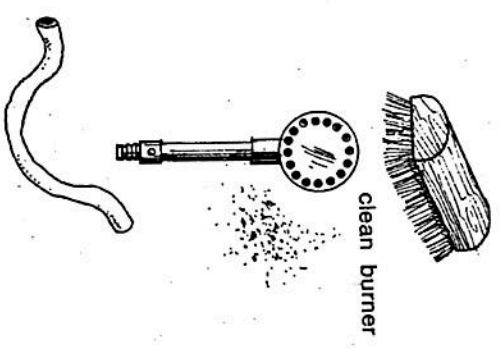
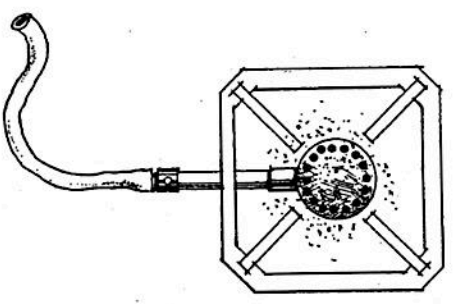


109. If there is too much air,
the flame will be blown out
and the biogas will not burn.
If there is not enough air,
the flame will be yellow,
the biogas will not burn well
and will not give enough heat.

110. When there is the right amount of air and the biogas is burning well, it will burn with a blue flame. By letting more or less air into the burner, try to make the flame as blue as you can.

111. Sometimes the flame may begin to turn yellow after it has been burning well. This may mean that the burner has become full of a black material called soot.

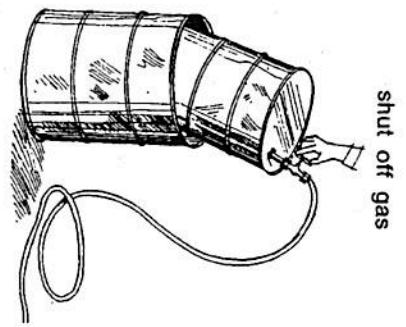
112. If this happens, clean the burner very carefully and clean all the holes in the burner with soap and water. Dry the burner well. This may help your biogas to burn well again.



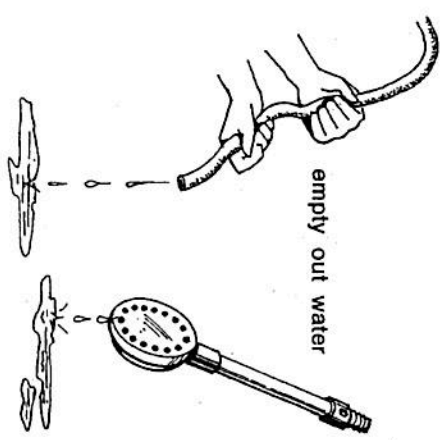
clean burner

113. If the flame is not steady, or if it is weak when there is still gas in the unit, this may be because there is water in the burner or the gas line.

114. Shut off the gas at the small drum and take off the burner. Empty out any water that is in the gas line or in the burner. Then put the burner back, turn on the gas and light the burner again.



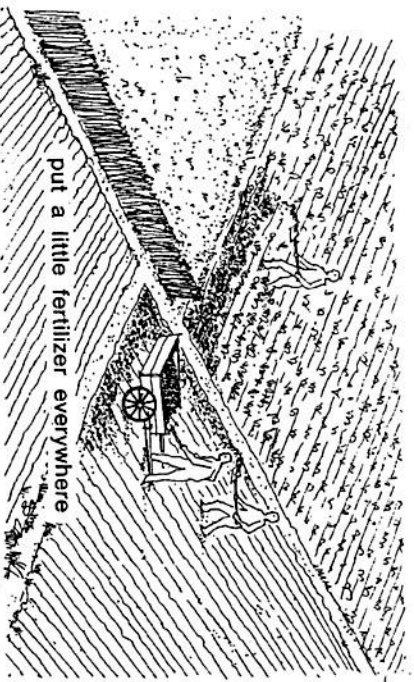
shut off gas



empty out water

USING THE FERTILIZER

115. You have already learned that when all the gas has been made, the material that is left in your biogas unit is a very rich fertilizer.
116. It does not have a bad smell, and the parasites that were in the animal wastes and the weed seeds that were in the plant wastes are no longer harmful.
117. You can spread this new fertilizer on your fields to help your plants grow well.



118. Do not put the fertilizer all in one place. Put a little of it everywhere on your fields. In this way, all of your plants will grow better.

TAKING CARE OF YOUR BIOGAS UNIT

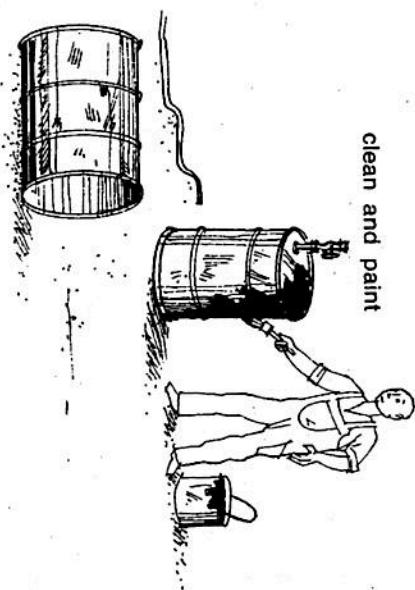
119. Always be very careful when you are near a biogas unit because gas may be leaking.
120. Never build a fire near the unit, smoke, or even light a match near the unit, because if gas is leaking it may explode.



121. If biogas is leaking and you breathe in too much of it, it can make you very sick.
122. Check your biogas unit and gas lines often to be sure that there are no leaks. Items 49 to 57 and items 82 and 83 have told you how to find and stop leaks.
123. After some time, rust will start to appear on the inside of your unit.

124.

Once a year you should take the unit apart and clean and paint the metal gas holder and all other metal parts.



125.

You can use paint which is used to protect metal or coat the metal parts with tar.

MAKING MORE BIOGAS

126.

After you have made biogas a few times with your small biogas unit, and have used it for cooking, you may find that you could use more gas if you had it.

127.

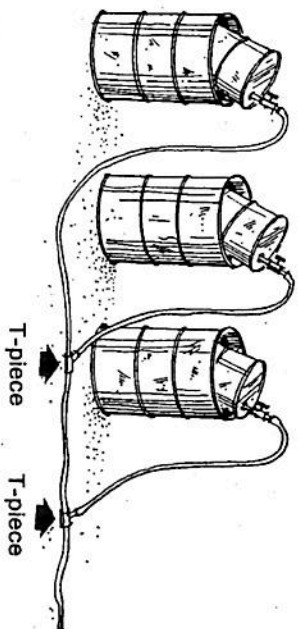
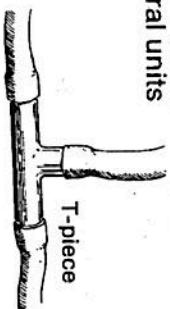
The easiest way for you to make more biogas is to build one or more biogas units just like your first one.

128.

If you can get more oil drums, pipe, valves and gas lines, and if you have enough waste materials, you can build and run several small biogas units and get gas from all of them.

129.

When you have several biogas units, you can connect them to your gas line by using T-pieces. The drawings show you a T-piece and how to connect several units to the same gas line.



130. When you have several biogas units fill them with waste at different times so that when all of the gas in one unit has been made, you will still get gas from another unit which is working.

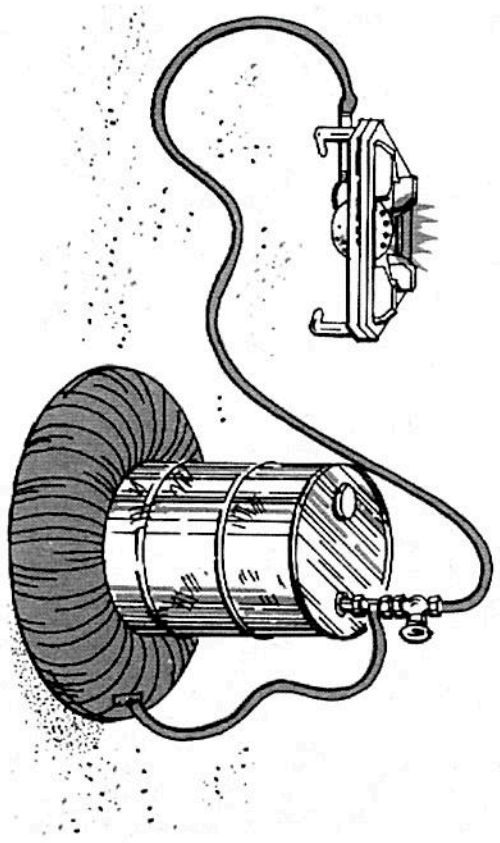
131. In this booklet you have learned how to build a small biogas unit and how to make your own biogas. You have also learned that you can make more biogas by building several small biogas units.

132. But there are still other ways to make more biogas. You can build an improved small unit or you can build a different kind of unit which is bigger and better and will give more biogas.

133. You will learn about these ways in a later booklet.

biogas 2

building a better biogas unit



biogas 2

building a better biogas unit

PREFACE

The first twenty-six volumes in FAO's Better Farming Series were based on the *Cours d'apprentissage agricole* prepared in Côte d'Ivoire by the *Institut africain de développement économique et social* for use by extension workers. Later volumes, beginning with No. 27, have been prepared by FAO for use in agricultural development at the farm and family level. The approach has deliberately been a general one, the intention being to constitute basic prototype outlines to be modified or expanded in each area according to local conditions of agriculture.

Many of the booklets deal with specific crops and techniques, while others are intended to give the farmer more general information which can help him to understand why he does what he does, so that he will be able to do it better. This booklet was added to the series owing to the favourable comments received on Booklet No. 31, **Biogas: what it is; how it is made; how to use it**. Both booklets have been based on published works by researchers and experimenters in small-scale biogas production in Africa, Asia, Europe and North America.

Adaptations of the series, or of individual volumes in it, have been published in Amharic, Arabic, Bengali, Creole, Hindi, Igala, Indonesian, Kiswahili, Malagasy, SiSwati, Thai and Turkish.

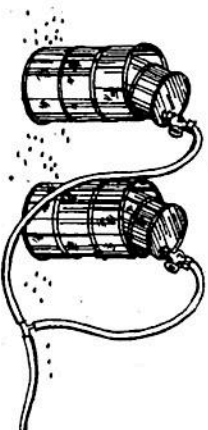
Requests for permission to issue this manual in other languages and to adapt it according to local climatic and ecological conditions are welcomed. They should be addressed to the Director, Publications Division, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

OUTLINE OF THE BOOKLET

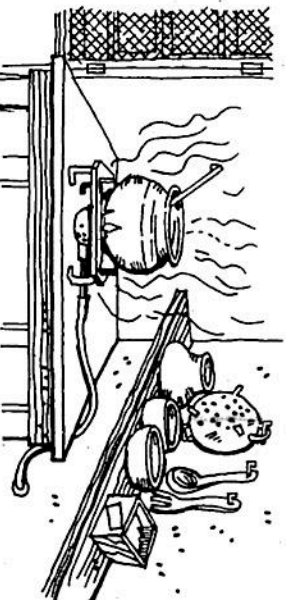
● Introduction	1
● How to build a better small unit	5
You will need	5
Cleaning the oil drum	8
Where to put your biogas unit	11
Preparing the oil drum	11
Testing for leaks	15
Preparing the gas holder	20
Attaching the gas holder	24
● Putting in the waste	28
The waste materials	28
The starter	29
Putting waste in this biogas unit	30
After the waste is in	33
● Time	35
● Temperature	36
Cold weather protection	36
● Scum	37
● When the gas is made	38
● Taking care of your biogas unit	42
● Making more biogas	44
● What more can you do?	45
Another kind of biogas unit	46

INTRODUCTION

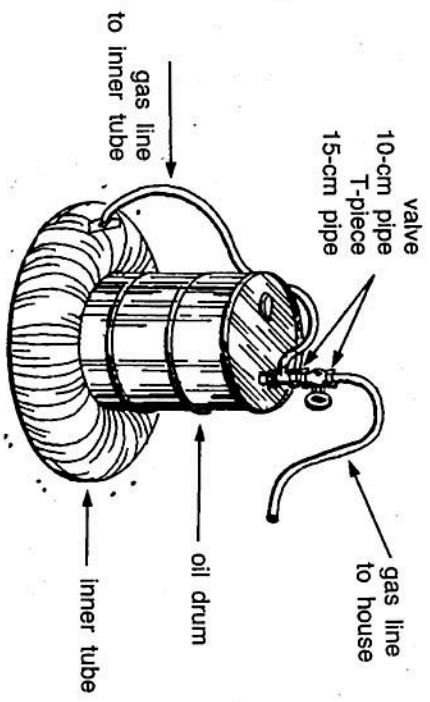
1. You have already built one or more biogas units like the one described in the Better Farming Series Booklet No. 31; **Biogas: what it is; how it is made; how to use it.**



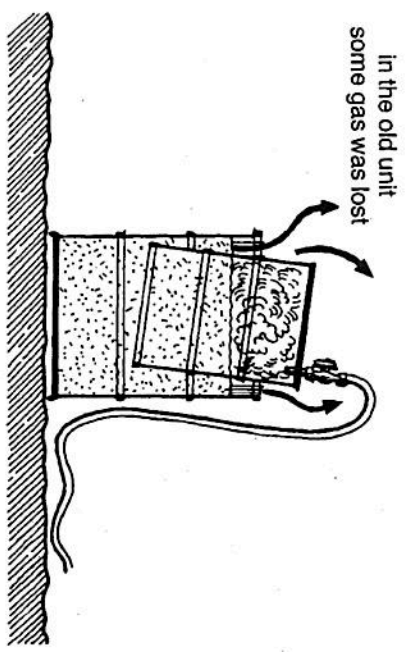
2. When you first began you found that you had to learn a lot of new things in order to make your unit work.
3. However, little by little you have learned more and more through your own experience.
4. When your first gas was made you used it for cooking. You found that cooking with gas was cleaner, easier and faster than cooking with kerosene, charcoal or fuelwood.



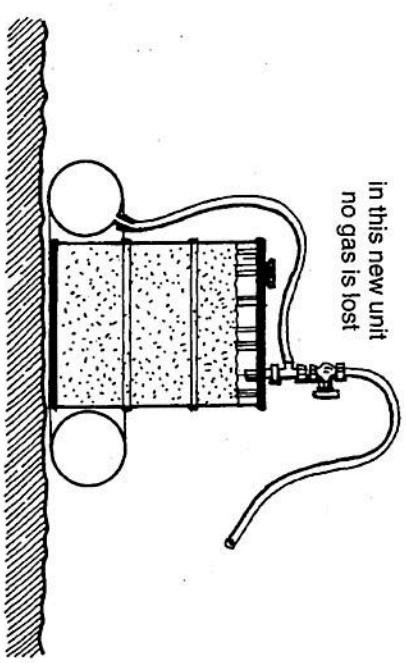
- Now that you know more about biogas and how it is made, let us look at another way to make biogas even better.
- In this booklet you will learn how to build and use a **better** small biogas unit like the one shown below.



- It too has an oil drum for a waste holder and, like your first small unit, **all** the waste is put in **at one** time when you begin.
- However, the new unit is closed. A closed unit is cleaner. You cannot smell the waste after you have put it in as you could with your old unit.
- In addition, with your old unit some of the gas was lost from around the open sides of the oil-drum waste holder.

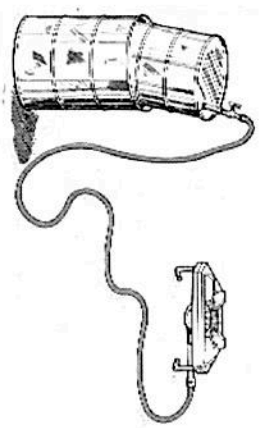
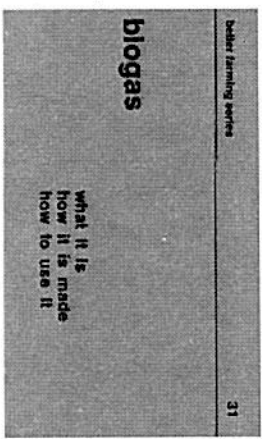


- Since the new unit is closed you will **not** lose any gas. You can collect it all so you will have more gas to use.



- Notice in the closed unit (see the drawing above) that the oil drum is filled nearly to the top with waste. There is little space to hold gas.

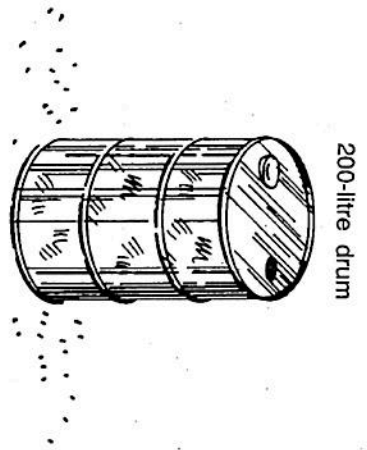
12. So, you will need something to collect the gas. In the new unit, the gas holder is a used inner tube as you can see in the drawing on page 2 in this booklet.
13. This new biogas unit looks much like your old unit and it works in much the same way. You already know a lot of the things that you need to know to put this new unit together.
14. However, before you begin it would be a good idea to read Booklet No. 31 again.



HOW TO BUILD A BETTER SMALL UNIT

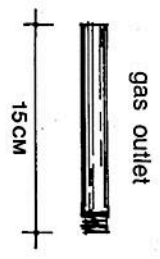
You will need

- an oil drum of about 200 litres, to hold the waste

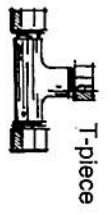


200-litre drum

- a piece of pipe about 15 centimetres long and about 2 centimetres in diameter to fit the oil drum, for the gas outlet



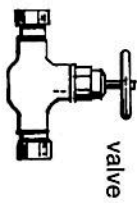
- a pipe T-piece, to connect the gas outlet to the inner tube



- a piece of pipe about 10 centimetres long to fit the T-piece



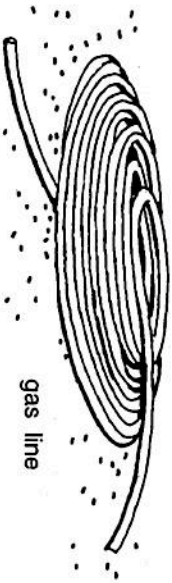
- a valve to fit the 100-centimetre pipe



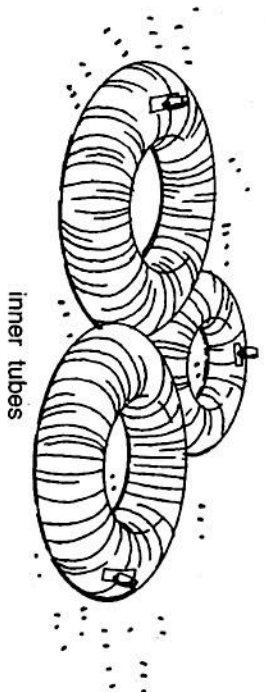
Note

The drawing on page 14 in this booklet shows you how these pipe fittings are attached to the oil drum.

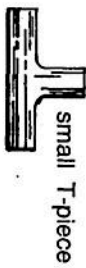
- at least 12 metres of rubber or plastic tube, about 2 centimetres in diameter, for the gas lines



- one or more inner tubes, to collect the gas

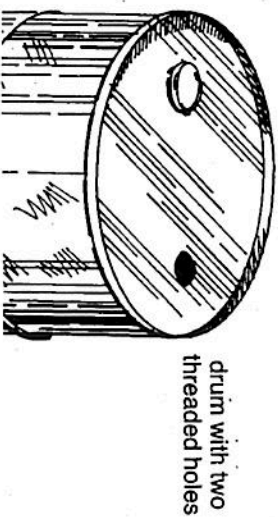


- if you are using more than one inner tube, you will also need one or more small T-pieces to connect the inner tubes.



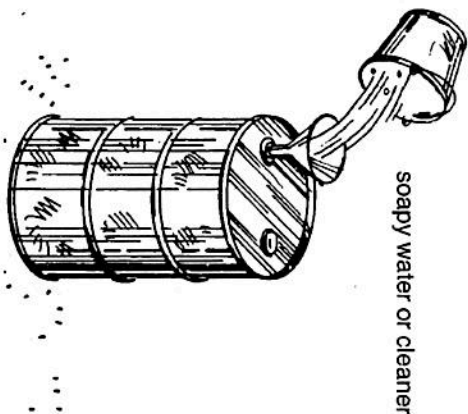
15. The oil drum should have one hole for putting in the waste and another hole for the gas outlet. Many drums have threaded holes with threaded plugs to close them.

16. Try to find an oil drum with threaded holes in the top. That way it will be easier to build this unit and to make it airtight.



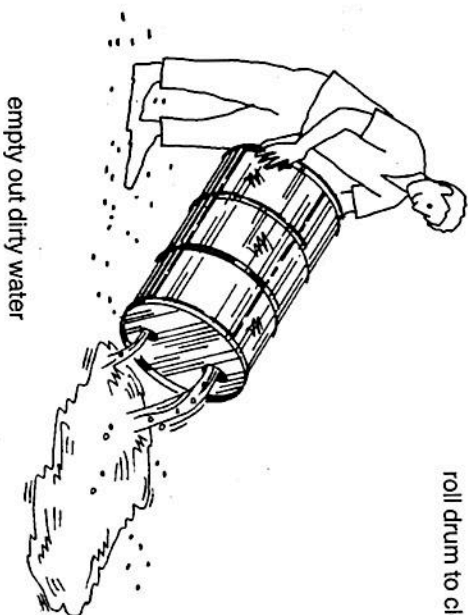
Cleaning the oil drum

17. Begin by cleaning the drum inside and outside to remove all oil and grease.
18. Take the metal plugs out of the holes and put them carefully aside, so that you can find them later.
19. First clean the **Inside** of the drum. Pour in a bucket or two of warm, soapy water or other cleaner. Then close all of the holes.



20. Put the drum on its side. Roll it back and forth so that the soapy water or cleaner can wash the whole inside. Then open the holes and empty out the water.

8

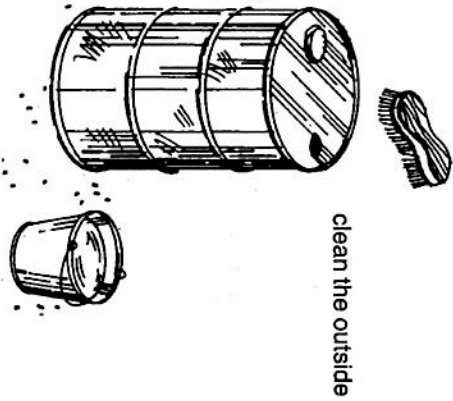


21. Continue to wash the inside of the oil drum with soapy water or cleaner until it is completely clean.
22. You can tell the oil drum is clean when the water you empty out is clean.
23. When you are sure that the inside is clean, pour in three buckets of fresh water and roll the drum back and forth once more. This is to rinse out any soap or cleaner that is still inside. Then empty it out again.

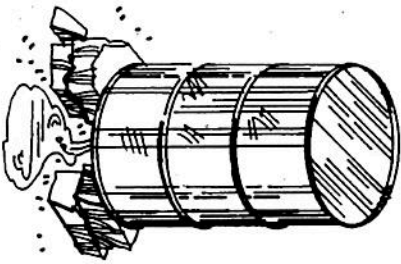
9

24. Now clean the **outside** of the drum with a brush and soapy water or cleaner. Rinse it with fresh water.

25. Open the holes in the top and put the drum on stones with the top down. Let it drain and dry.



raise the drum on stones and let it drain and dry



26. When the drum is dry inside and out you are ready to begin.

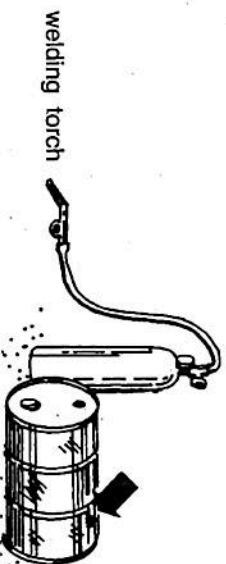
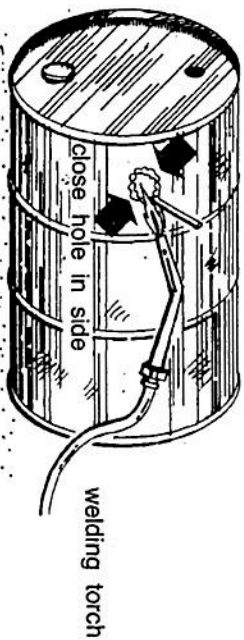
Where to put your biogas unit

27. Before you build your new biogas unit you should decide where to put it. Items 26 to 34 in Booklet No. 31 will tell you where.

28. However, **do not put this unit underground.** If the unit is underground you will not be able to shake it to break up the scum (see Items 109 to 113 in this booklet).

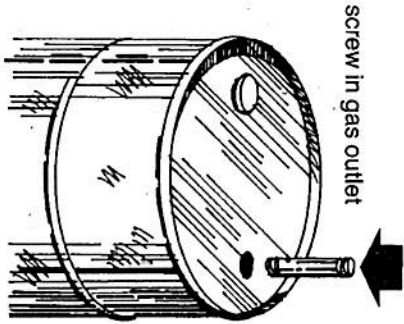
Preparing the oil drum

29. If your oil drum has a hole in its side, close it tightly. You can use a threaded metal plug or weld a piece of metal over the hole.

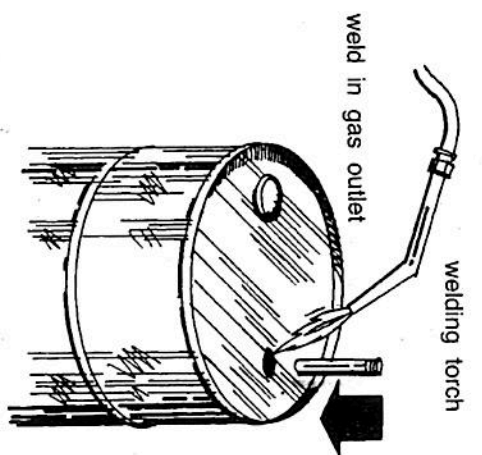


30. Now you are ready to put the gas outlet in the top of the drum.
31. If your drum has two holes in the top, use the smallest one for the gas outlet. Save the largest one for putting in the waste.
32. The gas outlet is made from a piece of pipe about 15 centimetres long and about 2 centimetres in diameter. However, it should fit the hole in the drum.

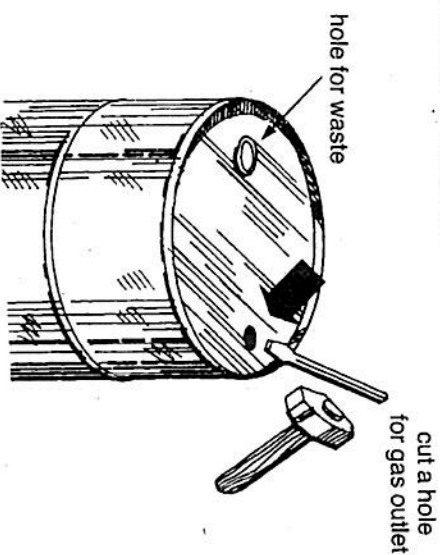
33. If the hole is threaded, use an outlet pipe that is threaded on both ends. Screw it tightly into the hole.



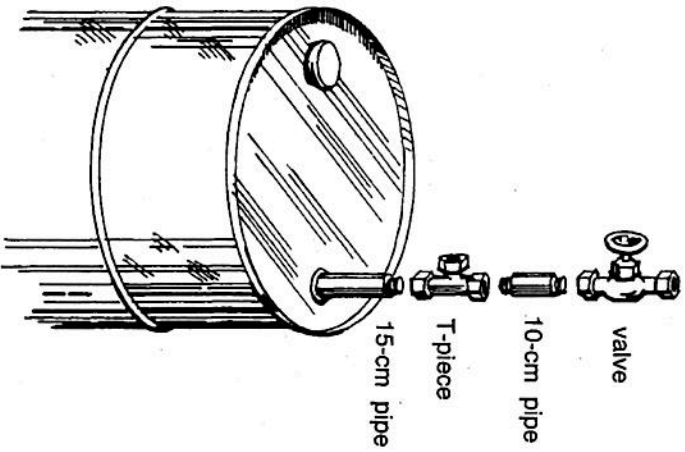
34. If the hole is **not** threaded, use an outlet pipe that is threaded on one end. Weld it into the hole with the threaded end up.



35. If there is **only one** threaded hole in the top of the oil drum, use it to put in the waste.
36. Then you will have to cut a hole about 2 centimetres in diameter for the gas outlet. Weld in a pipe that is threaded on one end, as shown in the drawing at the top of this page.



37. Now you are ready to attach the pipe T-piece, the 10-centimetre piece of pipe and the valve.
38. The valve you use must be alright so that it will not leak gas. You must be sure to screw all of these pieces tightly to the gas outlet.

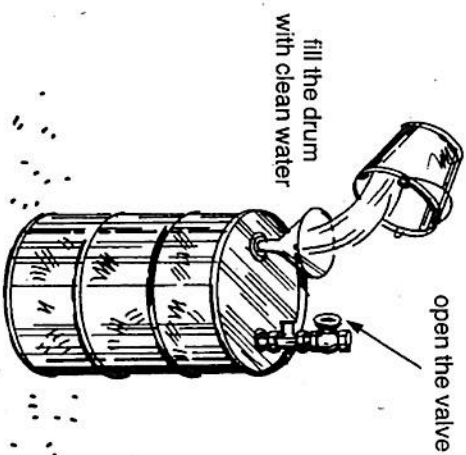


Note

If you do not have a valve, you can tie or clamp the gas line to stop the flow of gas (see Item 48 in Booklet No. 31).

Testing for leaks

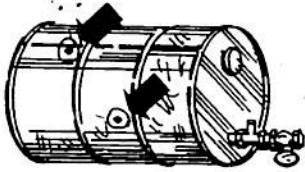
39. Now you are ready to test the drum for leaks. To make biogas, the drum must be alright.
40. To test for leaks, open the valve, take out the metal plug in the waste hole and fill the drum with water.



41. **Be sure** to fill it to the top. Then close the valve and put the metal plug back in the waste hole.
42. Use a piece of cloth to dry any water that you have spilled on the outside of the drum.

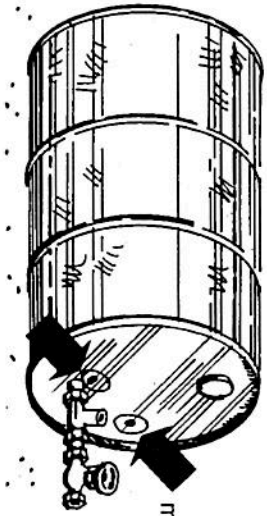
43. If you see water leaking from anywhere on the drum, mark the place of each leak.

mark each leak



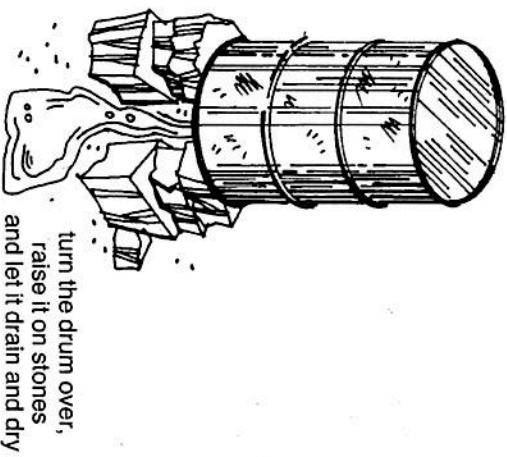
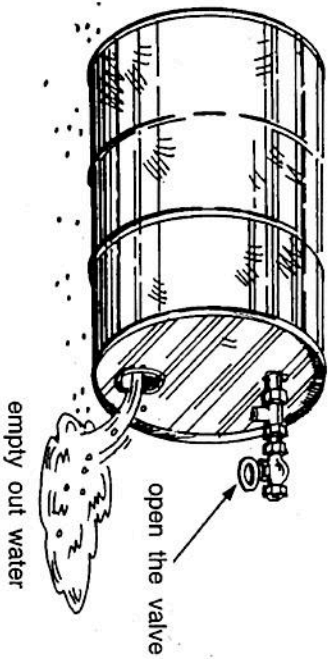
44. Then turn the drum over on its side. When the drum is full of water it is very heavy, so ask someone to help you.

mark each leak



45. Now check for leaks on the top part of the drum and around the gas outlet, T-piece and valve. If there are leaks here, mark them too.

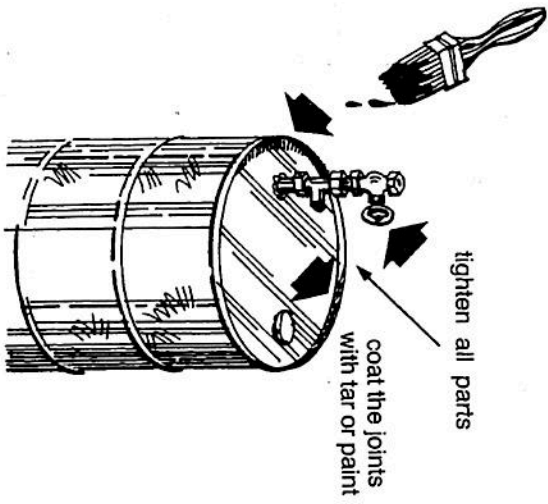
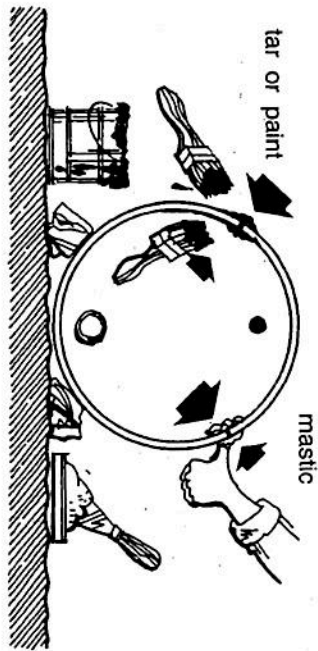
46. Then open the valve, take out the metal plug and empty out the water. Raise the drum on stones with the top down so it can drain dry.



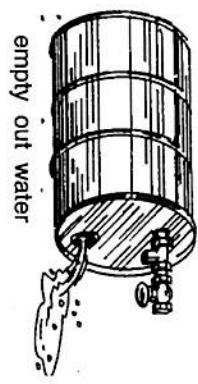
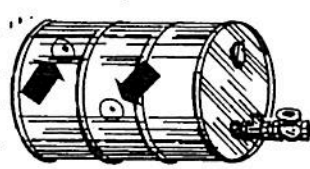
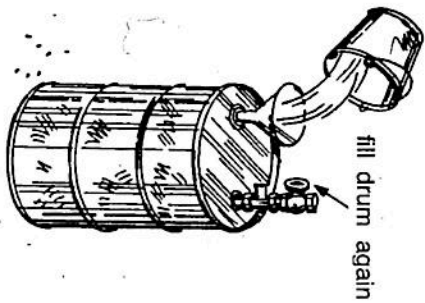
Note

When you put the drum on stones, be very careful not to damage the gas outlet, the pipe T-piece or the valve.

47. Seal the leaks by coating them with tar, mastic or paint. If there are any leaks around the gas outlet, tighten the outlet, T-piece and valve again. Coat the joints with tar, mastic or paint.



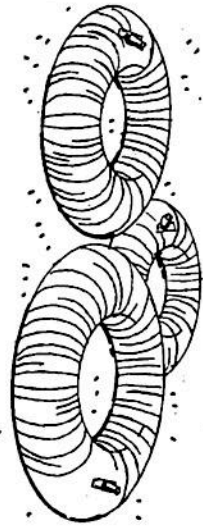
48. When the sealing is dry, fill the drum with water again. Check that all the leaks are sealed. If the drum still leaks, empty out the water and let it dry.



49. Put some tar or paint inside the drum. Then turn the drum around and around to coat the inside of it.
50. Fill the drum with water again. If it still leaks, start all over again. **It is very important to seal all leaks carefully.**
51. When the drum is well sealed and no longer leaks, let it dry completely. Now you can begin to prepare the gas holder.

Preparing the gas holder

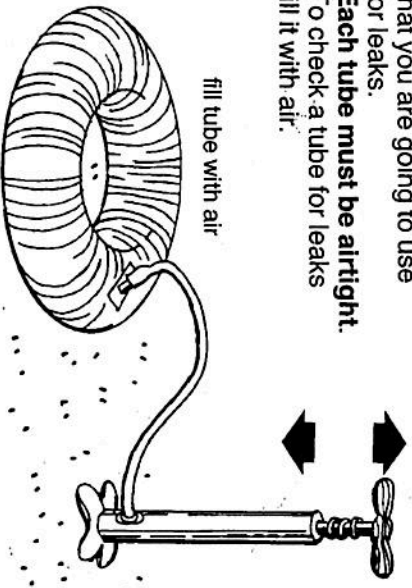
52. As you have been told, this unit has an inner tube which holds the gas.
53. If you can get a large truck or tractor inner tube, you will need only one.



54. You can also use tubes from automobiles. However, these are smaller so you will need two or even three.

55. Try to get a large tube because it is easier to attach one large tube than two or three small ones.

56. First, check each tube that you are going to use for leaks. **Each tube must be airtight.** To check a tube for leaks fill it with air.

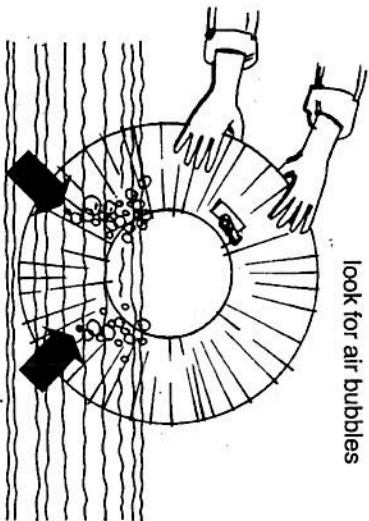


fill tube with air

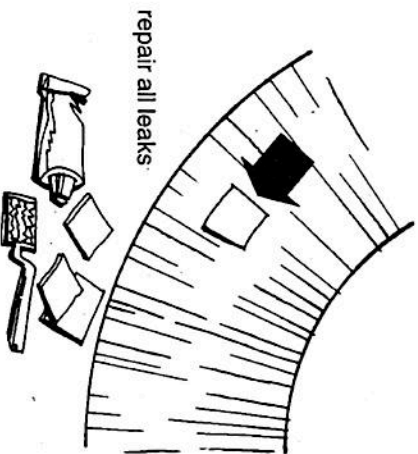
20

57. Then put the tube in water. You can put it in a pond or in a quiet stream.

58. Turn the tube slowly under the water. Look for air bubbles. If you see any bubbles, mark each place on the tube.



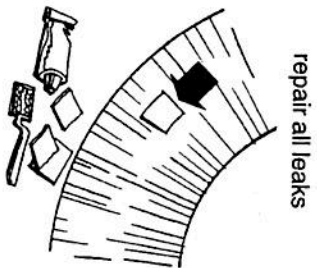
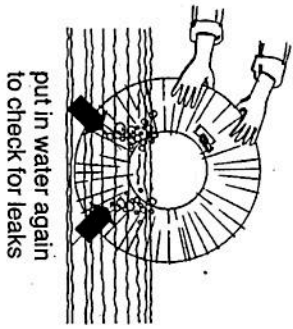
59. Let the tube dry. When it is completely dry, repair all of the leaks.



repair all leaks

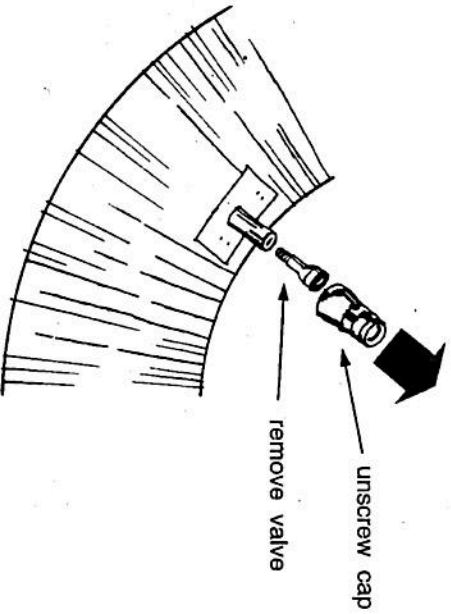
21

60. Fill the tube with air and put it in the water again to make sure that you have repaired all of the leaks well.

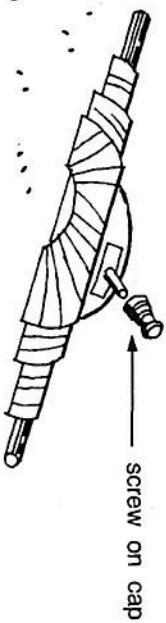
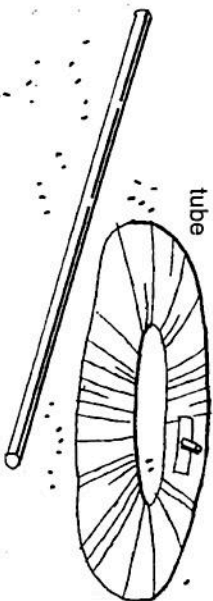


61. If there are still leaks, start all over again. **It is very important to seal all leaks carefully.**

62. When all the leaks are sealed let all of the air out. To do this, unscrew the cap of the air inlet and remove the valve.



63. Roll the tube very tightly. If you have a smooth, round pole, you can roll the tube around this.



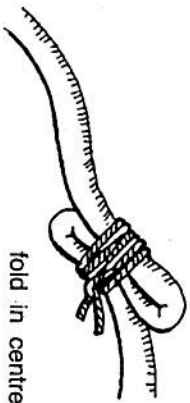
Note

When you screw the cap on the air inlet, **do not put the valve back, and keep the inner tube rolled up until you attach the short gas line** (see Item 70 in this booklet).

65. Now you are ready to attach the gas holder.

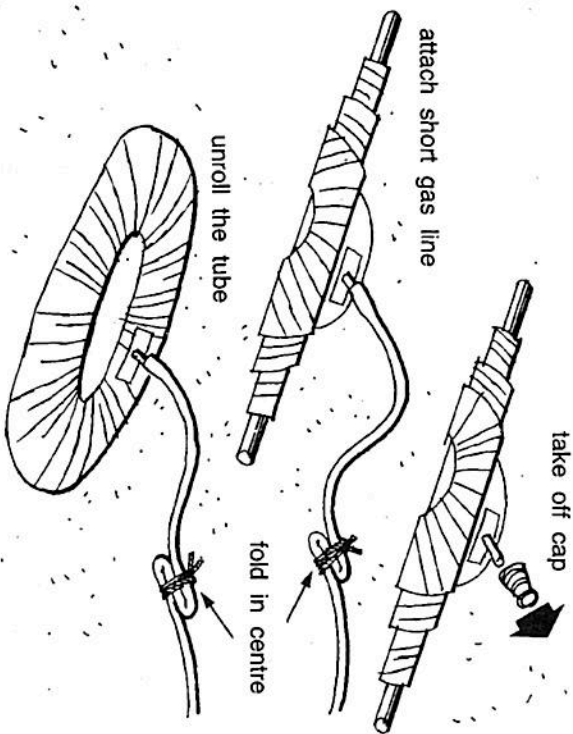
Attaching the gas holder

66. Cut a short piece from one end of the 12-metre gas line. This is to attach the inner tube to the pipe T-piece on the oil drum.
67. This piece should be long enough to connect the T-piece and the inner tube without being tight. If it is too tight, it may pull off.
68. Fold the short gas line at a place near the centre. Tie the fold tightly with cord. The drawing below will show you how.



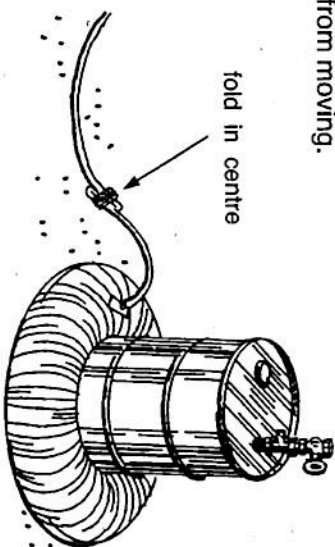
69. The fold will keep more air from getting into the inner tube when you attach it to the short piece of gas line.
70. Take the air inlet cap off the still-rolled inner tube and **attach the short gas line**. Be sure to attach it tightly. You may have to tie it with cord and seal it with tar or mastic. **Now you can unroll the inner tube** (see the drawings on the next page).

24



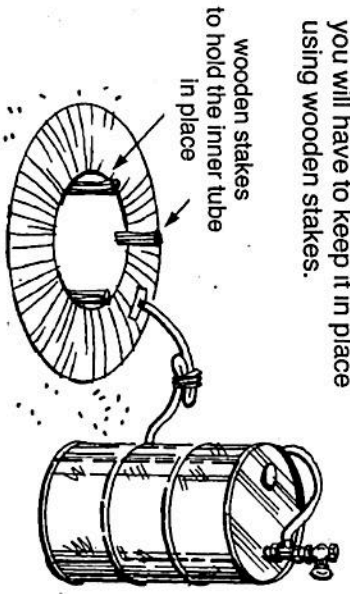
71. **It is very important to keep the gas holder from moving or the short gas line may pull off.**

72. If you are using a large inner tube, fit it over the oil drum and place it on the ground. The drum will keep the tube from moving.

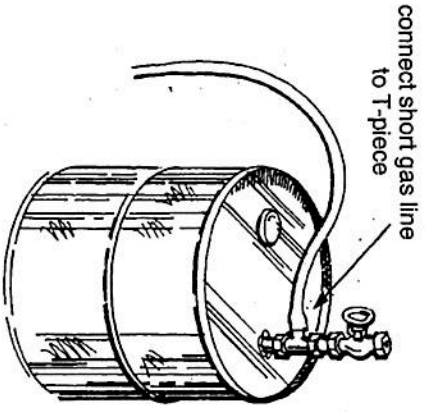


25

73. If you are using an inner tube that is too small to fit over the oil drum, you will have to keep it in place using wooden stakes.

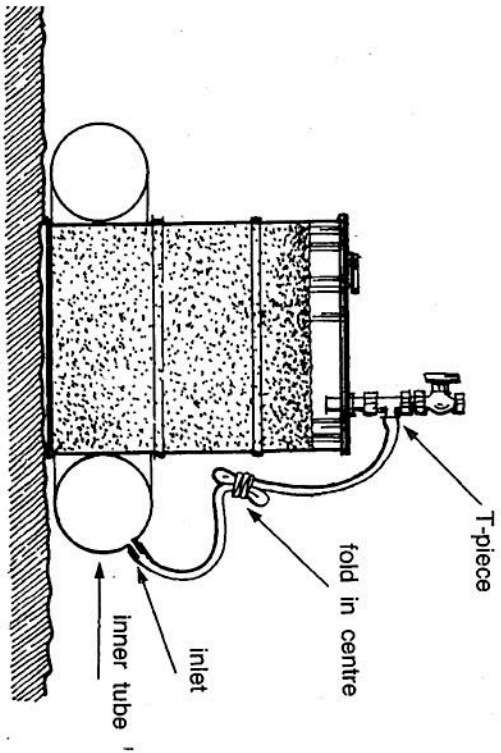


74. Connect the top of the short gas line to the pipe T-piece on the oil drum.

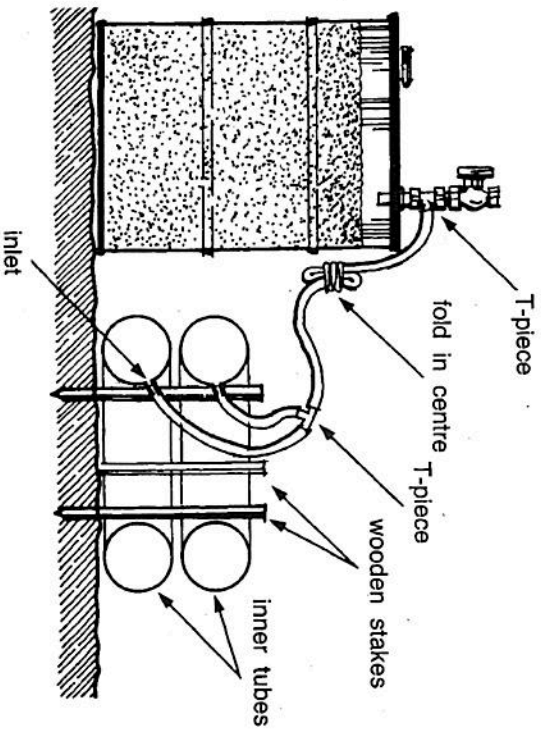


75. However, do not untie the fold in the centre of the short gas line (see Item 101 in this booklet) or attach the long gas line to the valve (see Items 89 to 122 in this booklet) until you are told to do so.

76. The drawings below show you how to connect both large and small inner tubes to this kind of biogas unit.



77. Now you are ready to put waste into the oil drum.

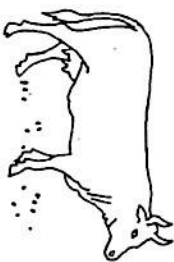


PUTTING IN THE WASTE

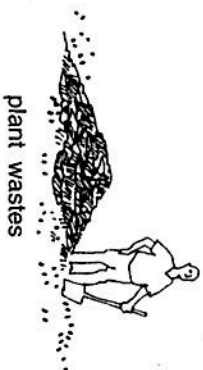
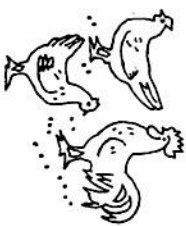
The waste materials

78. You have already been told that this biogas unit is very much like the one that you learned how to build in Booklet No. 31.

79. Since your new biogas unit is much the same as your old one, you can use the same kind of wastes in the same way. Items 58 to 66 in Booklet No. 31 tell you how to prepare them.



cow, pig, chicken manure



plant wastes



crop wastes

80. With the new unit, as with your old unit, you put in all of the waste at **one** time when you begin. Then, when **all** of the gas is made, you take out **all** of the waste, use it for fertilizer, and begin all over again.

81. However, be especially careful to mix the waste and water well. Once this kind of unit is closed you should not open it until **all** of the gas is made.

82. You **cannot** stir it or add more water if the waste becomes too thick as you could with your old unit (see Items 94 to 96 in Booklet No. 31).

83. So, the waste and water mixture for the new biogas unit should be thin enough to pour easily.

84. It should be about as thin as the paint or the whitewash that you use to paint your house.

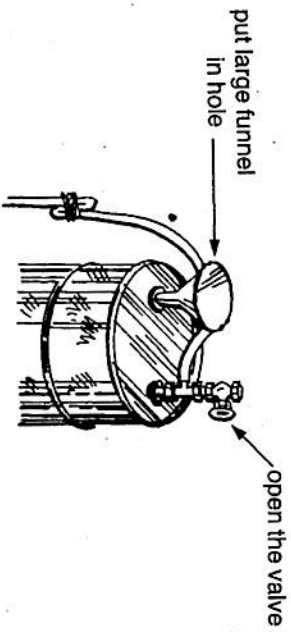
The starter

85. If your old unit is working, take 4 litres of waste from it to use as a starter when you begin.

86. However, if you do not have any waste to use as a starter you will have to make some. Items 67 to 70 in Booklet No. 31 will tell you how to do it.

Putting waste in this biogas unit

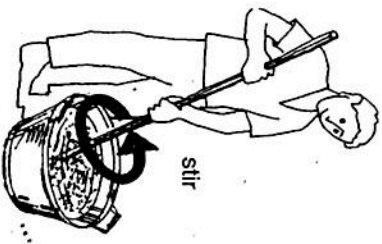
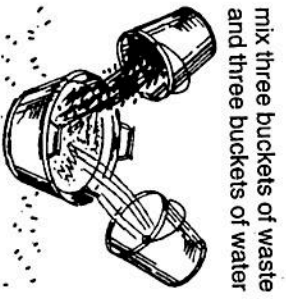
87. When you are ready to add the waste, unscrew the plug in the waste hole and put it carefully aside. Put a large funnel in the hole.



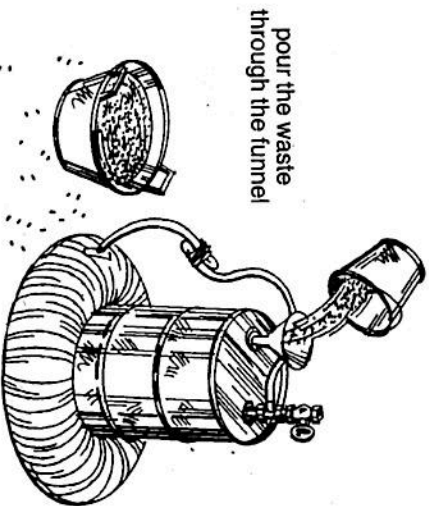
88. Open the valve so that when you add the waste the air that is inside the drum will be forced out through the gas outlet.

89. **You have not yet been told to attach the gas line and you should not have done so** (see Item 75 in this booklet).

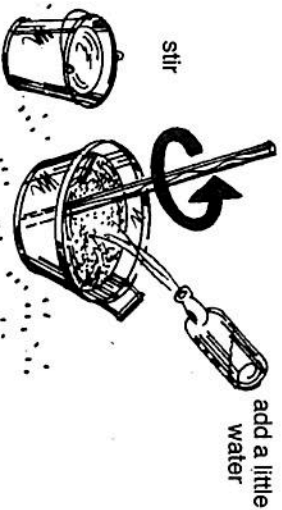
90. Put three buckets of waste and three buckets of water in a large container and mix it well (see Item 84 in this booklet).



91. When the waste and water are well mixed, dip out a bucketful and pour it through the funnel into the oil drum.



92. If it does not flow through the funnel, add a little more water to the waste mixture in the large container.



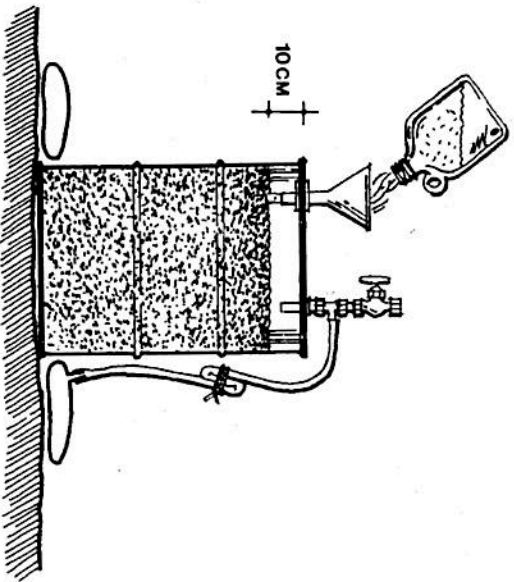
93. Then try to pour another bucketful through the funnel. If the mixture is thin enough to go through the funnel, pour the rest into the drum.

94. Again put three buckets of waste and three buckets of water in the large container and mix it as before.

95. Pour this mixture into the drum. Then take out the funnel. Put a pole long enough to reach the bottom of the drum into the waste hole and stir all the mixture well.

96. Continue in this way until the waste in the drum is about 10 centimetres from the top. Now put in about 4 litres of starter and stir it well.

pour in starter



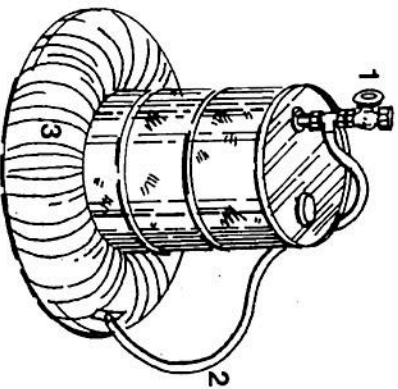
97. The starter, which has already begun to work, will help you to make gas sooner.

After the waste is in

98. Close the waste hole tightly and turn off the valve. After about two weeks, open the valve and let out all the gas that has collected in the top of the drum.

99. **While you are letting the gas out, be very careful not to have fire near the biogas unit.**

100. Listen as the gas escapes. When you hear the sound of the gas stop, turn off the valve **quickly**. This is to keep air from getting into the drum.



- 1 open the valve to let out the gas, then close it
- 2 untie fold in centre
- 3 when the tube begins to swell, gas is being made

101. **Now you can untie the fold in the centre of the short gas line that runs to the inner tube gas holder. When you see the tube begin to swell, you will know that gas is being collected.**

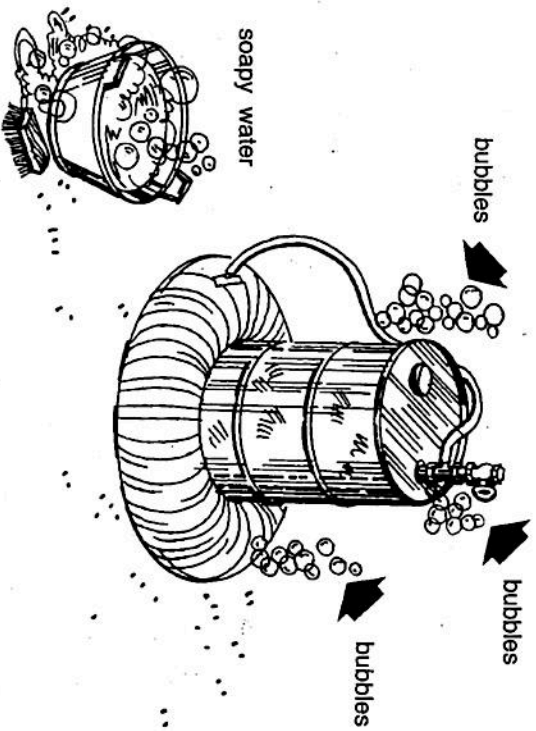
TIME

102. If you find that gas is leaking from the top of the drum after the unit has begun to work, seal the leaks with tar, mastic or paint as you were told to do in Item 47 in this booklet.

103. If gas is leaking around the gas outlet, T-piece, valve or inner tube, tighten them.

Note

A good way to check for leaks after the biogas unit has begun to work is to put soapy water on the drum and on the joints of the parts and lines. If you see bubbles anywhere you will know that there is a leak. Seal all leaks as you have been told to do.



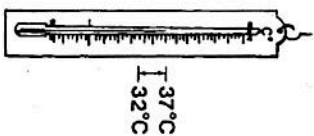
104. It may take up to three weeks or even a month for the waste in your new biogas unit to begin making gas. After that, the unit will continue to make gas for about eight weeks.

105. During these eight weeks half of the gas will be made in the first two or three weeks and the rest in the last five or six weeks.

106. If you find that too little gas is being made in the last weeks, empty the unit and start again.

TEMPERATURE

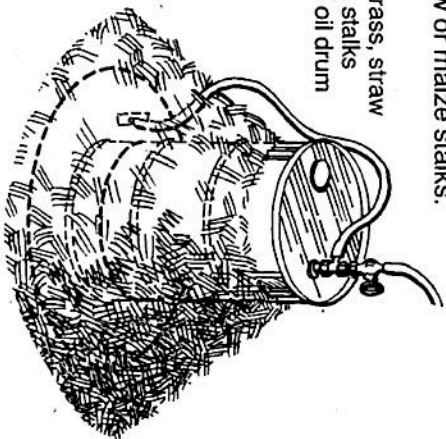
107. You have been told in Booklet No. 31 that **biogas is best produced at a temperature between 32 and 37°C.** When the temperature is below 15°C, almost no gas is made.



Cold weather protection

108. If the temperature where you live often falls below 15°C, you can keep the waste mixture warm by covering this biogas unit with plant materials such as leaves, grass, straw or maize stalks.

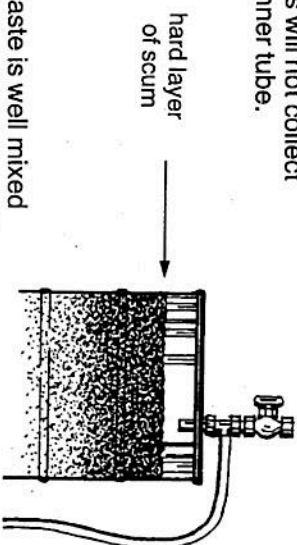
put leaves, grass, straw
or maize stalks
around the oil drum



109. However, as you were told in Item 28 in this booklet, **you must not put this unit underground** as you could with your old unit or you will not be able to shake it to break up the scum

SCUM

110. Sometimes a hard layer of scum may form on top of the waste mixture in your biogas unit. If this happens, less gas will be made and gas will not collect in the inner tube.

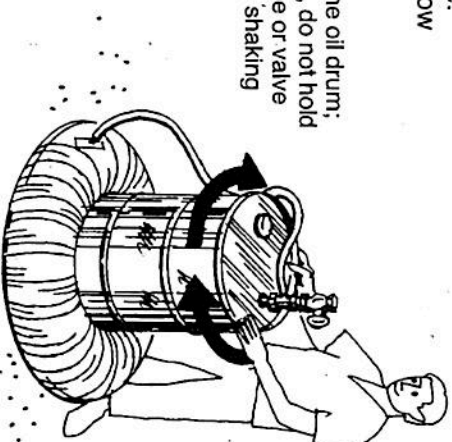


111. If the waste is well mixed before it is put into the unit, there will be less chance for scum to form and your biogas unit will make gas well.

112. Scum is more likely to form if you use plant materials than if you use only animal waste.

113. To keep scum from forming, shake your biogas unit from time to time. The drawing below shows you how.

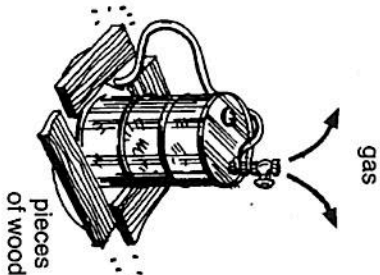
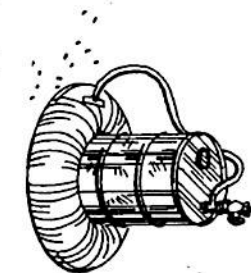
shake the oil drum;
however, do not hold
the pipe or valve
when shaking



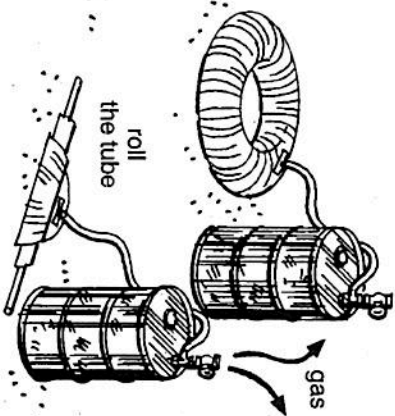
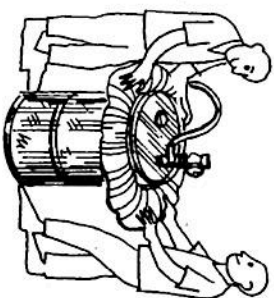
WHEN THE GAS IS MADE

114. **Do not burn the first gas that is made in your biogas unit. It may have air in it and could explode.**
115. A few days after the inner tube has begun to swell with gas, **open the valve and let out all of the gas that has been collected.**
116. **While you are letting the gas out be very careful not to have fire near the biogas unit.**
117. After the valve is open you will have to force the gas out of the inner tube or tubes.
118. You can force gas out of a tube by rolling it as you were told to do in Item 63 in this booklet, or by putting a weight on it such as pieces of wood or stones.
119. The drawings on the next page show you how to force air out of a biogas unit with one or more inner tubes.
120. When all of the gas is out, **close the valve and your biogas unit will begin to collect gas again.**
121. If you have done this carefully, the next gas that is made will have no air in it and will be safe to burn. Do not open the unit again until all the gas has been made.

leave large tube attached to the oil drum and force out gas with pieces of wood

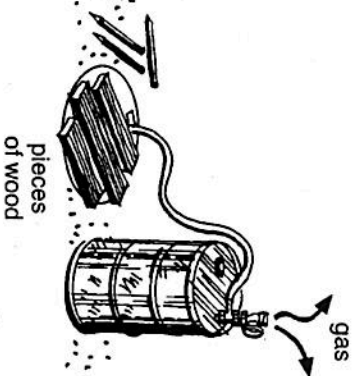
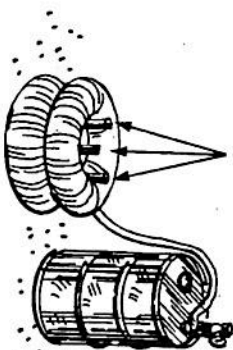


remove large tube and force out gas by rolling it

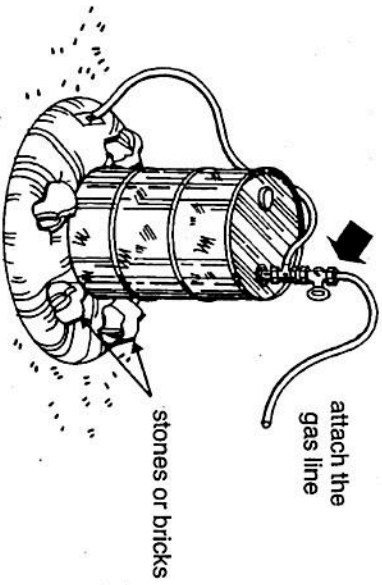


remove wooden stakes and force out gas with pieces of wood

remove stakes



122. **Now you can attach the gas line to the top of the valve.** However, **do not** open the valve until the inner tube is half full. Later, you can help to push the gas out of the inner tube by putting a few stones or bricks on it.

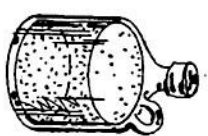


123. Items 108 to 114 in Booklet No. 31 tell you how to use biogas for cooking and how to clean the burner.

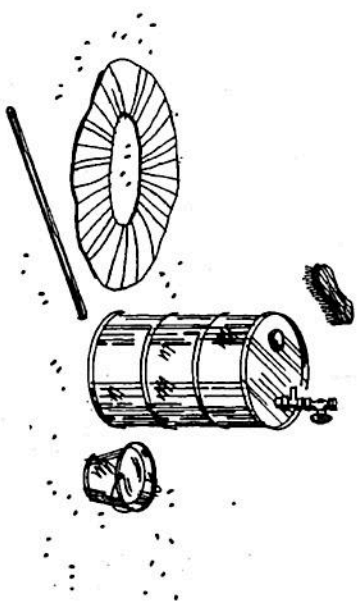
124. After all the gas has been made, take the unit apart and empty out the fertilizer. Items 115 to 118 in Booklet No. 31 tell you how to use the fertilizer.

125. However, be sure to keep about 4 litres of the fertilizer to be used as a starter for the next time.

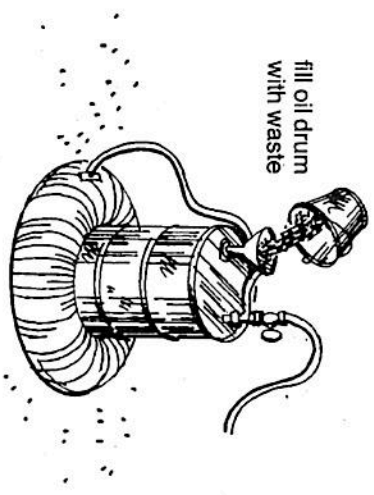
Keep 4 litres of fertilizer as a starter



126. Clean the unit carefully and check for leaks.



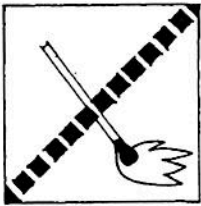
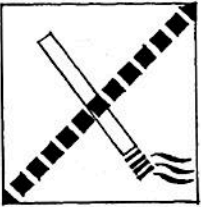
127. Now fill the unit with new waste material and add the starter. Close the unit tightly and it will begin to make gas again.



128. Remember, every time you start again, do not burn the first gas that is made.

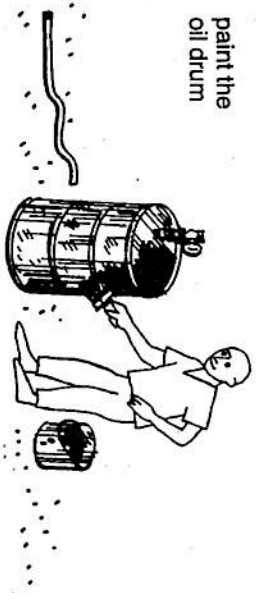
TAKING CARE OF YOUR BIOGAS UNIT

129. Always be careful when you are near a biogas unit because gas may be leaking.
130. If gas is leaking and you breathe in too much of it, it can make you very sick.
131. Never build a fire, smoke, or even light a match near the unit, because if gas is leaking it may explode.

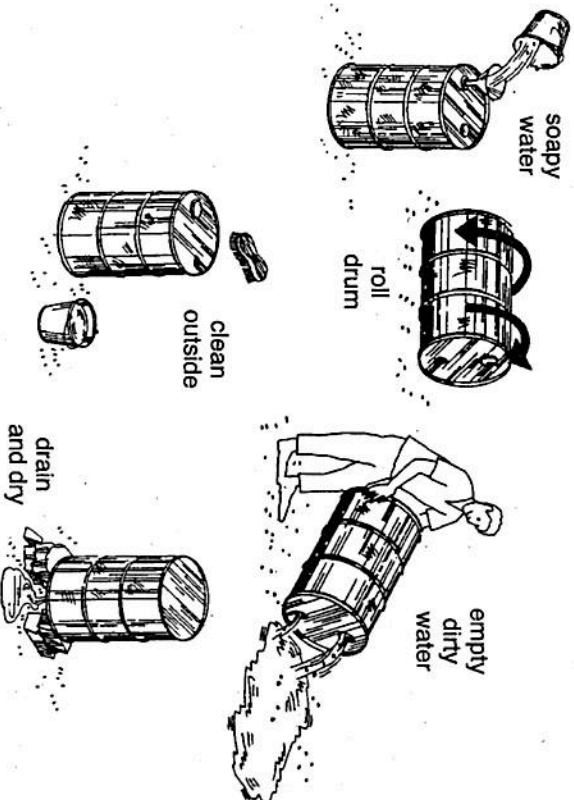


132. Check your biogas unit and gas lines often to be sure that there are no leaks. The note on page 34 in this booklet tells you how to check for leaks in a working biogas unit.

133. If the oil drum begins to rust, coat it with the kind of paint that is used to paint metal.



134. About once each year, when you are taking the unit apart, wash it inside and outside with warm soapy water as you were told to do in Items 19 to 26 in this booklet.

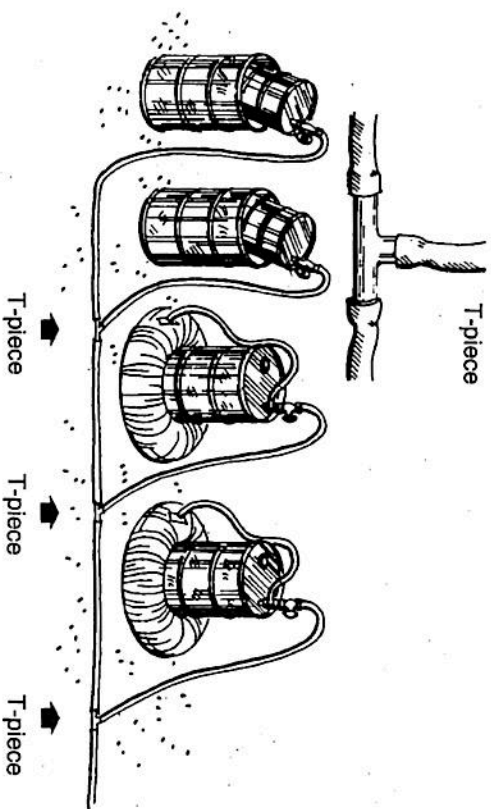


135. Then paint it inside and outside as you were told to do in Items 47 and 49 in this booklet.

MAKING MORE BIOGAS

136. As with your old biogas unit, the easiest way to make more gas is to build one or more small units and get gas from them all.
137. If you can get more oil drums, pipe, T-pieces, valves, inner tubes and gas lines, and if you have enough time, you can build and run more units.

138. The drawings below show you how to connect several units to the same gas line with T-pieces.

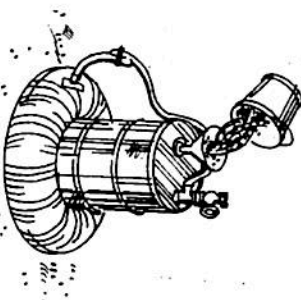
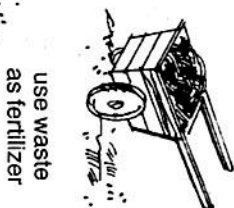


139. As you have already been told in Booklet No. 31, when you have several biogas units, fill them with waste at different times. That way, when all the gas in one unit has been used, you will get gas from another unit that is still working.

WHAT MORE CAN YOU DO?

140. The biogas unit that you learned to build in Booklet No. 31 and the biogas unit that you learned to build in this booklet are both small units that use one drum for the waste holder.

141. With both of these small units you put in all of the waste when you first began. Then, when all of the gas was made, you cleaned out the unit, used the waste as fertilizer and started all over again.

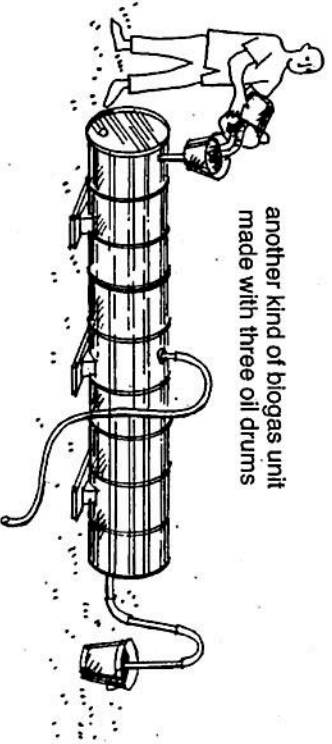


142. By building and using either or both of these units, you learned a lot from your experience.

143. Now, let us look at still another biogas unit that you can build using what you have learned to help you.

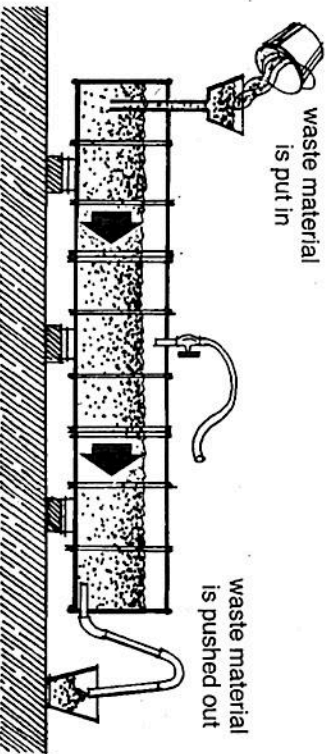
Another kind of biogas unit

144. This unit is bigger and better than your first two units. It is also more difficult to build and to use.
145. This kind of biogas unit can also be built using oil drums with the same kind of pipe fittings that you used before.
146. However, it can be built **much bigger** than your old units. You can use several oil drums instead of only one. So, you can make more gas than you did before.



147. This kind of unit is also filled with waste when you first begin.
148. Then, after the unit begins to make gas, you continue to put in waste from time to time. You may do this every few days or you may do it every week.

149. However, when you put new waste into this kind of unit, an equal amount of waste is pushed out of the unit.



150. With fresh waste material always moving through the unit, it will make biogas for a much longer time.
151. You will learn more about this bigger and better unit in a later booklet in this series.

SAVE HARMLESS AGREEMENT

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Laboratory work, scientific experiment, working with hydrogen, high temperatures, combustion gases as well as general chemistry with acids, bases and reactions and/or pressure vessels can be EXTREMELY DANGEROUS to use and possess or to be in the general vicinity of. To experiment with such methods and materials should be done ONLY by qualified and knowledgeable persons well versed and equipped to fabricate, handle, use and or store such materials. Inexperienced persons should first enlist the help of an experienced chemist, scientist or engineer before any activity thereof with such chemicals, methods and knowledge discussed in this media and other material distributed by Knowledge Publications Corporation or its agents. Be sure you know the laws, regulations and codes, local, county, state and federal, regarding the experimentation, construction and or use and storage of any equipment and or chemicals BEFORE you start. Safety must be practiced at all times. Users accept full responsibility and any and all liabilities associated in any way with the purchase and or use and viewing and communications of knowledge, information, methods and materials in this media.