72
AGROM84

BIOGAS, the Brown Revolution?

social aspects of introducing biogas technology in developing countries, with special emphasis on the potentials and/or consequences for the rural poor

友 vnc

STUDIUM GENERALE

72AGROM84-
1104

72
AGROM84
bn 1104

BIOGAS, the Brown Revolution?

social aspects of introducing biogas technology in developing countries, with special emphasis on the potentials and/or consequences for the rural poor

LIBRARY
International Reference Centre
for Community Water Supply

This publication has been prepared for a study day with the same title held on June 2 1984 in Wageningen, the Netherlands. This day was jointly organised by the Agromisa Foundation, the Holland-China Friendship Organisation and the Studium Generale of the Agricultural University in Wageningen, the Netherlands.

TABLE OF CONTENTS

1. Introduction

During the last decade the idea of applying biogas digesters in developing countries has gained popularity. The results reported from the Chinese People's Republic, where biogas technology was introduced on a large scale, and to a somewhat lesser extent, the experiences from India, have made biogas technology a main issue for many Third World governments, foreign aid organisations and individual development workers (see e.g. Borda, Kijne).

Undoubtedly, the main reason behind this are the increasing difficulties which developing countries face in obtaining cheap and durable energy sources. To mention some typical problems: On a national level many Third World countries are heavily dependent on the import of fossil fuels, using up a large part of the often scarce foreign exchange. At the same time large areas are rapidly deforested, at least partly because wood is still the most important local energy source in a number of developing countries. The resulting erosion problems are large-scale. Many families belonging to the rural or urban poor require an ever larger part of their income and/or time to obtain the minimum amount of fuel necessary for basic activities such as cooking etc. At present it is widely believed that biogas technology could solve the above mentioned and other related problems.

As a result of this a considerable amount of information related to biogas technology and its introduction in several Third World countries has become available during recent years. However, a substantial part of these data deals only with purely technical and/or economic aspects of biogas technology such as design, performance, maintenance, economic analysis of in- and outputs, price comparison with other fuels, nutrient value of the residue etc. (see e.g. Eggeling, van Buren). In contrast, little emphasis is placed on the social aspects of introducing biogas technology in developing countries. Moreover, since the information concerning these non-technical and non-economical aspects is scarce and widely scattered throughout a large amount of case studies, no coherent picture seems available.

Considering all this, it can truly be said that at the moment biogas technology is quite uncritically advocated as another new panacea for the Third World, following in the wake of the Green Revolution, windmills etc.

For this reason it seemed important for the Agromisa Foundation and the Holland-China Friendship Association to jointly organize a study day and to publish this book focusing attention on the social aspects of introducing biogas technology in developing countries, with special emphasis on potentials and/or consequences for the rural poor.

Firstly a short outline of the contents of this book. Chapter 2 is a review of the biogas technique and its potential applications for the non-technical reader. In the following three chapters a summary is given of the available information which can be deduced from the large amount of case studies. The chapters are organized geografically as follows:

Chapter 3 reviews the state of the art of biogas technology in the Chinese People's Republic. In this country biogas is most widely spread and propagated by the government, and importantly, at least initially in a number of areas the introduction of the biogas technique was a result of purely local initiative.

In chapter 4 the reasonably widespread experiences with biogas technology in India are summarized. Here the situation is not only characterized by a widely different social structure compared to the Chinese People's Republic, but introduction in India is occurring via a massive, government-initiated top-down approach. The results vary greatly.

In chapter 5 some, often isolated cases, of the introduction of bio-

gas technology in other countries will be described.
In the concluding chapter we will present a synthesis of the material from the previous chapters with which we will try to evaluate the potentials and consequences of biogas technology for the rural poor as well as the relevant factors and/or local prerequisites to be considered.
Furthermore, the experiences with biogas technology will serve as a starting point for a more general discussion on the strategies (of which technology transfer is one) for improving the position of the most marginal groups in developing countries.

An outline of this discussion will be given below; more details can be found in the concluding chapter of this book.

First we will mention the point of view taken in this book. Our development objective will be the structural development of the socially/economically marginal groups in the Third World, in most cases the rural poor, i.e. small and marginal farmers and landless labourers. A structural development will at least include the longterm accessability to 'basic needs' (consumption, work, education, power) and the reduction of inequalities and dependence at an individual and/or village level (local self-reliance). Any development strategy which initiates and/or consolidates this structural development will be 'appropriate' in our terminology. This global criterium may seem rather trivial, but, as will become clear in the concluding chapter of this book, only after explicitly stating the proposed development objectives and strategies, will it be possible to arrive at more specific local prerequisites for the 'appropriateness' of development strategies. It should be pointed out that the choice of development objectives and the ensuing strategies also involves a political choice, which is not often made explicit.

As a next step we will at length discuss technology transfer versus organisation as 'appropriate' strategies.

At this point a remark on the usage of the term 'technology'. In this book the term technology will include the whole collection of knowledge (a general framework of ideas about human surroundings), know-how (insight into specific processes and their technical as well as organisational way of control) and the actual techniques (tools i.e. particular pieces of hardware) to solve clearly defined problems. It should be strongly emphasised that this definition of technology implies that any culture, society or social group can and has the right to give shape to their own technologies.

Using this concept of technology will enable us to explain the strong interrelatedness of technology transfer and organisation as 'appropriate' development strategies and also enable us to formulate common local prerequisites for 'appropriateness'.

It should be noted at this point that the concept 'appropriate technology' is nowadays in general used in a much narrower, often solely technique-oriented sense, by the more professional but also by other development aid organisations who have discovered 'appropriate technology' as their new paradigma.

In the second part of the concluding chapter we will discuss the 'appropriateness' of biogas technology. We will also pay attention to the consequences for the rural poor where biogas technology is only applied by other, in most cases wealthier groups. A number of local prerequisites are briefly summarized in the following, to indicate our line of thought. These are roughly divided into two groups, which are however not mutually exclusive:

Cultural/social prerequisites: considering the cultural aspects, the first question to be asked is whether the technology is adapted to the traditions of the society in question. Relevant factors in the case of biogas technology are the existing ways in which people deal with possible inputs such as dung and/or nightsoil, the way food is prepared in case biogas is to be applied for cooking purposes, and the possibility to build the new technology upon existing skills. On the social level the organisational aspects of the technology are the most important. The technology should preferably be introduced cooperatively to a group of families/people rather than fostering actions of individuals since in the latter case inequalities between individuals and/or families might become larger. This implies the need for some basic form of organisation at village and/or small community level, as well as a maximum amount of participation from the start of the program introducing the new technology, resulting in a technology that can be understood, controlled and

maintained by the community itself. Attention should also be paid to the direct or indirect impact of introducing biogas technology on the employment situation, with special effect on the traditional division of labour between men and women.
Economical/technical prerequisites: under this heading various aspects could be mentioned. First of all the economic viability of the technology in terms of costs for building, maintenance and inputs versus profits on outputs. It remains of course to be seen if the technology is affordable for the rural poor, which will depend on the availability of individual and/or collective credit facilities which will not lead to increased dependence. Indirect effects are for instance the changing market value of the inputs (such as dung) and of alternative fuel sources (such as wood). Secondly, some of the more technical aspects involved are the right environmental conditions for operating the system, the local availability of the necessary materials (thus reducing dependence on transport), polluting effects etc.

The book is concluded with a number of recommendations for development aid agencies.

REFERENCES

BORDA (1980): Biogas Manual for the Realization of Biogas Programmes. Bremen Overseas Research and Development Association, West-Germany.

Buren, A. van (Ed) (1979): A Chinese Biogas Manual. Translated from the Chinese by Michael Crook. Intermediate Technology Group, London.

Eggeling, G. and B. Stephan (Eds) (1981): Biogas in the People's Republic of China. (Summary of the Project Report), GTZ, West-Germany.

Kijne, E. (1984): Biogas in Asia, Inventory Field Study on the State of Development of Biogas Digesters for Household Use in Tropical Rural Communities. Consultants for Management of Development Programmes b.v., Achter Clarenburg 25, 3511 JH Utrecht, the Netherlands.

2. Biogas Technique and its Applications

2.1 INTRODUCTION

This chapter starts with a short description of the process of biogas generation (anaerobic digestion). In the next part some technical and environmental constraints for the anaerobic digestion process are discussed. This part is followed by a description of the currently most widely used digester models in developing countries, together with their technical advantages and disadvantages. The chapter is concluded with a review of the most popular arguments used for application of biogas in the Third World. For the contents of this chapter we used material from Sathianatan, Stuckey, and Kijne, whom are hereby acknowledged.

2.2 BIOGAS? WHAT IT IS AND HOW IT IS FORMED (AFTER SATHIANATAN)

All dead plant and animal matter decay. It is nature's oldest method of disposing of waste. This decay or decomposition is carried out by tiny micro-organisms called bacteria. It is known that some bacteria (aerobic) carry out the decomposition in the presence of air and others (anaerobic) do it without air. When the decomposition takes place in the presence of air the gases gradually escape and a heap of manure (compost) is left. When a heap of vegetable or animal matter or the rushes and weeds at the bottom of a pond die, then the water first turns acid and gives out a rank smell, and then gradually begins to turn alkaline, and you notice bubbles rising to the surface. Sometimes these bubbles burn with a dancing flame at dusk, giving rise to tales of will o' the wisp, the fire fairy of the marshes.

This phenomenon was noticed for ages, but man was not able to explain the cause or imitate it as he was able to do with other things. But during the past one hundred years the patient investigations of many scientists have unlocked many of the secrets of the decomposition process. We now know that when anaerobic decomposition takes place, a mixture of gases (mainly methane and carbon dioxide) and residual undigested matter are left. The gas methane burns with a hot light blue flame in excess air. The knowledge of the biology and biochemistry of methane bacteria has developed slowly over a long period of time. Unfortunately this knowledge is still incomplete and superficial in many respects. Much time and effort will be required to bring our understanding of this group of bacteria to a level comparable with that of many other groups of micro-organisms. All the same we have gained enough information to copy nature's process and produce methane. We have been able to understand better the raw materials that best produce the gas and also the conditions under which this is best produced.

BIO-DIGESTION OF PLANT AND ANIMAL WASTES

It is possible to imitate nature's process of anaerobic digestion by putting organic wastes like cow dung into insulated air-free containers called digesters. The digester is fed with a mixture of water and wastes called slurry.

The anaerobic bacteria responsible for digestion cannot survive with even the slighest trace of oxygen. So because of the oxygen in the manure mixture fed to the digester, there is a long interval before methane-forming digestion starts taking place. During the 'aerobic' period the traces of oxygen are used up by the oxygen-loving bacteria and large amounts of carbon dioxide are released. Digesters are of two types:

1. Batch-fed digesters which are filled all at once, sealed and later emptied when the raw material has stopped pro-

ducing gas, and

2. Continuous-load digesters which are fed a definite quantity at regular intervals so that gas and fertilizer are produced continuously.

Most of the digesters used in developing countries are of the continuous load type. Inside the digester each daily load of fresh slurry flows in at one end and displaces the previous day's load which bacteria and other microbes have already started to digest. Each load progresses down the length of the digester to a point where the methane bacteria are active. At this point large bubbles force their way to the surface where the gas accumulates. The gas is very similar to natural gas and can be burned directly for heat and light, stored for future use, or compressed to power heat engines.

Digestion gradually slows down towards the outlet end of the digester and the residue begins to stratify into distinct layers (Fig. 2.1). The non-gaseous products can be used as organic fertilizer.

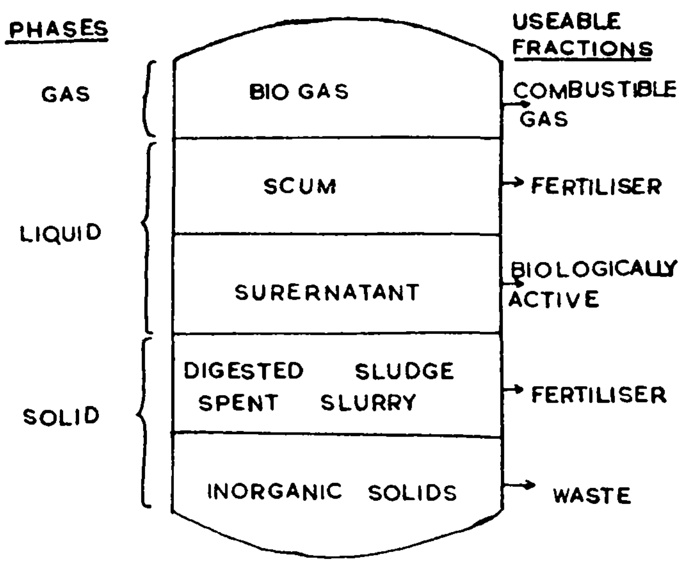


Fig. 2.1: Layering of by-products in the digester. Layers not proportional to actual situation. (from Sathaniatan)

BIO-SUCCESSSION IN THE DIGESTER

Once the oxygen disappears the steps leading to the digestion process for producing methane begins. This process involves anaerobic bacteria feeding on the raw organic matter.

Anaerobic digestion consists of three phases:

1. Hydrolysis
2. Acid formation
3. Methane formation

These processes are carried out by two sets of bacteria, the acid forming bacteria and the methane formers. The steps leading to methane formation can be described as follows:

HYDROLYSES:

Bacteria which are the work-horses of anaerobic digestion have a cell membrane, through which their food has to pass. Whereas soluble substances which are not of large molecular weight can pass through the cell membrane by diffusion, sludge particles and large polymers cannot pass through such membranes. Bacteria release what are known as extracellular enzymes into the medium in order to break down the sludge particles and large molecules into smaller molecules that are soluble. The process of hydrolysis is somewhat similar to that of the hydrolytic processes that occur in the digestion of food in the stomach and intestines of the human being. There are many enzymes to hydrolyse different materials. These steps may not be necessary if the raw materials consist of soluble and simple organic substances occurring in nature.

ACID FORMATION AND METHANE FERMENTATION

The bacterial cell gains energy and chemicals for cell synthesis through biological oxidation by oxidizing the organic substances that can pass through the membrane and enter the cell. In anaerobic digestion organic substances are oxidized by acetogenic bacteria to simple compounds, of which the volatile acids are the most important.

Certain specific bacteria convert the volatile acids produced in the acid formation phase to methane and carbon dioxide. The mixture of these gases is known as digester gas, gobar gas, or biogas. This gas generally consists of 30 to 40 percent carbon dioxide and 60 to 70 percent methane. The methane fermentation is known to be carried out by a specific group of microorganisms known as methane anaerobes and also to have long generation times. Although ubiquitous in nature, these organisms are sensitive to environmental conditions. They do not multiply fast enough below 10°C. Similar to a majority of the bacteria, they have an optimum temperature of 35°C (the mesophilic range). The acid bacteria are capable of rapid reproduction and are not very sensitive to changes in their environment.

As different kinds of bacteria become active, the by-products of the first kind of bacteria provide the food for the other kind. The reactions in the three phases have to go on simultaneously. If any one of the reactions (especially acid formation) precedes the other reactions, it will lead to an upset of the digester and consequent inactivation of the other organisms. Biologically, then, successful digestion depends upon achieving and maintaining a balance between those bacteria which produce organic acids and those which produce methane gas from the organic acids. The balance required for an optimum production of methane depends on many factors. The more important of these are discussed in the next section.

2.3 CONSTRAINTS FOR THE ANAEROBIC DIGESTION PROCESS (AFTER KIJNE)

As explained in section 2.2, the anaerobic digestion process is based on the stimulation of the stage-wise bacteriological breakdown of organic matter, producing a combustible mixture of gases and organic fertilizer. The variety of bacteria specific to this process require the total absence of oxygen, a particular temperature range and a degradable organic feed with specific carbon:nitrogen ratio (C/N).

OXYGEN

Digester designs are necessary in which the organic matter to be digested is not in contact with oxygen from the air. Leakages in the digester will release produced gas, and allow oxygen to enter, which may inhibit the anaerobic bacteria. Of all the different bacteria that are active during the anaerobic process the methane forming organisms are the most sensitive and strictly anaerobic. Even oxidised minerals such as nitrites or nitrates can inhibit those bacteria (NAS, 1981).

TEMPERATURE

Most digesters are commonly operated at the 25-35^{o}C range. As remarked in section 2.2, some of the bacteria do operate at other temperatures but especially the methane producers are very susceptible to a sudden drop in temperature of even a few degrees. The occurrence of process disturbances due to temperature changes can be reduced through adjustments in the building design. Depending on the external daily and seasonal temperature fluctuations and the suddenness of these, digesters may have to be insulated and in some cases even heated. However, most of the simple household digesters which are in operation in tropical rural areas are hardly insulated and unheated because of the favorable environmental temperature.

DIGESTER FEED

The growth in numbers of the micro-organisms during anaerobic digestion is related to the ease of availability of the required feed for the bacteria in the form of nutrients. The rate and degree of decomposition reflects the capabilities of the bacteria on the one hand and the resistance of the substrate compounds to microbial attack on the other. The more biodegradable the digester feed, the greater the quantity of methane generated. The particle size of the solids in the slurry determines the contact area with the bacteria and the biodegradability.

A large number of different organic waste materials can be fed to an anaerobic digester. Most common are animal manures, human excreta, crop wastes and aquatic plants. The animal manures are most widely used.

The main advantage of animal manure is that it is easy to collect in reasonable quantities, already in a degradable state and easy to mix as a slurry. It is most appropriate for biogas production because it is already inoculated with the required anaerobic bacteria from the animal intestines.

Other feedstuffs, such as crop wastes and aquatic plants will require pretreatment (chopping, soaking or decaying) to increase the surface area liable to bacterial attack and to break up the cellulose-lignin cell protection. Because plant material has not been decomposed as animal manure, it may lead to higher gas production values. However, it may not make up a homogenous slurry and can start floating and form a scum layer, or may sink and fill up the digester. In both cases operation management has to control and correct proper digestion conditions intensively.

The bacteria require a feed with a C/N ratio within the range 25/1 to 35/1 (Golueke, 1980). If the C/N ratio is beyond the desired range the nitrogen will be exhausted while there is still a supply of carbon left. C/N ratios which are too low cause an excess of nitrogen in the form of ammonia (NH_3) which can be toxic to the bacteria. Not only will the rate of decomposition be affected by the C/N ratios but also the composition of the biogas. C/N ratios that are below the optimum of 30 will produce biogas with high carbon dioxide values.

The C/N ratios of a feedstuff can be adjusted through the removal of solids, the addition of feeds containing high carbon, or by addition of feeds with a high nitrogen percentage.

WATER

Dilution with water is also needed to make up a slurry composition that contains a solid concentration of about 8%. The solids concentration of the original manure will be about 25%. Digestion of a slurry with a too high solids concentration can cause a concentration of toxic material that may inhibit bacteria growth. Low water contents will also reduce the spread of bacteria through the slurry, which will affect the digestion efficiency. In a continuously fed digester the bacteria may even stop functioning completely. If the slurry is too dilute it will become physically unstable and settle into separate layers.

The amount of water that is required depends on the total amount of digester feed used and the rate of dilution required. Different digester feeds have different chemical compositions with regard to the solids concentration.

The composition of cattle manure will differ according to the species and age of the cattle and the husbandry system followed, including the cattle feed and watering practices used and the method of handling the manure. The degree of exposure to the environment will alter the quality of the manure. In general it is roughly advised that cattle manure should be diluted with equal quantities of water, while poultry manure, because of high ammonia concentrations, should be diluted four times as much. Availability of, and easy access to the required quantities of water for making the proper slurry dilution is essential. Means and ease of collection, as well as the availability of labour will determine the maximum size of the digestion operation.

2.4 DIGESTER DESIGNS (AFTER STUCKEY AND KIJNE)

In this section some technologies available to carry out digestion will be briefly summarised, and their stage of development assessed. Also the ancillary technology involved in heating mixing, and gas storage will be examined. The primary techical requirement of anaerobic digestion is that it be carried out in airtight reactors with sufficient volume for the biological reactions to be carried out without stress. Based on external limitations such as capital cost, treatment efficiency, net energy yields, and operational skill, the technology available can range over a spectrum from very rudimentary to quite sophisticated. The fact that anaerobic digestion has been used in practical situations for over 80 years demonstrates that it is a viable technology. However, problems can arise when it is subjected to severe external constraints such as limited capital and low operational skills as in developing countries. The following is a summary of the technical options varying from the simplest to the most complex.

BATCH AND 'DRY' FERMENTATION

This is the simplest option available, and operation involves charging an airtight reactor with the substrate, a seed inoculum and in some cases a chemical to maintain a satisfactory pH. The reactor is then sealed and the fermentation is allowed to proceed for 30-180 days. During this period the daily gas production builds up to a maximum and then declines. This fermentation can be run at 'normal' total solids contents (i.e. 6-10%), or at high concentrations (more than 20%) which is known as 'dry' fermentation. This design is shown in Figure 2.2.

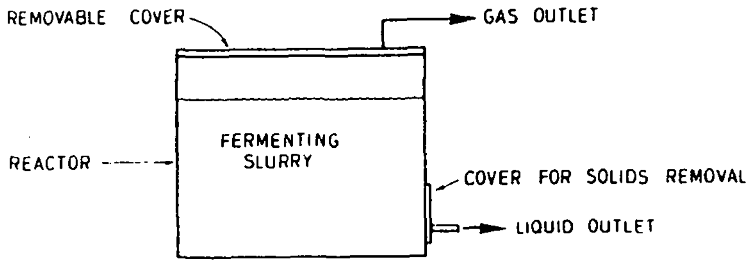


Fig. 2.2: Batch digester (from Stuckey)

From ongoing research it can be concluded that the stage of development for low solids batch reactors is quite advanced (Stuckey) and the technology has been used successfully for many years. At this stage it seems a viable technology, and its gas production rates are competitive with semi-continuously fed reactors.

FIXED DOME (CHINESE) DIGESTER

In terms of absolute numbers this is by far the most common digester type in developing countries, and the basic design originated in China. The reactor consists of a gas-tight chamber constructed of either bricks, stone or poured concrete. Both the top and bottom of the reactor are hemispherical, and are joined together by straight sides. The inside surface is sealed by many thin layers of mortar to make it gas tight, although gas leakage through the dome is often a major problem in this type of design. The digester is fed semi-continuously (i.e. once a day) and the inlet pipe is straight and ends at midlevel in the digester. The outlet is also at mid level, and consists of a fairly large storage tank. There is a manhole plug at the top of the digester to facilitate entrance for cleaning and the gas outlet pipe exits from the manhole cover (see Figure 2.3)

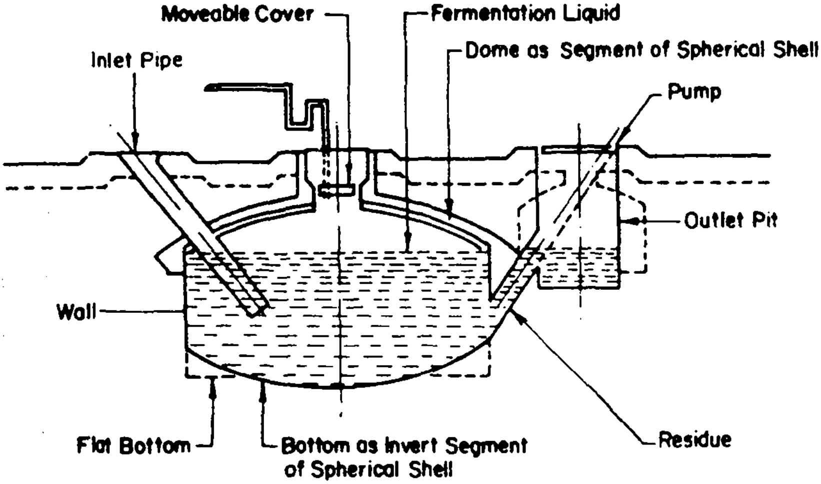


Fig. 2.3: The fixed dome (Chinese) digester design (from Tam & Thanh)

The gas produced during digestion is stored under the dome, and displaces some of the digester contents into the effluent chamber leading to gas pressures in the dome of between 1-1.5 m of water. This creates quite high structural forces, and is the reason why the reactor has a hemisperical top and bottom.

At the present time there are approximately 5 to 6 million of these digesters in China (Chan U. Sam, 1982) and a handful in India and other countries. The typical feed for these digesters is not homogenous and is usually comprised of a mixture of animal manure (ex.swine), nightsoil, and agricultural residues depending on their availability. Agricultural residues are usually pretreated by composting with nightsoil and a little lime before digestion (UNEP, 1981). Typical gas productions are in the order of 0.1-0.2 m^3 gas/ m^3 digester volume per day (V/V day). (Chan U. Sam, 1982) with detention times of 60 days at 25°C.

In India this Chinese circular fixed dome digester was adjusted and changed into the Janata design. Both inlet and outlet chambers have been enlarged to reduce differences in slurry level and gas pressure. Through this change it becomes possible for a man to enter the digester via the outlet. The manhole on top of the dome becomes redundant.

Advantages:

- Underground structure. The digester can be built under the surface and hidden from view. Construction of such a digester in a courtyard will therefore not easily get rejected on aesthetical grounds. It is covered by soil which supplies useful insulation in colder regions.
- Gas production. Most indications are such that a fixed dome digester generates higher quantities of gas than a digester with a floating gas holder.
- Maintenance. Since the digester has no metal or moving parts it will not require any maintenence. However, when cracks develop in the structure repairs will be needed. About once a year it may have to be emptied to remove the sedimented sludge.
- Costs of construction. The construction of such a digester is cheaper than of the one with a floating gas holder. However, regional differences will exist.
- Availability of building materials. In most rural areas the building materials for a fixed dome digester are usually available. Some problems with timing of supply of e.g. cement may exist.

Disadvantages:

- Leakages. It is very difficult to make the masonry structure and the cement plaster of the dome gastight. Especially since the gas pressure can reach high values. Cement has the tendency to get weaker and porous over the years, particularly if the cement fraction in the mortar is low. Movements of the soil can cause cracks to develop. Especially the inside plaster of the dome has to be made very carefully.

- Need for skilled labour. The fact that a very strong foundation and a digester that is gasproof are required as cheap as possible, implies the need for highly skilled masons. Training of masons is essential. See the chapters on biogas technology in China and India for a description of some of the training programmes.
- Gas pressure. The gas pressure is developed by the difference in slurry levels in outlet and digestion compartment. Increased gas storage will increase the gas pressure. Often wastage of gas is observed when cooking is done on too high a flame. If too much gas is produced, the effluent should be allowed to flow away or the gas should be allowed to escape.
- Stirring. Agitation of the slurry is difficult in this type of digester. Poking with a stick via the inlet and outlet is often done but this is not very effective. Also, in this way the scum layer cannot be broken. Sometimes a mixing device is installed in the dome.
- Loss of generated gas. Gas bubbles released from the slurry in the inlet and outlet are lost in the atmosphere. Since the surface area of inlet and outlet is rather large the quantity of gas that is lost can be quite high.

FLOATING COVER (INDIAN) DIGESTER DESIGN

This design is the most popular in India, and is used extensively throughout the world being the most common type of digester used for treating sewage sludges in developed countries. The Indian (KVIC) design consists of a cylindrical reactor with a H/D (height/diameter) ratio of between 2.5 and 4.1 (see Figure 2.4). The reactor is usually constructed of brick, although chicken wire reinforced concrete has also been used. The construction does not have to be as strong as the fixed dome type since the only pressure on the walls is the hydrostatic pressure from the liquid contents. The gas produced in the digester is trapped under a floating cover on the surface of the digester, which rises and falls on a central guide. The volume of the gas cover is about 50% of the total daily gas production, and the cover is usually constructed of mild steel, although due to corrosion problems other materials

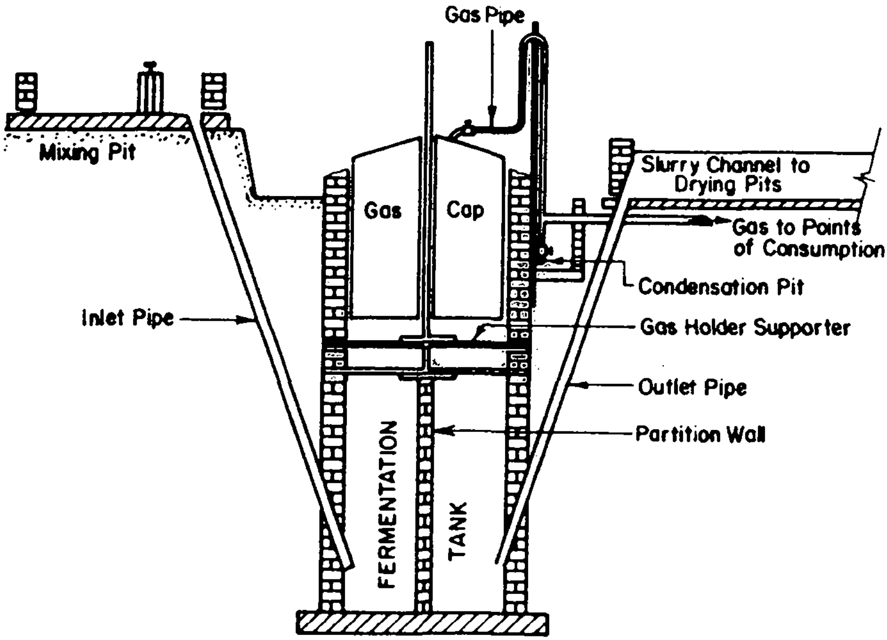


Fig. 2.4: The floating cover (Indian) digester design (from Tam & Thanh)

such as ferrocement and fiberglass have been used. The pressure of the gas available depends on the weight of the cover per unit area. The reactor is semi-continuously fed through an inlet pipe, and displaces an equal amount of slurry through an outlet pipe. When the reactor has a high height/diameter ratio, a central partition wall is built inside to prevent short circuiting. Typical detention times vary from 30 days in warm climates (e.g. Southern India) to 50 days in colder climates (e.g. Northern India). With cattle manure at 9% total solids content, gas yield of between 0.2 and 0.3 V/V per day are achieved. The typical feed of such digesters is usually cattle dung, although substrates such as agricultural residues, nightsoil and aquatic plants have also been used.

Advantages:

- Gas pressure. Due to the lifting of the gas holder and its own weight the gas pressure will be very low and not exceed 10 cm water column. This pressure is sufficient to supply gas to stoves and avoids wasting of gas due to a too high flame.

- Scum removal. The gasholder can be removed from the digester to break up the floating scum manually or empty the digester in case of blockages or repairs to be carried out.
- Mixing. The floating gas holder can be rotated occasionally. The mixing bars which are fitted inside the digester cause agitation of the slurry. Mixing of the slurry may lead to higher gas production due to the increase of contact area with the bacteria and/or through the forced removal of small gas bubbles from the slurry. The daily rise and fall of the gas holder will also break up the scum layer. However, rotation of the gas holder is not an easy task because of the connected gas pipe. Damage to the gas pipe due to this rotating is not uncommon.

Disadvantages:

- Depth of digester. Digging the required depth for the digester is often a difficult and labourious job particularly in rocky soils. This depth will also restrict construction of a digester in areas with a high ground water table.
- Gas holder. The gas holder is the most costly part of the digester. These high costs are due to the high price of metal sheets and the high quality welding. The demand for gas holders needs numerous workshops that construct them. However, in a lot of developing countries these workshops are often situated around urban regions incurring high transportation costs and organizational problems to reach remote rural digester construction sites. A most serious problem of the KVIC digester is the corrosion of the metal gas holder. Because the drum is usually floating in the slurry, rusting takes place very quickly. Particularly the zone of the drum that is in contact with the surface of the slurry and which is alternatively dipped under and exposed to air is affected. Painting of the drum is essential. Yearly maintenance is strongly advised. Even though high quality epoxy paint will lengthen the life of the metal drum, it will usually only delay corrosion for five years. Practical field experience reveals the problems of the required yearly lifting of the heavy drum be-

cause mostly no hoisting facilities are available. If yearly painting is done at all, the crucial contact zone where the drum moves in and out of the slurry is often not properly treated.
The metal gas holder is an ideal conductor of heat and transmits most heat from the slurry into the air. Heating of the slurry via the sun-heated gas holder will on the other hand not reach very deeply into the slurry because the gas is an ideal insulator.

BAG (TAIWAN) DESIGN

The bag digester is essentially a long cylinder made of either PVC, a Neoprene coated fabric (Nylon), or red mud plastic (RMP) (see Figure 2.5). Integral with the bag are feed inlet and outlet

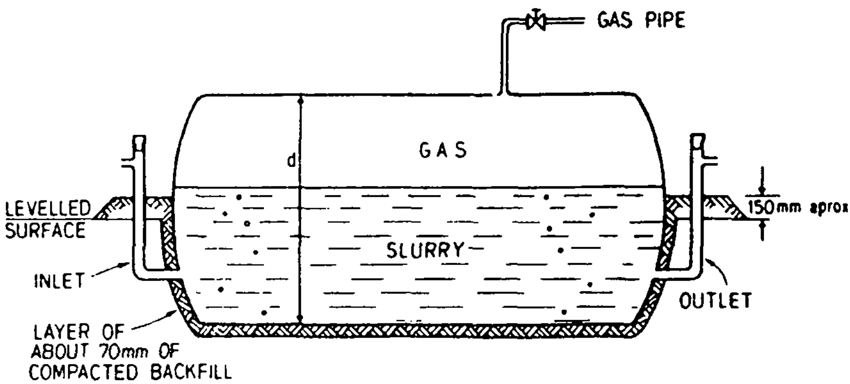


Fig. 2.5: The bag (Taiwan) digester (from Stukey)

pipes, and a gas pipe. The feed pipe is arranged such that a maximum water pressure of approximately 40 cm is maintained in the bag. The gas produced is usually stored in the reactor under the flexible membrane, although it can be stored in a separate gas bag (Park et al. 1981).

The basic design originated in Taiwan in the 1960's (Hoa et al. 1980) due to problems experienced with brick and metal digesters. However, the original material used, a Neoprene coated nylon, was expensive and did not weather well. In 1974 a new membrane red mud plastic (RMP) was produced from the residue of aluminium refineries, and was both inexpensive and had a life expectancy of around 20 years (Hong et al. 1979). Due to its availability, PVC is also started to be used extensively, especially in Central A-merica (Umana, 1982). The digester can be installed easily by ex-cavating a shallow trench slightly deeper than the radius of the digester.

The Taiwanese evolved the bag digester to treat primarily swine manure, and this is the most common substrate in Korea (Park et al., 1981) and Fiji (Chan 1981). Due to its low cost and excel-lent durability the Chinese have also started producing these di-gesters. Depending on the availability of the plastic, a rapid ex-pansion in the use of bag digesters is expected in China, and in time it may eventually displace the fixed dome type as the most common in China (Chan U. Sam, 1982).

Typical detention times in bag digesters for swine waste vary from 60 days at 15-20^{O}C, to 20 days at 30-35^{O}C. One advantage of the bag is that it's walls are thin and hence the digester contents can be heated easily if an external heat source is available (e.g. sun). The Chinese have found (Chan U. Sam) that average tempera-tures in bag digesters are 2-7°C higher than dome types. Park et al. also found this to be true in Korea, and obtained gas pro-ductions varying from 0.14 in winter (8^{O}C) to 0.7 in summer (32^{O}C) for swine manure.

Advantages:

- Installation. A bag digester is very easy to install. No special preparations and expensive constructions are needed. Transport of the folded bag is cheap. Danger exists for the bag to get punctured during transport and/or erection).
- Gas pressure. The bag is expandable and causes the gas pressure to be reasonably constant. Saubolle & Bachman (1980) reported that these bags can withstand a pressure of 250 cm water column, which is more than double the working pressure normally needed.
- Costs. These will depend on the region but imported bags will cost about 10% of the KVIC-design digester or 50% of the Chinese dome type digester.
- Durability. The RMP is resistant to UV-rays and erosion by acid or alkali, whereas normal plastics are not. Digesters have been inflated and deflated 6000 times per year with no apparent

damage. The average life of such a digester is estimated at more than ten years.

- Sludge and scum formation. Due to the narrow path the slurry passes through the bag, the flow speed will prevent sludge to get sedimented. As only highly diluted piggery waste is used, problems with scum formation are low. Any crust formed will be loosened through the expansion and contraction of the bag.

Disadvantages:

- Damage. Bag digesters are liable to damage and punctures are not uncommon. Damage can happen due to movement of the bag in the ditch caused by wind that can shake the bag and by rainwater that may fill the ditch causing the bag to start floating.
- Environmental influence. Most of the times the bag is exposed to all environmental weather changes and a sudden drop in temperature can reduce the digestion efficiency. Rain can also cool the slurry considerably which justifies an additional insulation sheet.

2.5 ARGUMENTS FOR THE APPLICATION OF BIOGAS DIGESTERS (AFTER KIJNE)

In order to promote the use of biogas digesters two different categories of arguments have been brought forward.

One set of arguments amplifies the benefits for individual users. It should be mentioned that in a given situation it will be highly improbable that all these advantages can be enjoyed at the same time.

A second set of arguments to substantiate biogas development programmes amplifies the advantages for the nation as a whole. Governments try to stimulate the use of biogas because it may offer an alternative to firewood and thus may slow down the continuous deforestation. Since biogas may substitute for fossil fuels (such as kerosine) and the effluent of biogas digesters can be applied as a fertilizer, the favorable effects on the balance of payment are mentioned too.

In this paragraph we will focus ourselves on the potential benefits for individual users.

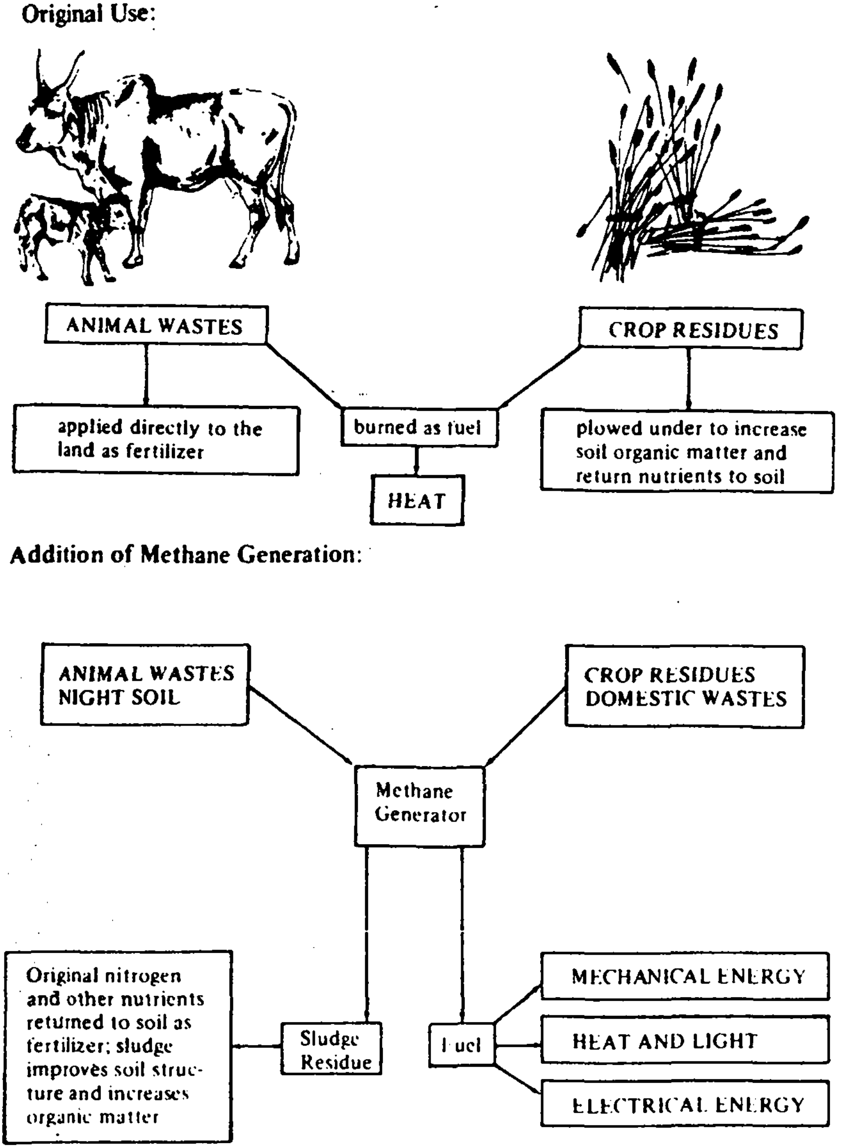


Fig. 2.6: Impact of anaerobic fermentation on use of organic wastes (from NAS)

BIOGAS AS A SUPPLIER OF COOKING FUEL

Motives for the development of biogas digesters are mainly based on their ability to supply a source of energy which can replace the various cooking fuels which are generally used in rural households in developing countries. The increasing scarcity of these fuels has led to a growing effort to accumulate them and has put a money value of them.However, as will become clear in the following chapters, local fuel situations are extremely complex. Access to biogas as a fuel substitute for some social groups does not necessarily alleviate but can even worsen the fuel situation for other groups. Three common cooking fuels can be mentioned:

- Firewood. Woodfuel is the primary source of energy covering 90% of the total energy demand in the rural areas of developing countries. Introduction of more efficient woodstoves is one way of reducing the consumption of firewood; substituting the wood with biogas is another.
- Dung cakes. The use of dung cakes for cooking purposes is mainly employed in India and not so much in other developing countries. Aspects of the 'dung cake economy' are discussed in chapter 4.
- Kerosine. Users of kerosine for cooking mention as advantages of biogas that it will stop the pollution of their cooking utensils and the typical smell of kerosine cooking.

BIOGAS AS A SUPPLIER OF FUEL FOR LIGHTING

Application is rather simple. In principle the usual pressurized kerosine mantle lamps can be used. Although the quality of lighting of a biogas lamp is rather poor, a saving on kerosine consumption can be obtained by using biogas fuel.

Biogas as a substitution of electricity has also been mentioned. Apart from the larger size of digester needed in this case with all associated problems of operation and maintenence, it should be pointed out that a rural electrification program does not in general intend to supply electricity to every household. Only the richer classes will be able to pay for the connection and the monthly bills.

BIOGAS DIGESTER AS A SUPPLIER OF ORGANIC FERTILIZER

In most publications on and by most promotors of biogas the favourable effects of anaerobic digestion on the fertilizing value of the manure is mentioned. Improvement of the manural value is claimed to be due to the increase of the amount of nitrogen available to the plants. The total nitrogen content does not change during digestion. It is only the closed construction of the digester that prevents early disappearance of the ammoniacal nitrogen. In raw manure the nitrogen is held in a complex form and will be released slowly. The quick release of nitrogen is particularly important in the tropics because of the instant necessity right in the beginning of the rainy season and the planting time. It is for this reason that chemical nitrogen fertilizers have a distinct advantage over organic fertilizers. Anaerobic digestion of manure will give a product which is closer to the characteristics of chemical fertilizers than the original manure.

In field operations, however, application of effluent to the crops directly following digestion will hardly ever take place. Fertilization of crops is needed once or twice a year. Effluent therefore needs to be stored for the rest of the year. This storage can affect the quality of the effluent to such a degree that it might even lose all its acquired improvements over the original manure. Open pit storage of digester effluent is general practice in India, Thailand and Indonesia. Liquid efflent flows into a pit next to the digester. Compared to the total surface area of the digester plant the size of this pit needs to be quite large. The problem of space together with the fact that cattle dung effluent dries very slowly cause handling difficulties. Farmers are advised to bind the nitrogen in the liquid with dry organic matter like fodder wastes and straw to obtain a compost product which is of a better quality and easier to store and handle. Kijne gives more details and according to his findings the few farmers who try to practice this device experience the difficulties of mixing the effluent with the organic matter.

This implies that changes in the traditional farming practices would be required to make full use of the benefits of the liquid effluent. For example, transportation in drums will be needed and quick plowing of the soil will stop further evaporation. The seasonal cropping schedule at the farms is a severe constraint that will obstruct this change. Fertilization of fields with dry dung is usually done during the dry season. Small heaps of manure should be put on the fields and distributed only shortly before the rains start. This practice requires less labour in a period in which all labour available is demanded for field preparation and planting.

BIOGAS DIGESTERS FOR IMPROVED SANITATION

It has been reported that an anaerobic digester can significantly reduce the number of bacteria, parasite eggs, viruses and other pathogenic organisms in the effluent compared with the amount in fresh material (see e.g. UNEP, 1981; NAS, 1981). However, different organisms show different behaviour during the digestion process. It is therefore dangerous to rely on certain percentages of die-off to ascertain the bacteriological safety of the slurry.

The design of the digester may affect the presence of organisms in the effluent. As these may float or stick to the organic particles in the scumlayer or sediment on the bottom of the digester, the effluent from the middle of the digester will most problably have lower amounts of organisms. Note that in the Chinese dome type design effluent is removed from the middle of the digester in contrast with the KVIC model from India where the outlet pipe extends to the bottom of the digester.

Knowledge of this sanitation aspect of the anaerobic digestion process has been associated with the increasing problem of human waste managements in many parts of Asia. The large majority of the population living in the rural areas has to practice open air defecation in the bush, fields or in open pits. Problems concerning open air sqatting facilities do increase in the crowded clusters of people who are living in and around urban areas. Rains and floodings will deteriorate this situation. This has given rise to sanitation programmes for better control and management of human waste in many developing countries.

As nightsoil might contain many pathogens, worms and parasites, special precautions should be made concerning the handling because of contamination. Most latrine systems that are developed only need the removal of the nightsoil after a "composting" period of one to two years. Then the excreta have changed into a black, dry and bacteriologically reasonably safe product that does not smell. Social constraints regarding the utilization are few.

Instead of using the nightsoil for composting in pits, it can also be fed to a biogas digester, a current practice in China. When only nightsoil is used, single family latrine digesters will not be able to supply a sufficient amount of gas for cooking purposes. Community latrine digesters that are used by more people are viable on this point. However, the use of flushing water with latrine digesters which is needed for the optimalization of hygienic conditions, may upset the slurry composition. A good latrine utilization requires a lot of water and even disinfectants for cleaning purposes, particularly when latrines are used by more persons. The large amounts of water can dilute the slurry and affect digestion conditions negatively. Disinfectants can kill the bacteria that are required for digestion. Utilization of the biogas nightsoil for cooking purposes might be objected to by some people, particularly for preparation of food that is used for worship in the temple. Sentiments on this subject will differ according to the different regions and different social groups. Kijne visited and describes some types of latrine digesters currently in use in India.

REFERENCES

Chan, G. (1981): Integrated Biogas Development: Fiji. In: Biomass Energy Projects; Planning and Management, Ch. 4 pp 120-139, Pergamon Press.

Chan U. Sam (1982): State of the Art Review on the Integrated Use of Anaerobic Processes in China. Internal Report prepared for IRCWD.

Golueke, C.G. (1980): Basic Principles of Anaerobic Digestion. In: Biogas and Alcohol Fuels Production, J.G. Press, Emmaus.

Hao, P.L.C., A.P. Yu and H.S. Tang (1980): Design and Development of a Red-Mud Plastic Digester, Union Industrial Research Laboratories, Industrial Technology Research Institute, Hsinchu, Taiwan.

Hong, C.M., M.T. Koh, T.Y. Chow. P.H. Tsai and K.T. Chung (1979): Utilization of Hog Wastes in Taiwan Through Anaerobic Fermentation. Food and Fertilizer Technology Centre, Taipei City, Taiwan, Extension Bulletin no. 131.

Kijne, E. (1984): Biogas in Asia, Inventory Field Study on the State of Development of Biogas Digesters for Household Use in Tropical Rural Communities. Consultants for Management of Development Programmes b.v., Achter Clarenburg 25, 3511 JH Utrecht, The Netherlands

NAS (1981): Methane Generation from Human, Animal and Agricultural Wastes. National Academy of Science, Washington D.C.

Park, Y.D., N.J. Park and J.H. Lim (1981): A Study of Capablity of P.V.C. Bag Type Biogas Generator. Research Report of the Office of Rural Development, Suweon, Korea.

Sathianathan, M.A. (1975): Biogas, Achievements and Challenges. Association of Voluntary Agencies for Rural Development, New Delhi 110048.

Saubolle, B.R. and A. Bachman (1980): Fuelgas from Cowdung (2nd ed.), Sahayogi Press, Kathmandu, Nepal.

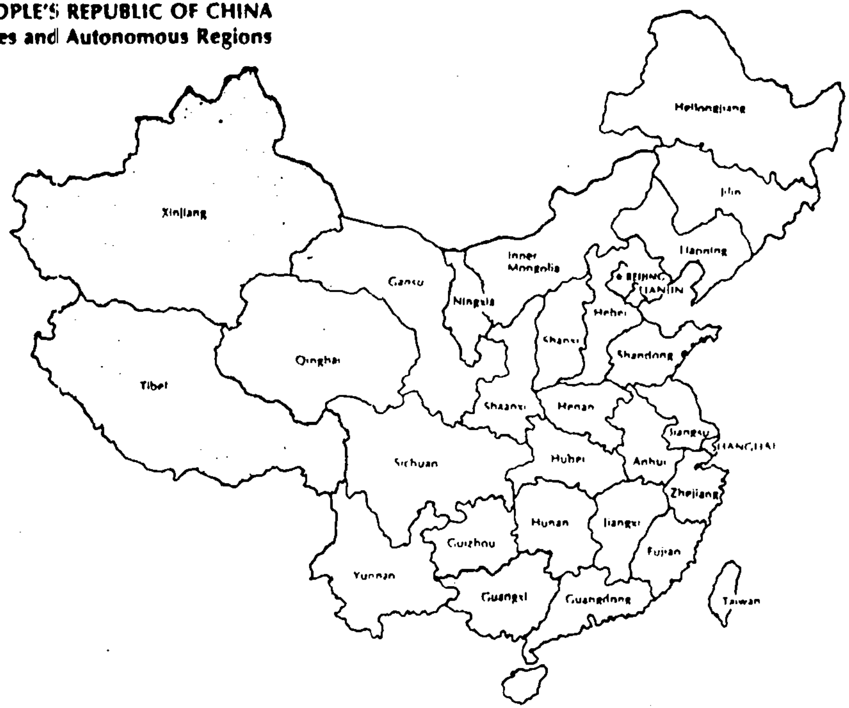
Stuckey, D.C. (1980): Technology Assessment Study of Biogas in Developing Countries. Prepared for the World Bank as executing agency of UNDP Global Project (GLO/80/003)-Testing and Demonstration of Renewable Energy Technologies.

Tam, D.M. and N.C. Thanh (1983): Biogas Technology in Asia: The Perspectives. Renewable Energy Review Journal, vol 5(1).

Umana, A. (1982): State of the Art Review of Anaerobic Processes in Latin America. Internal Report Prepared for IRCWD.

UNEP (1981):Biogas Fertilizer System, Technical Report on a Training Seminar in China.

THE PEOPLE'S REPUBLIC OF CHINA
Provinces and Autonomous Regions



3. Biogas Technology in the Chinese People's Republic

3.1 INTRODUCTION

In China the technique of waste disposal through fermentation to produce organic fertilizer and gas is more than a technology in the Western, i.e. industrial sense. In many areas biogas is now a normal practice on the family level. It was first intoduced by some communes in the fifties. When the technique was fully developed it was incorporated in government programs for loans for investments and propaganda campaigns. This further enhanced biogas utilization. The technique is based on the principle of the complete utilization of resources which is still a necessity in many rural areas. The technology improves environmental conditions, but this is not the first priority for the authorities. The methane which is generated in the process was originally only of lesser improtance, although this has become more important recently. It was seen as a further step in the ancient practice of producing fertilizer by composting organic wastes. The aim of improving rural health by controlling fecal disposal was merely secondarily imposed when biogas became part of the official program. In some areas the use of biogas is still in early stages of development; the gas itself is in these areas seen as only a bit more than a useful by-product of the other functions, health and fertilizer.

Outside China, most versions of biogas installations use cow dung as the major substrate for the fermentation process. In many cultures it is considered wrong to use human excreta for such purposes and agricultural wastes are often not used because of the expected management and technical complications. In China such taboos are less of a problem and the agricultural function of biogas technology is backed by a geat deal of experience, both traditional and modern. Based on experience from local initiatives a total system was created encompassing the digestion of all organic wastes in the immediate surroundings, converting it fully to fertilizer and gas. Organic resources are utilized and recycled instead of becoming pollutants: the balance of the environment is better controlled.

3.2 SOCIAL STRUCTURE

The fact that biogas has been successfully introduced on a large scale in China is unmistakenly related with the social organization in rural areas. The great majority of agricultural work in China is done collectively. State farms have always played a secondary role, while the private sector at present accounts for only 10-15% of the total area farmed.

The foundation for the present organizational structure was laid during the Great Leap Forward in 1958, when the communal system was introduced. The commune operates at three levels, each with its own function. The highest level is the commune itself. This consists of a number of villages and is set up to have more capital and workers at its disposal. This results in the following tasks:

- Support of rural industries requiring much financial and technical backing.
- Coordination of operations in the social sector, including clinics, secondary schools, storage facilities, credit, and trade.
- Water management and land reclamation projects.

The land, the means of production, and the livestock were considered to be property of all members of the commune.

Until recently the commune formed the lowest political as well as economical unit. According to the original goals a commune must possess a structure which guaranteed independence in economic, social, administrative and defense matters. However, communal policy was subordinate to national planning. Because the commune did not function properly as a work unit, it was divided into smaller groups. Each commune is divided into brigades, which are in turn subdivided into production teams. Each team consists of 30-35 households. A team is the basic work unit, and can operate fairly independently. Incomes of the individual households are determined by the total economic productivity of the team, and by the number of labor points gathered by the families.

Attempts have been made, especially during the cultural revolution (1966-1976) to transfer the responsibilities of the team to the brigade level, and so, to finally disband the team. The Dazhai production brigade served as a model for this. Dispite its poverty, this village (population 500) was able to become self-supporting in grain without help of external inputs. A central aspect of this was the abolishment of all types of individual agriculture. Later research showed that an important part of the figures from this village were false. The Dazhai campaign had little success on a national level because the farmers no longer felt directly responsible for the production.

After the demise of the Band of Four, emphasis switched to increasing agricultural production and income in rural areas. For this, three important reforms were carried out in 1976.

To begin with,the private sector and free market were given new room to operate. Private lands now occupy 10-15% of the total farmed area, although each individual plot is not larger than a garden. The land is used to raise small animals, pigs, or vegetables. Sales of these form an important part of the family income.

The second reform introduced changes in the collective agricultural production system. Since 1979 direct responsibility for cultivation of a field could be placed with individual households. Quota were set via a contract between the household and the commune. Any extra yield above this level could be held or sold by the household itself. This called for great personal initiative, and the hardest working families were also the best rewarded.

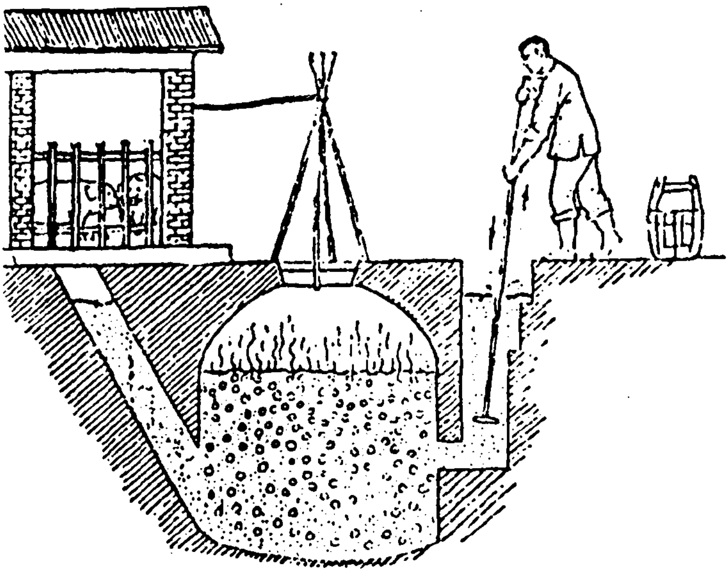


Fig. 3.1: Stir liquid fertilizer frequently
(from A.van Buren)

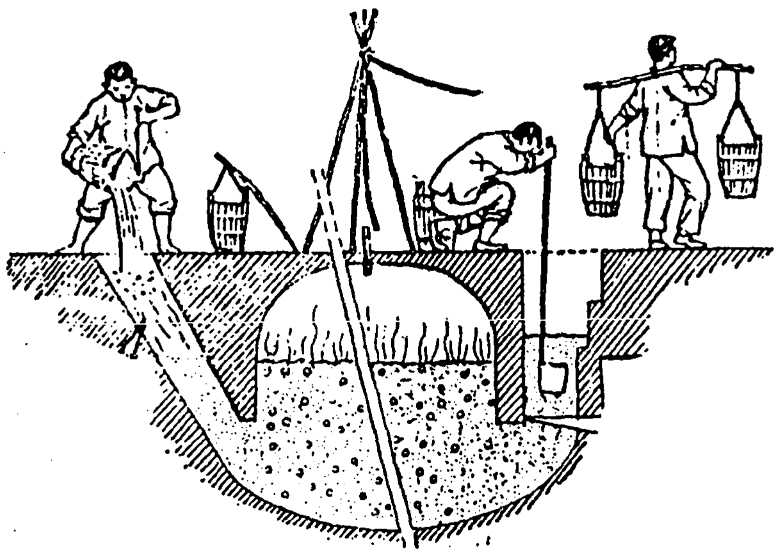


Fig. 3.2: Put in and out material frequently
(from A.van Buren)

Three main types of these so-called responsibility-systems can be distinguished:

- In richer communes with communal management and bookkeeping special work by groups can be carried out on a contract basis.
- In communes with an average production and communal bookkeeping, workgroups can be given contracts for longer and less clearly deliniated tasks. The land is divided into smaller plots, which families or groups can cultivate on a piece-wage basis. Distribution of the earnings is done at the team level.
- In poor, isolated areas, where the commune never really worked properly, but also in other areas, land is being divided among the families, based on their size. The family is given free choice in the production process, but does have to meet certain producton quotas.

The liberalization has met the economic expectations, and annual family incomes of more than 10,000 yuan (ƒ15000.-) are not exceptional. However, there are certain disadvantages of this system. Because the farmer is now held individually responsible for the production, the demand for labor has increased and the population control policies are coming increasingly under pressure. Especially the last described farming system gives the family complete management of the fields. Purchase of tools and other production means (especially hand-powered tractors) by individual farmers is now possible. Poorer farmers often do not have the means to do so, and social inequalities which were earlier only noticeable on a communal or a regional level are now increasing.

The last reform took place in 1982. At this time communes were denied the management tasks which were originally one of their main goals. The most important arguments for this were:

- the increasing autonomy of the production teams
- the introduction of the system of responsibilities which made possible trade contracts outside the communal system, such as direct contacts with urban factories. It is hoped that excessive bureaucracy will be limited by this division of responsibilities.

3.3 History

In some reports on biogas in China applications based on historical experiences are mentioned from 1920 onwards but in the standard Chinese bibliography on this subject (first published in 1975) the earliest official sources referred to are Western scientific papers from the 1930's; no Chinese sources are mentioned prior to 1957. By that time there existed much local experience. Many Chinese papers were published during the Great Leap Forward but after this campaign most information again comes from Western sources. After the first energy crisis in 1973 biogas was presented in official papers as a new "revolution". To this day, however, most information on recent biogas production and consumption in China is unfortunately based on personal interviews of Chinese workers in the field during short visits and travel reports, rather than on local research.

The use of biogas was first officially promoted in 1958 after a directive delivered in Wuhan by Mao Zedong coinciding with the start of the Great Leap. In the same year, some scientific papers on methane fermentation were published. The first applied reports appeared the same year. However, the goals for the Great Leap were set too high. In the rural areas this took the form of consolidating cooperatives into large scale people's communes that could theoretically undertake all manner and scope of development projects combining industry, agriculture, trade, education, and military affairs. Biogas was incorporated into this program and thus was more centrally planned than in the past. In this period, middle large and large biogas digesters of the USSR and DDR design were built to raise energy in cities and villages for the smaller rural industries. The digesters were technically unsatisfactory, a result of the incomplete transfer of the know-how from abroad, rather than a low technical level in China. These complications make an objective analysis of the negative experiences on the various levels very difficult. The poor results led to impopularity of biogas in the communes and eventually, to a general stop in the official promotion of biogas technology at the end of the Great Leap. Many other programs were terminated at this time as well. However, some secondary applications associated with the use of biogas were successful in many provinces, where water pressure devices, lamps, etc. were invented by farmers using biogas. This technology was not generally applied, but was locally improved and thus successful. These devices led to a second attempt to introduce biogas after 1970. In this period the problems which were a result of the quickly increasing population reached a peak. Fuel shortages occurred in many villages when the government had problems supplying enough coal. In the communes improved fertilizer comparable with the fermenter's end product attracted attention. All these energy and fertilizer problems resulted in the simultaneous reconsideration of biogas in many places. Especially in Sichuan many team leaders in the communes personally decided to devote themselves to popularizing biogas technology. The Dashai campaign for construction investments in agriculture at this time enabled many production teams to develope the applications of biogas. However, the investment campaign was directed to collective investments while the new biogas applications were meant for separate households. In this manner the contrasting actions of the team leaders developed biogas in a different way than most other construction investments. The local leaders were responsible for unequal developments within the provinces (also in Sichuan) even where the fuel supplies and other economic factors were comparable. In a later stage some provincial leaders also supported this favored strategy of biogas development on the political level. The use of biogas was popularized in many areas of Sichuan using various radio, newspapers, wall bulletins, and other methods of propaganda. All information used in these regional campaigns was based on local experiences in the villages with available construction materials for the biogas digesters and with the products of the digesters, which could vary during the seasons. The use of biogas gradually shifted from a local initiative to a common feature; the province speeded this development further by opening institutes for technical advice, the so-called biogas bureaus.

It is not surprising that in this phase of popularization of biogas the first national conference on biogas was organized to exchange practical experiences on the recently built fermentaters. During this Mianyang conference in May, 1975 the main principles of construction, as derived from these early experiences, were defined and documented. Some social and political statements were also made. These were that self-reliance of the participants in the commune is the basis of biogas application, that the state supports the farmer financially and that the team or commune should play a secondary role. This policy of "self-reliance with public assistance" was defined by the Biogas Development Office; it meant that on his own initiative a commune member could purchase the building materials to construct a digester for his family. The production team would compensate in work points for the labour used, which otherwise would have been for the commune, and the government would provide free technical training courses for special technician-candidates from the commune. The bank would advance loans to the few who were unable to raise enough funds to build their own digesters. The office was convinced that the implications of this policy would stimulate more commune members to build a family-sized digester; this later proved to be a successful approach. The term "self-reliance" meant the use, as far as possible, of the owner's private resources, i.e. finance, labour, and management for the digester. The "public assistance" amounted to the recognition, valuation, and institutional support of private expenditure, both by the owner's own production team and by the state, through local, regional, and national branches.

Although it has been stated that self-reliance of the masses was the major point in the popularization of biogas, other political events, such as the rehabilitation of Deng Xiaoping, made larger efforts in applied sciences possible. Research in the technique of constructing digesters was intensified and experiments were started to optimalize the process of fermentation.

After the arrest of the gang of four a new Great Leap was announced. The major aim of this was to rapidly mechanize the rural areas before 1980. Between 1975 and 1978 the number of biogas fermenters increased from half a million to seven million. The second Mianang conference in 1978 stood in the sign of these stormy developments. Biogas digesters, including large digesters for the whole commune to raise energy for machinery, were planned for over 1000 areas. The new small digesters were built with a small, flat, round, removable lid and a straight fill pipe. Some teams from Sichuan reported on the functioning of the digesters built in 1975. An increasing number of installations had collapsed or no longer reached full production capacity; this negatively influenced the popularity of biogas. The role of the biogas management, the training of the technical workers in the construction of the installation, and the uses of the gas were discussed.

The third plenar meeting of the Central Committee at the end of 1978 stopped the new Great Leap Forward abruptly; the new slogan "truth from the facts" was launched. It became known that up to half of the installations which were centrally planned no longer functioned well; two million digesters could no longer be repaired and another two million had severe problems. At a conference in 1979 it became clear that the main responsibility for the installations had shifted from the separate households to the collective, which resulted in a stronger professionalization of biogas management. Biogas was announced to be the main solution for the fuel crisis in the villages. As a result of the conference, biogas was incorporated in the plans for state investments. A central institute was responsible for the total budget in all provinces, but Sichuan remained the main province for biogas.

For the midlong term 40 million installations are centrally planned for areas where about 70 million families live with severe fuel shortages. In this project only small digesters are used; in the city medium or large size installations will be constructed.

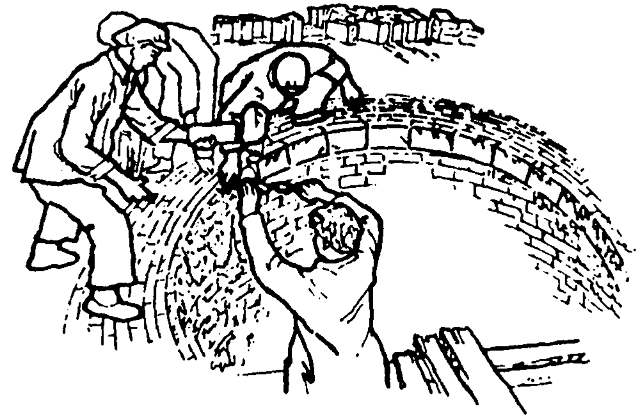


Fig. 3.3: Bricking a dome without support (from A. van Buren)

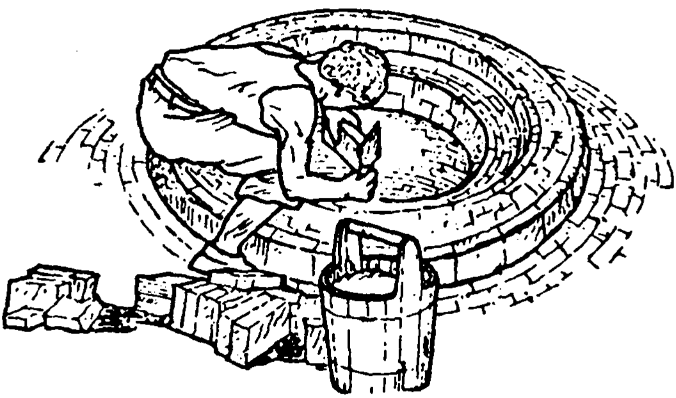


Fig 3.4: Bricking the mouth of the pit without support (from A.van Buren)

3.4 PRESENT ORGANIZATION

The family undertakes the management of the digester. Their responsibilities consist of maintaining a watch over the pressure gauge of the digester (burning gas when the pressure rises above a median) and feeding the digester daily with kitchen wastes, latrine "night soil", and the rinsings from the family pigsty. In return the use of the gas for cooking and lighting accrues fully to the family. The production team (as far as this still exists in the present dismanteling of the communes) carries other costs, benefits and responsibilities. It includes the construction labour time in its own accounting and renumerates for it. Some of the means of transport for the construction materials are furnished by the collective. It also so provides the bulk of the fermentation material used to charge the digester every six months and composts the mixture of straw and pig manure prior to charging, which speeds up fermentation. It is not clear at present whether the new "total" self-reliance system for the farmers affects this help from the collective. In return for the fermentation material the collective covers the major (now less?) part of its fertilizer requirements with the fermented high-grade organic material coming out of the digester. This increased recycling of nutrients in agriculture, necessitates fewer expenditures for chemical fertilizers. It also benefits from improved waste disposal and sanitation, and reduced deforestation (as far as still present).

3.5 SOCIAL AND POLITICAL FRAMEWORK

In biogas literature the social and political framework associated with the introduction of this technology is poorly described, in contrast to the well-documented process in India and Thailand.

In Chinese agriculture an understanding of biological systems was already present long before energy was produced through biogas fermenters. This agricultural and ecological tradition, and the new socialist principles, give the basal acceptance of biogas a high chance. Until recently earnings and consumptions were relatively undifferentiated. This, together with the state-directed immobility of the people, allowed new planning to be relatively easily carried out. The management and use of biogas fermenters were thus easily integrated into this society. Since the collective as well as the separate households feed the fermenter, it is easy to distribute the gas and fertilizer.

When biogas was first introduced people doubted whether such a fermenter would actually produce gas which they could cook on. In some areas the gas was suspected to promote the occurrence of tainted food. Others had doubts about the nutritional value of bio-fertilizer. In many brigades model fermenters were constructed to overcome these doubts. In fact, the cadres built the first fermenters on their private pieces of land not only to convince farmers in serious doubt but also to try out whether the type of installation was good enough and adapted to the special local requirements. Besides training courses and test fermenters, biogas was popularized through films, exhibitions, news items in newspapers and on the radio, wall drawings, wall paintings and popular scientific booklets.

The responsibility for the functioning of the biogas fermenter was the task of the specially trained technicians who, as a result of their biogas education, earned 10% more than during labour in the field. Bonusses were calculated according to the number of installed fermenters; only fully contructed and functioning fermenters were counted. The types of fermenters in China proved to be reliable and easy to adjust. Various types of organic material produce biogas in differing designs of digesters and with differing procedures. The only criterium of success for a farmer's family is the amount of cooking gas produced during the summer months (Sichuan). The dirtiest work in fermenter maintainance is the periodical cleaning. Since dealing with faeces and wastes is in many countries more or less a taboo, this type of labour is a key factor when introducing biogas in third world countries.

In ancient China tradition, religion, and society placed women in a position inferior to men. Some relics of the feudal system still exist today, as can be seen in rural marriage habits. Since 1949 however, the position of women has greatly improved, although the revolutionary slogan "liberation from heavy housework" is not yet outdated. The economic and social role of the chinese female farmer in the collective and family is fundamentally altered. In all communes the collection of fuel materials and the transport of coal from the free market took a great deal of time; the use of biogas reduced this labour to a minimum. Furthermore, solving the fuel problems for cooking meant an important relief for many women. Womens' labour inside the house has changed considerably since biogas met the fuel problems in the villages. The women are still responsible for cooking (although official reports state differently). As a result of biogas introduction, the cooking time could be reduced from 4-6 hours to 1½-3 hours, although when guests are present the normal biogas supply is often not sufficient and the traditional stove has to be lighted. In areas where temperature in winter drop below zero biogas is only a help in a limited number of months. The use of biogas improved the hygenic situation, especially in the kitchen. The traditional fire is increasingly becoming a matter of history, and typical female diseases such as eye, neck, and bronchial diseases are diminishing.

The larger commune fermenters also help save time. Usually these fermenters are capable of delivering electrical power a few hours a day for each household. In general, biogas has freed the women from the household and increased their role in the collective labour, mainly in agriculture and small industry. Industrial generaters have especially helped, since industry is not seasonal, as is work in the field. Biogas has also increased the spare time of the women; this time, however, is rarely used for leisure. It is usually spent on secondary tasks such as nursing animals in the house. Chicken, sheep, rabbits, etc. have been introduced into the separate household, depending on the market situation. Development of private enterprises such as growing plants, herbs, mushrooms, etc. are also popular.

REFERENCES

Buren, A van (Ed.) (1979): A Chinese Biogas Manual. Translated from the Chinese by Michael Crook. Intermediate Technology Group, London. 135p.

Buren, A van (1980): Transfering Biogas Technology to the Rural Areas of the Third World: Achievements, Obstacles, and the Next Steps for an Underdeveloped Country presented at the Seminar on "Reutilization of Excreta for Biogas and Innocuous Bio-ferilizer Production", Guatemala, 25-29 August 1980. 11p. International Institute for Environment and Development London

Eggeling, G. and Stephan, B. (Eds.) (1981): Biogas in the People's Republic of China (Summary of the project report) GTZ, Germany

Fu, K. (1983): Biogas in China Mazingera 32:12-34

Kijne, E. (1984): Biogas in Asia: Inventory Field Study on the State of Development of Biogas Digesters for Household Use In Tropical Rural Comm-nities. Consultants for Management of Development Programmes B.V., Achter Clarenburg 25, 3511 JH Utrecht, the Netherlands

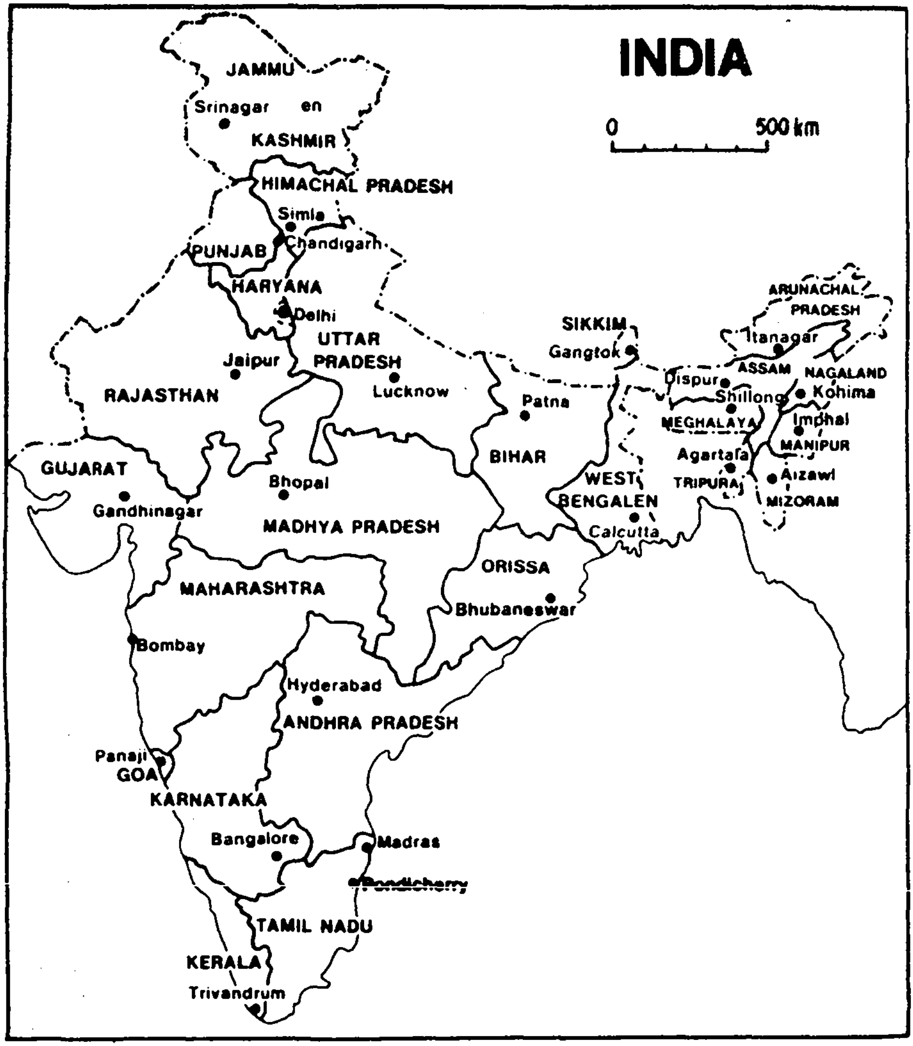
Loveloy, D. (1980): Biogas in China United Nations Energy Report 433-434

4. Biogas Technology in India

4.1 INTRODUCTION

After the Chinese People's Republic India is the second most important developing country where biogas digesters have been introduced on a fairly large scale. The introduction of biogas technology was mainly a result of the extensive promotion activities by governmental and semi-governmental institutions. It was felt that biogas was relevant to the nation as an additional source of energy and as a means to counteract deforestation. A historical review of the biogas programs is presented in part 4.2. As was already pointed out in the introduction of this booklet, technology includes the research activities, the organisational network and the extension services that support a specific technique. For this reason the institutional arrangements for the dissemination of biogas and their constraints, especially from the point of view of reaching the poorer sections of society, are discussed extensively in part 4.3. Part 4.4 discusses the constraints related to the technical nature of the digester.

Since the introduction of biogas in India is characterized by a strong top-down strategy, motivated by the possible benefits for the nation rather than for individual users, a next point will be to examine from our point of view expressed in the subtitle of this booklet, the potentials (part 4.5) and the socio/economic implications (part 4.6) of the current biogas program in India for the rural poor. Related to this,


INDIA
0
500 km
JAMMU
Srinagar
en
KASHMIR
HIMACHAL PRADESH
Simla
Chandigarh
PUNJAB
HARYANA
Delhi
UTTAR
PRADESH
Lucknow
Jaipur
RAJASTHAN
GUJARAT
Gandhinagar
Bhopal
MADHYA PRADESH
SIKKIM
Gangtok
Patna
BIHAR
WEST
BENGALEN
Calcutta
ARUNACHAL
PRADESH
Itanagar
ASSAM
Dispur
Shillong
MEGHALAYA
NAGALAND
Kohima
Imphal
MANIPUR
Agartala
TRIPURA
Aizawl
MIZORAM
ORISSA
Bhubaneswar
MAHARASHTRA
Bombay
Hyderabad
ANDHRA PRADESH
Panaji
GOA
KARNATAKA
Bangalore
Madras
Pondicherry
TAMIL NADU
KERALA
Trivandrum

part 4.7 describes some experiences with community digesters. In the last part some conclusions are formulated.

4.2 HISTORICAL BACKGROUND

In the beginning of the 20th century the method of anaerobic fermentation or digestion was successfully applied for sewage treatment. The first plant for treatment of sewage and production of biogas was constructed in Bombay in 1937. This inspired S.V.Desai, the founder of the biogas digester in India, then working at the Department of Agricultural Chemistry in New Delhi, to explore the possibilities of using animal dung and cellulose waste materials for the production of biogas. In fact, Indian biogas research started at the Indian Agricultural Research Institute in 1939. Later on. N.V.Joshi, working at the same institute, developed a small biogas digester which was made available to the public. J.J.Patel, of the Khadi and Village Industries Commission (KVIC) in Bombay, continued their work and designed and developed a biogas plant in 1951, called Gramalaxi Gas Plant (the forerunner of the KVIC-plant or gobar gas plant which was popularized on a large scale later on). It was a continuous load plant in which the gas holder was used as a negotiable cover on the open digester. The former could also rotate. In the next few years several other individuals made attempts to build gas plants at small cost. Also, J.J.Patel continued his efforts resulting in the designs Gramalaxi II and III. Besides the KVIC, other institutes were working on the development of biogas plant, such as the Gobar Gas Institute in Etawah (U.P.), but it was the KVIC that started the introduction of biogas plants among farmers, by means of subsidies and loans without interest. Free technical guidance for the construction was also supplied. The actual promotional work was carried out by the state level representatives of the KVIC, by the Khadi and Village Industries Boards (KVIB) and by institutions related to these Boards. The KVIC itself concentrated on the development of gas burners and gas lamps. In 1979 the KVIC also got involved in training activities for extension workers, masons and users.

The efforts of the KVIC in propagating and installing biogas plants were handicapped by the lack of policy support from the Central and State government. The government policy was mainly geared towards rural electrification and increasing the availabilty of chemical fertilizer. Under the pressure of a deteriorating energy situation, caused by the oil crises and the shortage of firewood, the government decided to install one lakh (100,000) plants during the fifth five year plan ('75-'80). A subsidy of 25% of the estimated cost of the biogas plant was granted by the government; the rest had to be paid by the owner of the plant himself or via a loan. However, the banking institutions made high demands upon the credit standing of the potential owner: a minimum of five to six heads of cattle and two hectares of productive land was required. This could not be met by most of the population, especially not by landless labourers and small marginal farmers. This, and a number of other reasons, which will be outlined in the next pargragh, slowed the dissemination of biogas plants. The target of 100,000 was not met; only about 70,000 were installed of which only 2/3 were in working order. These disappointing results led to a withdrawal of the government support during the period '79-'80, but the KVIC continued its efforts to popularize biogas plants.

Under the pressure of the KVIC renewed efforts were undertaken in november 1981, when the Department of Agriculture launched the National Project on Biogas Development. The objectives of this project were decribed as: "Conservation and use of organic materials as fertilizer and energy through biogas systems in order to supplement and optimize the use of chemical fertilizers and to reduce increasing pressure on demand for firewood and commercial fuel." (Madhi, 1982 p.6). The target for the program was set at 400,000 biogas plants, to be achieved during the sixth five year plan ('80 -'85). The government has allocated an amount of Rs 50 crores (US$ 50 million) for this programme. During '81-'82 a total of 35,000 plants were planned; the targets for the following years were fixed progressively higher at 75,000 , 125,000 and 165,000 plants. According to Kijne, it was reported that the actual numbers constructed during the first year were 10,000 below the target and that during '82-'83 a total of 57,500 digesters had been constructed. This implies that the total number of biogas plants installed in India is about 150,000.

Besides these programmes for the development of individual family size biogas plants, the government has more recently started a programme for the development of community type biogas digesters in order to reach the poorer sections of the population. Both these programmes will be discussed.

It can be said that in particular the KVIC has been the main initiator for the popularization of biogas plants in India. Apart from the KVIC, a number of other, mainly small rural voluntary organisations have contributed to the improvement of existing designs, to the development of new designs and to the dissemination of these. In Gujarat state, especially, a number of Gandhian institutions have concentrated on this technology. These include the Khadi Gramodyog Prayog Samiti, Halpati Sewa Sangh and Swaraj Ashram among others. One aspect of the Gandhian philosophy is directed at self reliance and group responsibility. One of the beliefs is that happiness in life is also a result of the healthy state of people and the hygienic conditions in which they live. One mean to reach this is the introduction of latrines, which in a next step can be connected to a biogas digester, used to treat human waste and to produce gas for cooking. For some examples see Kijne and Blankenberg.

Initially only one type of digester, the so-called KVIC or gobar gas biogas plant was propagated. However, nowadays also other types, such as the fixed dome (Chinese) type are being installed.

4.3 THE INSTITUTIONAL ARRANGEMENTS FOR THE DISSEMINATION OF BIOGAS PLANTS; THEIR CONSTRAINTS

INTRODUCTION

The national biogas plan set up to install 400,000 biogas plants during the sixth five year plan, consists of the following major elements:

1) financial support to state governments for organisational arrangements

2) financial support to implementing agencies and village level workers
3) financial support to state governments for various training programmes
4) subsidies to different categories of potential users
5) supply of steel and cement at quota prices

These elements will be discussed separately in the following paragraphs. In this way a picture of the institutional arrangements made, the official scheme and the experiences with this scheme in the actual implementation will be given.

THE ORGANISATIONAL STRUCTURE

A number of agencies are involved in popularizing the biogas technique. Among them are production agencies (fabricators, agro-industrial corporations), financial agencies (various nationalized banks, subsidy giving organisations), voluntary organisations (social workers), trade organisations (fabricators, after sales service organisations, suppliers of raw material), technical agencies (KVIC, SKGB, departments of Agriculture, district and block level commitees). All these agencies have been brought together in a joint effort to achieve the objectives of the scheme by promoting the biogas digester. In the past there has been a serious lack of coordination of their activities. For this reason the National Project for Biogas provides for the creation of specialized "biogas cells" within the ministries of Agriculture and Rural Development. Already 19 states have received financial assistance for the establishment of these cells. Their task can be described as: the coordination of all state level activities concerned with biogas plants, the control of the achievements of the targets, the supply of subsidies, cement and steel, and the communication between the central government and the implementing agencies at state level. In addition the cells also initiate and support research activities. In Figure 4.1 the organisational structure in the state of Tamil Nadu in Southern India is shown. Although every state has a different structure, it gives a rather good picture of the main organisational elements. With the establishment of these cells (directorate of Gobar Scheme), some decentralization to the state

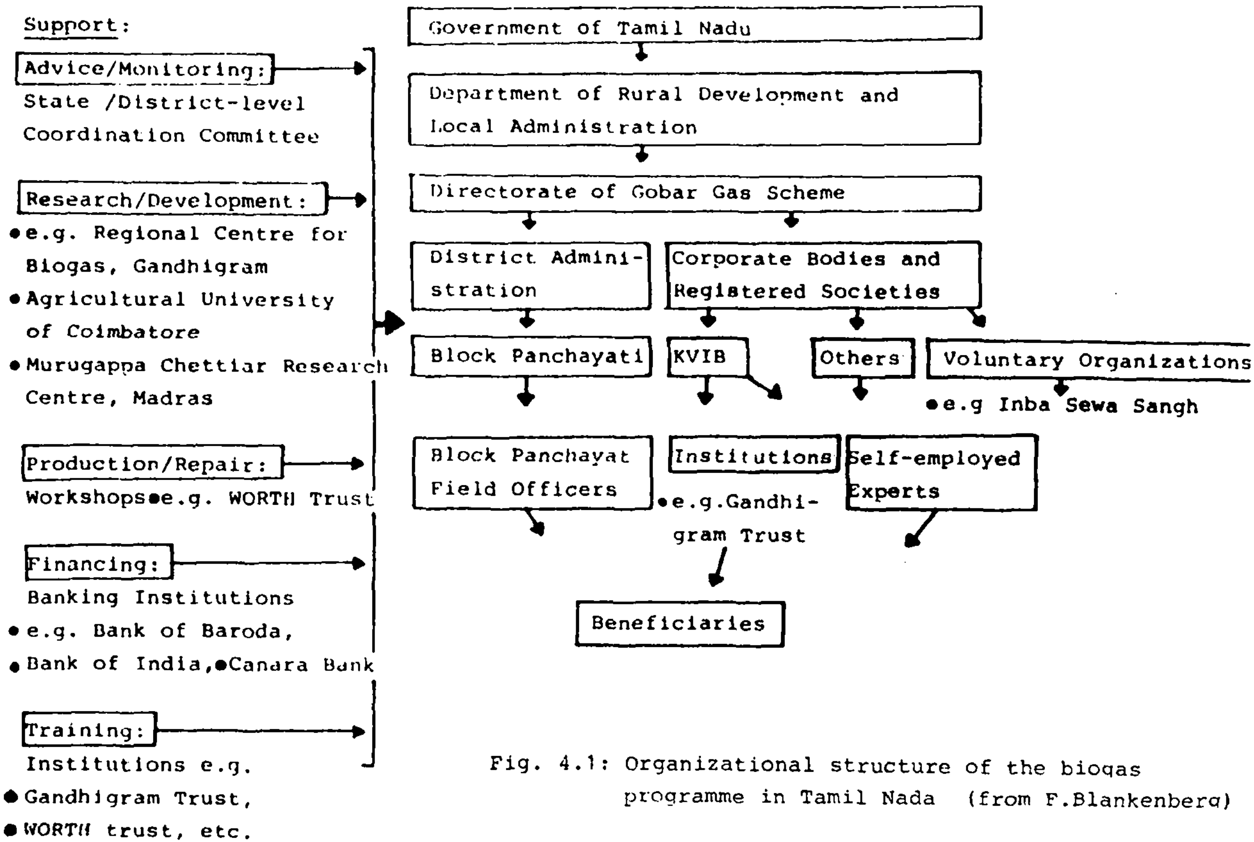


Fig. 4.1: Organizational structure of the bioqas programme in Tamil Nada (from F.Blankenberq)

and district level has taken place for the first time. However, experiences in the state of Tamil Nadu show that the cell is not functioning properly. The following short description of the functioning of the organisational structure will clarify this (after Blankenberg).

The biogas cell in Tamil Nadu is operating within the framework of the Department of Rural Development and local Administration. All the activities of the cell have to be approved by higher level functionaries, which causes much delay in the implementation of the scheme. The biogas cell is presently occupied with administrative procedures such as fixing targets per block (administrative units consisting of 100,000 to 150,000 people), publishing progress reports, controlling application forms, paying subsidies etc. and little time is left to maintain contacts with the lower levels. The cell confines itself almost entirely to written communication. Regular field visits of higher functionaries to lower levels to stimulate installation of biogas plants are not undertaken. Instead, lists of orders are sent to the districts and blocks without giving the support and advice necessary for the implementation of the orders. The responsibility of higher level functionaries are too easily delegated to lower level functionaries, who are in fact not capable to fulfill their tasks properly. This certainly holds for the government officers of the Block Panchayat. (Every Block in Tamil Nadu is headed by a Panchayat Union Council. These councils are elected bodies that recieve administrative and practical support of civil servants. They are entrusted with the execution of the National Extension Service scheme of Community Development.).

Since the field officers are involved in a number of different activities, of which biogas is a relatively new element in the entire packet, the biogas scheme recieves little attention. In addition it can be stated that the Panchayat officers are not sufficiently familiar with the prospects and problems of biogas plants. The following quotation from a study done in the Madurai district is illustrative: "Panchayat unions....are loaded with work; they cannot give full attention to the popularization of the scheme. Moreover, they don't have enough technical know-how about gobar gas plants. They cannot be blamed for this since they are forced from above to do the job." (Marimuthu, 1979, pp 66-67).

The major part of the applications have to be gathered in the field, but the field officers are not always able (due to lack of transport) or willing to make regular field trips. To stimulate this, government officers nowadays recieve an incentive of Rs 30 per biogas plant installed. Whether this is enough might be questioned.

Before the support of the government was given, the implementation of the biogas plants was mainly in the hands of the KVIB (the KVIC representative at state level) and related institutions (see part 4.1). Self-employed supervisors and those connected to the KVIB organisations guided the implementation of biogas plants. These supervisors are more active in the field and have a greater knowledge of the technical aspects of a biogas plant than the government officers. However, their organisations have a limited range, since they are only active in a small number or even only a single village, and they have limited manpower available. Furthermore, there is resistance to cooperate with other non-government and government organisations. However, considering their know-how and work methods, one can question the decision of the government to concentrate on governmental agencies rather than on non-governmental agencies to implement the biogas scheme.

It can be said that insufficient knowledge among Panchayat officers, lack of support from higher level agencies, restricted number of field visits and a limited range of the non-governmental organisations have greatly hampered the implementation of the biogas scheme. The scheme has so far not been very successful in Tamil Nadu. It is difficult to tell whether the situation in this state is representive for the whole of India, but most of the shortcomings are not unique to Tamil Nadu. This was confirmed by Moulik, who found in his 1976 study in Haryana, Uttar-, Madya- and Andra Pradesh several shortcomings in the organisational set-up e.g. "The promotion of biogas plants has been merely an additional burden on the personel of the Department of Agriculture, who have been assigned to different levels of the programme... The major responsibility for extension work and promotion has been left with the village level workers, already over-burdened with a large number of development activities." (p 51). The manpower alloted by the participating agencies to implement the scheme is totally inadequate. This is equally true of the state offices of KVIC and KGBP (Moulik, 1982, p 58): "After installation service facilities were extremely poor. With high breakdown rates, lack of quick and proper service facilities were reported to be the major complaints among the customers. There was no organisational follow-up, with the result that a large number of plants remain inoperative for a long period." (loc. cit. p 49).

EXTENSION WORK

To stimulate the involvement of agencies in the promotion activities and the actual implementation of the biogas project the government provides a fee of Rs 200 per biogas plant on turn-key basis. For this, the agencies have to assist in the construction of a biogas plant and guarantee the quality and functioning of the digester for one year. The fee will be paid after completion of the biogas plant. The agencies who receive this fee can be governmental or non-governmental. To mention a few agencies involved: KVIC, Agro Industries Corporations, Dairy Development Corporations and a number of public and voluntary organisations.

To stimulate the village functionaries for their help with the collection of applications, the motivating of potential beneficiaries, the technical guidance or supervision of construction of biogas plants, the government pays Rs 30 per biogas plant.

Three types of extension agents can be distinguished. The first type is the promotor. It is someone who has followed on orientation course and who is able to explain to interested people the first principles and advantages, as well as the financial consequences of the purchase of a biogas plant. The second type is the supervisor, who is either employed by an institution or self-employed. He guides the process of identification, promotion, installation and maintenance of a biogas plant. Both the promotor and the self-employed supervisor receive Rs 30 per biogas plant installed. The requler employed supervisor does not. The third type is the village level worker employed by the government. His

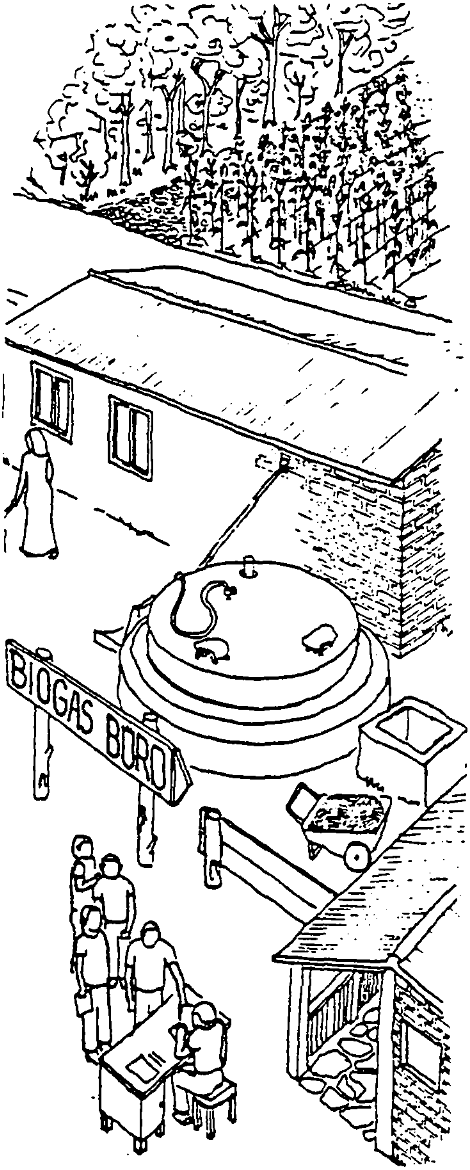


Fig. 4.2: Biogas Buro (from G.Eggeling)

main task is to advise the villagers in all types of agriculture-related affairs, biogas being just one of these. In some states they also receive a fee of Rs 30 per biogas plant.

In general the extension workers are not very active in gathering applications among the rural poor. The regular employed extension worker is 'target-oriented', and must gather a fixed number of applications within a limited period of time. The self-employed extension worker depends on applications for his monthly income. Both have an interest in finding persons who easily adopt a biogas digester. These are generally the more well-to-do rather than the poor in a village.

TRAINING

As there was a sortage of skilled masons, the government has started two types of training programmes to solve this problem. The first trains masons and technicians to construct and maintain biogas plants, particularly the dome of the Chinese type biogas digester (see chapter 2). During 1982/'83 150 courses for 20 masons each were implemented.

The second training course trains people who will in turn train masons themselves. In 1984 40 of such courses for 10 trainees each are to be organised, so that 400 skilled trainers will be available.

Furthermore, a third type of training is given to provide basic understanding about biogas plants, their value and implications to a variety of functionaries. These "orientation programmes" are attended by agricultural officers, bank managers and representatives of KVIC/KVIB, dairy corporations, voluntary organisations etc. Five orientation programmes are organised every year.

As far as one can judge training facilities seem to be sufficient. Skilled masons continue to be in short supply, due to migration to urban areas and Arabic countries, but this problem will probably solve itself in the long run.

SUBSIDIES

A central subsidy on a fixed amount basis for various sizes of biogas plants to different kinds of beneficiaries is given in order to stimulate the diffusion of biogas plants. A subsidy scheme is given in Table 4.1. The subsidy schemes are changing so rapidly that this one is perhaps already out of date. This also brings about confusion among beneficiaries, promotors and village workers, who have trouble keeping up with the newest rules. For example, sometimes information which is already out of date is provided, resulting in financial problems.

Subsidies officially have to be paid in advance in order to prevent beneficiaries from having to first supply the amount themselves. Without this, many potential biogas plant owners would have difficulties as they are not able to provide the money required, while bank loans are not easily given. Even if bank loans are given, the interest to be paid is too high for a number of people. Unfortunately, in many cases the subsidy was paid after the completion of the plant due to the extremely complicated procedure to acquire a subsidy.Long waiting periods, even periods of more than two years, were reported. As a result of the long procedure for subsidy payment, many people are forced to take a loan for a longer period than was expected, leading to higher interest payment. In

Type	Size m-3	Total Costs (Rs)	Scheduled tribes & hilly areas				Small & marginal farmers				All other applicants			
			Subsidy (Rs)			loan/	Subsidy (Rs)			loan/	Subsidy (Rs)			loan/
			Cen	Stat	Tot	self	Cen	Stat	Tot	self	Cen	Stat	Tot	self
KVIC	1.2	2000	-	1000	1000	1000	-	800	800	1200	-	666	666	1334
Dome	2.0	2700	1500	-	1500	1200	1000	80	1080	1620	750	150	900	1800
KVIC	2.0	4340	1500	670	2170	2170	1000	736	1736	2604	750	697	1447	2893
Dome	3.0	3450	1950	-	1950	1500	1300	80	1380	2070	1000	150	1150	2300
KVIC	3.0	5850	1950	975	2925	2925	1300	1040	2340	3510	1000	457	1457	4393
Dome	4.0	4370	2300	-	2300	2070	1500	248	1748	2622	1200	950	2150	2220
KVIC	4.0	6700	2300	1050	3350	3350	1500	1040	2540	4160	1200	257	1457	5243
Dome	6.0	5280	2900	-	2900	2380	1900	-	1900	3380	1500	260	1760	3520
KVIC	6.0	8910	2900	1555	4455	4455	1900	1070	2970	5940	1500	1470	2970	5940

Table 4.1: Financing scheme of Gujarat State, Total Construction Costs, Subsidies from Central (Cen), State (Stat) Government and their Total (Tot). Also shown is the amount of capital needed as own input (e.g. as a loan), this for different social groups (Rs 10 = US$ 1).
It should be noted that the Gujarat State government also provides an additional subsidy, mainly to compensate for the large differences in costs between the Dome and KVIC models.

the interum prices can also rise, meaning that even more money is required. Another point which needs some attention is the fact that subsidies are paid in fixed amounts of Rs and not in percentages of the actual price of a biogas digester. The latter pay-method is more realistic because prices are changing frequently and differ from region to region.

The supply of subsidies could be one of the instruments of the government to involve the poor in the biogas scheme. Small and marginal farmers, as well as the people living in "tribal and hilly areas" do get more subsidy. In itself this should be appreciated, but three remarks can be made: Firstly, the subsidy is not enough; even the smallest plant costs Rs 1200 and is too expensive for the poor. Secondly, no special arrangements are made for landless labourors. Thirdly, the people living in backward areas do get special attention, but these outlying areas are seldomly visited by promotors/supervisors. It is much easier for them to reach their targets in near-by places.

BANKLOANS

In the past there was a lack of cooperation and interest by the banks to provide financial assistance. This assistance, in addition to the subsidy, is necessary for most people, as they don't have the money themselves. To stimulate the financial assistance, the government has urged the banks to participate in the implementation of the biogas scheme by means of bankloans. A number of banks are involved in this "biogas low interest loan scheme". The State Bank of India and the Central Bank of India are the most important among these. The present commercial lending rate is 11% with a repayment period of 5 to 7 years for 6 m^3 and 2 m^3 plants respectively. Interested persons must fill in the application form, with the help of the supervisor involved. This form is also used for the request for the subsidy. It is a certificate about the site, size and number of cattle required. The bank uses the following guidelines:

size of plant	number of cattle required
2 m^3	3
3 m^3	4
4 m^3	6
8 m^3	10

In addition to this certificate, which is meant to indicate the amount of money required for a biogas plant, there is a certificate of credit security, since the bank requires a guarantee for the repayment of the loan, either in the form of other persons willing to take over the loan in case of non-repayment, or in the form of goods and cattle to be mortgaged. Land, the only commodity of high value, is generally (at least in Gujarat State) not appropriate as security because banks are convinced that it is impossible to mortgage land. Poorer people face problems in finding guarantees, especially since they are often already indebted. This leaves a poor farmer but one alternative, that of going to a shopkeeper or middleman to get a loan for a far higher interest rate. Thus the poor have little access to the banking institutions because they have nothing to offer as a guarantee;alas, it is just these poorer groups that are in need of a low interest loan to improve their situation.

INPUTS FOR THE CONSTRUCTION OF A PLANT

Two important inputs, steel and cement, are needed to construct a biogas plant. Steel is required for the construction of the walls in the case of a steel-concrete reactor, and for the gas holder. Since steel is scarce in India, the government is providing steel for quota prices.

The supervisors will inform their offices how many plants will be installed the coming year. The offices estimate the amount of steel required and send an application form to the Government Agricultural Steel Authority, who makes the decision about sending steel. The amount of steel is generally enough for one year, but scarceties still do occur. Due to the long procedure required for the delivery of the steel, steel may have to be bought on the free market against higher prices. Mostly, only the well-to-do have access to such markets.

The procedure for obtaining cement is more or less similar to that of obtaining steel. Scarceties for cement are also severe. As in the case of steel, the government is providing cement at quota prices. In Gujarat State for example, it was decided to sell 66.6% of the cement production at quota prices and 33.3% at market prices. Since the demand for cement was high, black market selling was a profitable business. High prices were asked, which is obviously not very conductive to the development of biogas.

SOME CONCLUSIONS

In the foregoing sections we have outlined some of the main institutional arrangements that have been made under the National Project on Biogas Development. The design of this project makes a rather favourable impression, but in the implementation stage several shortcomings can be noticed. These include the strong bureaucratic control of the "cell", the lack of field visits of government officers, the limited extension work among backward areas/people, the long procedures of bankloan and subsidy application and the shortages of masons, cement and steel.

The institutional constraints in the implementing stage of the biogas program are only some of the problems; the others are inherent to the nature of the biogas technique itself.

4.4 CONSTRAINTS RELATED TO THE NATURE OF THE BIOGAS DIGESTER

In this paragraph we will confine ourselves to the more technical constraints of the biogas technique. The potentials of biogas for the poorer sections of society in India will be discussed in a following paragraph.

INPUT PROBLEMS

Most of the plants in India are fed with cattle dung. Human excreta are seldom used, since this is unacceptable in the Indian culture. In China these taboos are less of a problem. Use of agricultural wastes is also very uncommon, but their potential should not be overlooked. However, studies of its potential show that its use for gas production often competes with its use as animal feed.

Presently, thus cow dung is required to feed the biogas plant. The preceding paragraph contained a list indicating how many cows, buffaloes or bullocks are roughly required for the daily feeding. However, before the plant begins to produce gas, the reactor has to be filled with dung. For this initial feeding large amounts of

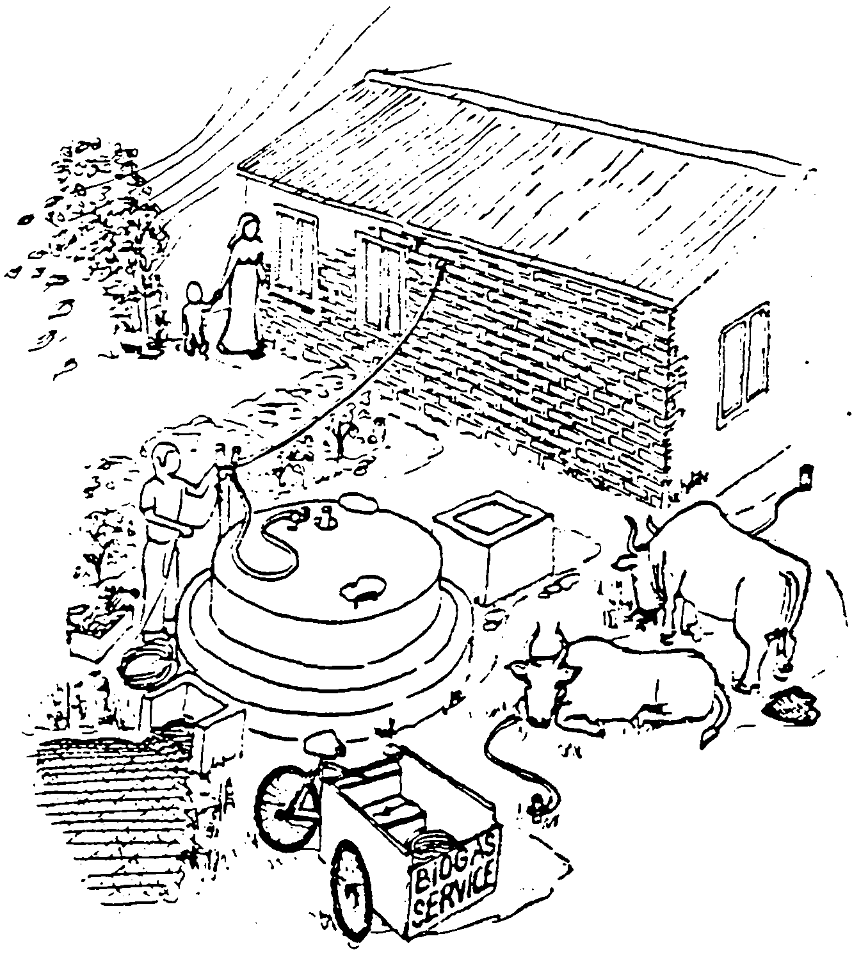


Fig. 4.3: Biogas service (from G.Eggeling)

cowdung, at least two or three bullock carts full, are required. Farmers with a large number of cattle do not face problems in this respect: if they start gathering the dung a few weeks before the steel gas holder is placed or the fixed dome constructed, they will have enough dung available. For others, however, it can be a problem. Small farmers with few cattle have to purchase the dung or gather it free of costs with family members, friends or employers. Usually they can gather it free of cost, but in areas where it is scarce purchase is often required, often at fairly high prices. The best solution to this problem is to prevent the purchase of large amounts of dung by starting to gather it long before the actual installation of the biogas plant. In this way, high expenditures for the initial feeding can be prevented.

Cowdung for daily feeding should in principle be available at the farm, in order to prevent time- and money-consuming daily gathering acivities. However, this is not always the case. Nevertheless the lack of the number of cattle required to feed a digester is not necessarily a constraint to install a biogas plant. Besides the commercial sale of cowdung, there is an informal circuit (see next paragraphs) in which it is possible to collect a considerable amount of cowdung. It can be gathered free in villages, on waste lands or on the farms of friendly neighbours or patrons. Relevant questions to be asked at this point are whether this free collecting can yield enough to feed a whole digester, whether it will create possiblities for landless labourors (who don't have cattle) and whether the dung will rise in value when biogas is becoming common practice. The following paragraphs will try to shed light on these questions.

Another essential input is water. This has to be mixed with the cowdung before it is fed into the digester, to ensure a proper fermentation process. In dry areas this will be a problem and it might take hours each day to fetch the amount of water needed. Furthermore, the little water available will be used for drinking purposes first. Paradoxically, in dry areas firewood is a scarce product and in these areas there is an urgent need for other fuels, such as biogas.

TECHNICAL AND MAINTENANCE PROBLEMS

Many technical problems have shown up in the past. In an All India study ('76-'77) the following problems were reported by the respondents (Moulik '82, p 21):

- Accumulation of water in the pipeline which connects kitchen appliances to the gas holder.
- Joints between pipelines and corks rusted.
- Leakage of water either from the pipeline or the pipeline joints.
- Low production of gas in winter.
- Excessive accumulation of water in the plant during the rainy season.
- The accumulation of carbon in the burners, requiring regular cleaning.
- Daily preparation of slurry is monotonous and time consuming.
- Maintenance (checking the gas holder, the outlets, the gas pipeline and its joints, the corks and the burners, removal of excess water) was time consuming and difficult.

As long as there were no major breakdowns, the routine maintenance of a plant was not considered to be a great problem. In the case of major breakdowns, the owners felt that the maintenance of the plants was a costly affair. Once in three or four years the gas holder must be welded to prevent gas leakages. Other repairs or replacements of hose pipe, pipeline, cork and similar items increase the cost of maintenance. The respomdents also felt that the repair services were a little bit expensive.

Most of these problems may have been solved presently, since the renewed support of the government in 1981 placed much attention on technical training. Besides, some of the problems mentioned are easy to solve, e.g. corrosion of the gas holder can be prevented by putting some paint or oil in the water jacket (if it is available and not too expensive).

The problem of the rusting gas holder is typical for the KVIC type digester. The fixed dome type, which is more popular nowadays, has other problems, such as leakages in the dome construction. The government therefore provides special training for masons, to teach them, among other things, how to stop the gas leakage with a special cement mix.

FINANCIALLY UNATTAINABLE

The per capita yearly income in India is very low. In Gujarat State for example, the minimum daily wage for an agricultural labourer is fixed at Rs 5½; in reality he earns even less. It is clear therefore that for the poor an expenditure of Rs 2000, the price of the cheapest digester, is impossible. The subsidy of Rs 1000 will not be enough to change this.

Another, more crucial point, touches the question of the relevance of biogas for the poor. We will give special attention to this point in the next section, as it is overlooked by most institutions who try to introduce biogas digesters in rural areas.

4.5 BIOGAS AND ITS RELEVANCE FOR THE POOR

The majority of the rural population in India is poor and is living below the subsistence level. This certainly applies for those who have neither land nor cattle. They lead a day-to-day life, without knowing what the next day will bring. Often they are desperately looking for work, to earn a little money for food. When they can't find a job in one place, they will go to another driven by their needs. In general these people are always looking for the basic necessities of life. Obviously, biogas has little to offer to them, especially when we take into account their access to alternative fuels for cooking. The dried dung cakes which they use for cooking purposes are often free of cost. They can gather them from the roadside or they can get them from friends. Large farmers sometimes allow their labourers to use some of their cattle dung, and they usually have no objection if the labourers take a few baskets home. Other fuels are often freely available from the waste lands or forest areas where reasonable amounts of wood or twigs are still available free. Agricultural wastes are sometimes sold, but many landlords allow their labourers to take some of the wastes home. This is in fact part of the deal with the landlord; the labourer supplies labour for which he gets a (low) wage and some 'extras' in return, although there are some indications that even these extras are grudged to landless labourers, especially in areas with great tensions between landlords and labourers, for instance South Gujarat State.

It can be said that agricultural labourers without land or cattle still have a degree of flexibility in the way in which they are able to satisfy their daily fuel needs. An expensive biogas plant is of not much use to them.

Neither does biogas have much relevance to the small and marginal farmers, with even more access to alternative fuels. Other requirements such as cows, bullocks, carts, bicycles and fertilizer are much more urgently needed. Biogas, as compared to other priorities has no direct economic benefit: it is not productive but will only benefit the owner in the long run. A cow on the other hand will probably indeed be considered productive.

We can conclude that seen from the point of view of the poor, biogas is hardly relevant. However, it may be so for the more well-to-do, who will enjoy the status, cooking, manuring and other convenience etc. of a biogas digester. Their use of a biogas digester might have negative economical and social consequences for those who cannot afford one. These will be studied in the next paragraph.

4.6 SOCIO-ECONOMIC IMPLICATIONS FOR THE POOR AS A RESULT OF THE INTRODUCTION OF BIOGAS

With the introduction of biogas digesters some effects similar to those noticed in the Green Revolution might show up, for example the commercialization of firewood and dung cakes. More importantly, we would like to point out the impact on the division of labour among social groups and sexes. Although the implications of biogas might not be as far-reaching and as structural as in the Green Revolution, introduction of biogas could have severe negative consequences, certainly in areas where biogas plants are becoming common (see also concluding Chapter). In this paragraph we will discuss the implications in detail, drawing heavily on Kijne's report (pp 43-52).

CHANGES IN THE FUEL ECONOMY

Firewood:

In many places woodcutting has developed into an income generating activity which is mainly carries out by the poorer villagers and which is sometimes even organized by entrepreneurs. A large portion of this wood supply is required for the timber industry, paper factories and fuel for cities. Only the cheap waste wood remains for the village fuel supply, and even that product is traded in many instances. Wood is used mainly by the richer social groups in the village communities. Due to the scarcety of wood, it has become a marketable cash product and is thus being sold to social groups that can afford these purchases.

Early adoption of biogas plants takes place with the 'better-off' and the richer persons in the rural community. The installation of a biogas plant minimizes their demand for firewood. The reduction of this demand can affect the fuel economy in a number of ways:

- The richer families will mostly obtain their cooking fuel through the assistance of others. Abolishment of their needs for conventional fuels through the introduction of biogas digesters will reduce these employment opportunities and income generating activities of the poor.
- The reduced use of firewood by the rich will increase the availability of this fuel on the market. This might lead to a lower price on the village market, if no alternative outlets are available elsewhere, which might give the poor a better access to this traditional fuel. A lower price will result in reduced incomes for the woodcutters and fuel collectors.
- It has been noticed that in some cases the richer farmers have their fuelwood supply collected from their own land by labourers in the form of wood, branches and crop stalks. Reduction of their own demand for fuel will not imply that it will become freely accessable to others in the community. Since this fuel has a market value and a labour cost for collection it will probably be sold.

The net result of such changes cannot be predicted and it varies in each particular case. Charges will of course only be considerable when biogas plants are in common use with the top level of the rural population.

Dung cakes:

The use of dung cakes for cooking purposes is practised in

India and is related to cooking and dietary habits (the low and persistant heat is appreciated for the boiling of milk) and to the availability of other fuel sources. Dung cakes are even sold in some cases, but in general they are freely available to all villagers. The use of dung cakes as a cooking fuel can vary quite a lot depending on the local scarcity of other fuel and on the traditional habits of cooking. In some areas the use of agricultural wastes as cooking fuel is more common.

As has already been pointed out in paragraph 4.5, the poor have only access to droppings from the roadside and/or the fields. Sometimes they also get some dung (or other agricultural wastes) as part of their wages. The cattle owners mainly get their dung from the stables, where the cattle are housed overnight.

Agricultural development might lead to forced stall feeding and other changes in the cattle farming system. This process will endanger the dung availability for the poor in a more structural way. It is not yet expected that to meet the dung requirements of a biogas digester, cattle owners will keep their cattle stable-bound for longer periods, since the extra dung collected will not outweigh the extra costs of fodder and water supply for the cattle.

As soon as a family switches to a biogas digester, the amount of dung used for cooking purposes is substituted by biogas, while the dung itself is used as an input for the digester. In here lies a great danger, since the dung might get a price, having severe consequences for the poor who rely on dung cakes for cooking purposes. In areas where dung is scarce, the poor will have to buy their dung cakes, the price will rise whereas in areas where the amount of dung available is abundant, the dung might become commercialized, making it profitable to hire someone to collect the dung from the streets and the fields. From a study by the State Planning Institute in Uttar Pradesh, Kijne revealed the following:

" The study showed that before the introduction of biogas digesters, between 30 and 50% of the available dung was converted into dung cakes and burnt. This was done by the cattle owners themselves and no dung was given free of charge to the labourers. Following the installation of a digester the use of dung cakes for fuel had dropped considerably. Between 60 and 90% of the available dung was being fed to the digester. This change enlarged the quantity of organic manure from 50 to 90% of the total amount of dung produced. Adoption of the digesters is found not to bring any change in the availability of dung to the weaker sections of the community".

To us it is still an open question whether the introduction of biogas in this case has had adverse effects or not for the poor, since from the study as presented in Kijne's report, it is not quite clear whether the dung had a price before the introduction of the biogas digesters, neither is it clear whether the price has risen as a result of this.

CHANGES IN DIVISION OF LABOUR

The introduction of biogas digesters will influence household activities carried out by the different family members. Possible changes in time and effort required will be discussed as far as cooking fuel supply and cooking practices are concerned, as well as digester operation and maintenance. It should be noted that this section is written from the point of view of a (small) farmer owning a biogas digester.

Substitution of biogas for traditional fuels will considerably reduce the time spent in collecting a family's supply. In most villages, fuel is being collected by women, and the time and effort involved varies of course with availabilty and distances to be covered. Increased scarcety of fuel can even require the assistance of children (often girls assist their mothers). Time spent for fuel collection can be as much as two to three hours a day. Collecting fuelwood can have detrimental effects on the health of women and children.

Cooking on biogas is said to be quicker and on average completed within one hour in the morning and one hour in the evening, while traditional firewood users require two to six hours a day (Srinivasan, 1982). As biogas cooking leaves cleaner pots and pans, time is saved by servants in rich households and by women in poor ones. Kitchen cleanliness appears to be one of the arguments for women to favour the introduction of biogas. However, such time savings will partly be offset by labour requirements for the operation and maintenance of the biogas digester (apart from its construction). Extra labour is daily needed for dung collection, water collection, digester feeding and slurry mixing and seasonly for digester maintenance/painting, effluent disposal and sludge removal.

In general, the small farmer has fewer family members and lacks servants or hired labour, compared to the richer farmer. Extra labour for the digester operation will have to be divided between man and wife. As it is often the man who gets involved in the digester operation, a remarkable shift in the division of their labour may occur. It would of course be much more logical to use part of the time saved by women (from reduced fuel collecting and cooking time) for operating the digester. From the flame-behaviour in the kitchen women will immediately notice when special attention is required which may avoid a disturbance in the gas production. As their interest in a properly functioning digester increases, they might wish to get involved in the operation.

The little cattle that a small farmer normally owns, produce only a limited amount of dung. Moreover, the limited amount of land he has forces him to leave the cattle on the roadside. As he is in need of dung to feed his digester, he will also have to collect all the droppings which his own cattle leave at the roadside, which is a time-consuming job to do. Furthermore, little dung will be left for others.

Supplying the water to make up the slurry for the digester can be one of the most labour intensive activities, at least for the poor. For cattle dung a mixture of 1:1 is advised. Water collection again is mainly the job of women (and children) and sometimes impressive distances have to be covered daily. Fuelwood-scarce regions are mostly short of water as well! Net time savings after the introduction of biogas will therefore be less noticable for the poor than for the richer households.

One can also query whether the time saved will be used productively. If there is a net result of time and labour savings for the individual woman, it is important to wonder who (e.g. husband, mother-in-law) will control this time and labour. If it will be controlled by others, it may imply her switching from one kind of hard labour to the other. When the woman herself is in control, the time and labour may be used for e.g. resting, playing, education or productive activities such as gardening or even field work.

BIOGAS AND WOMEN

Though the preceding discussion already pointed out some aspects of particular relevance to women, something more can and should be said in this respect. The introduction of biogas affects women in particular, certainly but not exclusively in relation to their cooking activities.

Release of the environmental pollution caused by the smoke and heat of traditional fires is an important health benefit for women. Changes of the cooking environment appear to be a major benefit of biogas (Srinivasan, 1982). The fact that cooking on biogas produces less smoke, means that eye and lung diseases could be diminished. Cooking on biogas also means that the cooking utensils will get less dirty than on an open fire. Though one would expect cooking practices to change only very slowly due to deep-rooted traditions, actual evidence about the biogas adoption appears to contradict this. Srinivasan reports that very few women reveal any problems related to the change to gas cooking, such as the taste of the food, the fact that not all dishes can be cooked on biogas or not all pan sizes used, or problems of heat control and 'tending' of the gas fire. All praise the improved convenience, cleanliness, cooking in upright position, time saving, health improvements and above all, increased social status.

The cooking on biogas requires less time. However, a negative aspect of this fact could be that the use of biogas might not be suitable for every common dish. So, for some dishes which require a long and slow cooking time, wood or dung still may be preferred. Also the influence of cooking with biogas on the cooking practices themselves and the nutritional value of food should be considered.

Despite the direct impact of biogas on women in particular, the new technology is largely directed towards men. Men are approached by promotion organisations, engaged in training programmes, and manage the digesters. Of course this is not surprising in view of general development practices and attitudes. As long as men continue to dominate the village scene (at least in its public manifestations), this bias will not be easily reversed! However, interests of men and women are not always similar, not even within one family. What is 'appropriate' for men may not be beneficial to women. Both parties may have different needs and priorities. Where men do not consider a number of activities of women as work, time savings in these fields may be much less appreciated by them then by the women involved.

If the collection of firewood or dung is a source of cash income for a number of women, it may occur that as a result of the introduction of biogas these women will be deprived of this source of income. This reduction of cash income for women ought to be seen as a negative benefit from biogas, with negative consequences for the food and health situation of children. The introduction of community gas plants may entail a decreased influence of women, as long as community affairs remain a 'male business'.

The gender division of labour is most certainly altered by the introduction of biogas. Time savings occur mainly in the field of women activities, men undertake extra activities related to biogas. Time savings for women might be endangered where the release from firewood and dung collection is replaced by highly increased amounts of time and effort for water collection. As long as the workload of women is reduced, such a redistribution of work seems appropriate given the existing unequal division of labour (hard working days for rural women in particular, at least the poor ones). Both interests have to be carefully considered in order to verify a positive outcome in each particular case. A crucial point in this matter is who actually is doing the work. There may be time saving on a household level, but not for the individual woman of the household.

4.7 COMMUNITY BIOGAS PLANTS

In the foregoing sections of this chapter we have confined ourselves to the pros and cons of family size biogas digesters. In this section we will have a look at the potential merits of a community biogas plant. A case study of a Gujarati village, based on a study by T.K. Moulik in "Biogas Energy in India", is used to give a fairly good idea of the problems and prospects of these community plants. Special attention will be given to the position of the poor.

Compared to the family size biogas plants, a community biogas plant (CBP) is more economic because of its larger scale, but as will be shown, this larger scale is also the origin of a number of technical and maintenence problems. Moreover, a CBP has the potential to reach the poor who have no cattle. A great disadvantage of a CBP is that it makes high demands upon the organization and cooperation. Firstly we will describe the programme for the promotion of CBP's that the government of India has launched, along with the programmes for introducing family size biogas plants (described in 4.2).

COMMUNITY BIOGAS PLANTS PROGRAMME

The government considers the CBP as an instrument to solve the energy problems of the poorer sections of the population. It was reported that by Februari 1983 20 CBP's were operational and 30 were nearing completion (this figure includes village community digesters as well as some institutionally managed digesters). For 1983/'84 a provision of Rs 5 crore (US$ 5 million) has been made available for the construction of 100 digesters. The subsidies as a percentage of the capital costs are as follows (Kijne p 26):

- Village Community biogas plant: 100%
- Other community/institutional plants: in rural areas: 66%
  in urban areas: 33%
- Institutional biogas plants: hospitals/teaching institutes: 75%
  dairies: 50%
- Community biogas plants organized by commercial organizations: 25%

The sizes vary between 30 and 145 m^3 gas production per day and can supply cooking gas to 30-140 families. Most of them have community toilets installed and the night soil is being mixed with cattle dung. Some digesters have a separate inlet for agricultural wastes.

A CASE STUDY FROM KUBADTHAL VILLAGE, GUJARAT STATE

The initiative to install a community biogas plant was taken by a voluntary agency, the Vimla Gram Seva Samaj Trust (VGSS). The VGSS Trust was created by a well-known Gujarati industrialist whose main purpose was rural development. The VGSS aimed at participative community action through the community biogas plant. Various class and caste groups were expected to partake and the plant was specially meant to benefit the poorer groups. On the average Kubadthal village is rather rich (90% above Rs 1000 per year, of which 35% above Rs 5000 yearly) and its infrastructure is well developed. As in most Indian villages, the socio-economic structure is highly stratified and at least 30% of the villagers belong to the lower castes.

A detailed technical and economical feasibility study for the installation of a community biogas plant was carried out by a semi-governmental agency. The agency ascertained that the CBP was economically attainable. A meeting was organized where the villagers and the village leaders were informed of the pros and cons of certain operating conditions.About 23% (123 households) of the inhabitants agreed to take part in the project. A huge floating metal gas holder plant to be constructed. In 1980 the start was made. However, during the construction of the plant, it collapsed twice causing the total cost to rise by 88%, to Rs 389,000. In December 1980 the plant was finished. The digester was designed to supply 140 m^3 gas daily, sufficient for the 123 households. All their houses would be connected with pipelines. While the initial plans called for the use of nightsoil as well as cattle dung, social resistance about the use of human excreta changed these. All kinds of problems emerged during the implementation phase. Water supply became a problem. The higher construction costs resulted in higher prices than earlier expected for digested manure and gas. It was also stated that the consumers had to pay for their own pipeline. Moreover, the VGSS Trust had taken out an 11% interest loan to be paid back by the beneficiaries in 10 years, without informing the villagers involved first. This resulted in their withdrawal and the plant was closed down for six months. A period of tension between the Trust and the villagers followed.

The villagers requested a higher price for their dung because they understood the dependency of the Trust on their dung supply. They wanted the price to be raised from 2 paise/kg to 5 paise/kg. In the beginning the Trust refused and thought of buying dung from the nearby surrounding villages and operating the plant to supply gas to the poor landless labourers almost free of cost. The landowning caste Hindu's households were outraged at this idea and made propaganda to keep the lower caste landless people from taking gas connections. Under great pressure the VGSS Trust agreed with the request for a higher price of the dung.Finally, in May 1981 new conditions were made. In May 1981 only 45 of the 83 families already connected accepted the new conditions. These were mostly high class/caste families. No poor and/or backward caste people joined, in spite of earlier willingness of villagers to provide gas to the poorer families at lower cost. The only benefit for them was the chance to earn some money by gathering dung for the digester. Furthermore it should be noticed that especially the women appreciated biogas cooking. But complaints were made about the low gas production. The Community biogas plant closed down again in November 1982 because the villagers demanded a further rise in the price of dung.

From this case it can be concluded that:

- The participation of the villagers in the decision making and operational phase of the project was very low. No real identification of the needs had taken place. It was in fact the Trust who decided what should happen.
- With the introduction of the community biogas plant the fuel-economy has commercialized. This has negative consequences for the poor; dung now has a price. A positive side-effect could also be noted: the increased labour opportunities for dung collecting.
- The CBP was far too big, resulting in serious management and maintenance problems.
- The Trust did not take into account the social differentiation in the village. Due to caste/class contradictions the participation of the poor was limited.

4.8 CONCLUSIONS

The massive introduction of biogas in India has taken place via a government-initiated top-down approach, which is in contradiction with the decentralized nature of biogas energy. The Indian governmental (and non-governmental) programmes centered primarily on one standard (relatively expensive and sophisticated) type of digester (the KVIC-digester), developed in a sterile reseach centre, which was thrust upon the rural population via a heavily bureaucratic organizational network. Rather than that the people themselves felt the need for biogas, the programme was a result of the extensive promotion activities by governmental and semi-governmental organizations, who felt that biogas was relevant to the nation in terms of environmental control, to counter deforestation, as additional source of energy etc. These national considerations, however, are not the major factors influencing individual decision-making and the acceptance of the technique. The individual is more concerned with such basic needs as food, water, energy, hygiene, clothing etc. This certainly holds for the more deprived members of society, i.e. small and marginal farmers and landless labourers. Although the biogas technique has some points of contact with the basic needs of the poor (for example hygiene and cooking fuel), it does not seem to have the highest priority. Even where it does have priority, the poor simply cannot afford a biogas plant nor do they have sufficient access to the necessary manure, water, credit facilities and subsidies. We can state that biogas is not a poor man's technology in India.

The government's choice for biogas logically implies ignorance of the needs of the poor. 50 million crores will be spent on biogas while other needs should have higher priority. Therefore, the government's first task should be to identify the real needs of the rural poor and to develop special programmes for them.For example parallel fuel programmes such as planting fast-growing trees and disseminating improved cooking stoves could help those not covered by the biogas scheme. First and foremost, however, should be the poor's priorities, which can vary from region to region.

The use of a biogas digester by those who can afford one will probably result in a commercialization of the dung-economy. This is certainly true in the case of a community biogas plant. This might have severe negative social/economic implications for the poor since they are deprived of an important fuel source.

REFERENCES

Blankenberg, F. (1983): Implementation of Biogas Plants in Gujarat and Tamil Nadu, Unpublished Reports.

BORDA (1980): Handbuch zur Durchführung von Biogas Programmen, Bremen Overseas Research and Development Organisation, West-Germany.

Eggeling, G.: Biogas Plants Building Instruction, GATE, pp.64.

Kijne, E. (1984): Biogas in Asia, Inventory Field Study on the State of Development of Biogas Digesters for Household Use in Tropical Rural Communities. Consultants for Management of Development Programmes b.v., Achter Clarenburg 25, 3511 JH Utrecht, the Netherlands.

Madhi, S.S. (1982): Biogas Programme in India. In: Financing Agriculture, Volume XIV, 2-3.

Marimuthu (1979): A study of Working of Biogas Plants Installed in Dindigul Taluk, Madurai District, Tamil Nadu, Nadu Gandhigram.

Moulik, T.K. (1982): Biogas Energy in India. Ahmedabad.

Srinivasan, H.R. (1982): The Health Aspects of Biogas as an Energy Sources. Reprint from "Health Impacts of different Scources of Energy", IAEA, Vienna.

Tam, D.M. and N.C. Thanh (1983): Biogas Technology in Asia: the Perspectives 1983. Renewable Energy Review Journal, Vol 5(1).

5. Biogas Technology in some other countries

5.1 INTRODUCTION

Contrary to India and especially China biogas technology has not been introduced in any developing country on such a large scale. In many places in the world, however, people are busy experimenting with this technique. At this stage it is rather difficult to get an idea of the social and economic implications of this technique, since no reports are available on this topic. It should be stressed that this kind of research could be an important factor in determining the success of introducing biogas or any other technique whatsoever. This chapter will consist of rather superficial information on the state of the art of biogas in a number of developing countries other than China and India.

5.2 AFRICA (GENERAL)

Anywhere in Africa outside the tropical areas around the equator (and even in mountainous areas at that latitude, such as Rwanda) an increasing scarcity of firewood can be observed. The first cause of this is the increasing population pressure which in many cases uses the trees faster than they can regrow. Additionally, wood is used on an ever increasing scale for industrial purposes. This is due to the explosive growth of the urban population, which more than doubled in many African countries in the period 1960-'70. Also, there is an increasing commercial production of charcoal, because of the ease of transport (often to urban areas) and the ease of use as a fuel. This is however a rather inefficient method of using wood as a fuel. In some areas firewood has become so scarce, that one must resort(like Tanzania) to cooking on crop wastes. This will eventually decrease soil fertility which was originally maintained by ploughing these crop wastes under.

5.3 POSSIBILITIES AND CONSTRAINTS FOR USING BIOGAS IN AFRICA

Climatological/technical constraints:

Except in higher altitude regions, temperatures are favourable for biogas production; in Sahel regions with an average soil temperature of 26-28°C even near optimum. However, a severe constraint for Sahel regions is the availability of water. Therefore, Indian and/or Chinese digester types are not very useful for these areas. In Upper-Volta experiments were carried out with serially connected batch digesters, using 'dry fermentation' (see Chapter 2). When using the serial batch digester approach, a reasonable spread in the workload (filling and emptying) can be obtained as well as a more or less constant gas production. A separate gas holder is useful in this case. As was pointed out in Chapter 2, a well functioning batch digester can produce gas at rates comparable to or higher than continuously-fed digesters. A problem can be the considerable quantities of input materials which have to be available at a specific time and the large quantity of output material which becomes available when emptying the digester. However, in this case the minimal production unit is in general larger than family size (lineage groups, extended families) which could solve the labour problems.

Because of the separate gas holders, the costs of serial batch digesters are considerably higher than the costs of continuously-fed digesters, especially those with smaller volumina. The system might be advantageous in a cooperative set-up, if organized in the right way. In this case an additional necessity is the population density (villages); in Upper-Volta these conditions seem to be met.

Social/economic constraints:

The necessary feeding material for a small digester is available for most small farmers. Still there will be some constraints which are not easily avoided:

- substitution of firewood by biogas is not to be expected as long as reasonable quantities of wood can still be gathered (although the governments would like to reduce this activity before all the forests have disappeared).
- the costs of a biogas digester are still too high for the small and marginal farmer
- credit is not easily obtained. Governmental credit institutions are often inaccessible and approached with distrust by the villagers.
- there is no tradition of collecting cattle dung for fertilizing fields; therefore using the effluent of the digester as fertilizer is also not obvious.
- acceptation of different cooking methods when substituting biogas for wood as fuel might cause problems.
- biogas as a cooking fuel would have a definite advantage for women (who collect the firewood). However, the decision to obtain a digester is in general taken by men.
- objections can be expected to cooking on gas produced through anaerobic fermentation of night-soil.

At this moment the traditional African village community is pressured by the increasing population density, urban migration, commercialization and growing governmental influence. This village community was characterized by strong social mechanisms to equalize wealth as much as possible, although often under strong authoritarian leadership. It is possible that biogas technology could contribute to a greater self-reliance of such a community, thus at least partly preventing the total collapse of the traditional social system. In the past the African society has shown to be able to assimilate new techniques into its cultural pattern (e.g. growing banana, sugar cane and maize).

However, in general the introduction of biogas will need the consent and assistance of the central governments. A change of national politics towards greater self-reliance of rural areas is not likely considering the present urban-oriented governments. (policies are in general directed at increasing agricultural production at minimal costs, to feed the urban areas or for export).

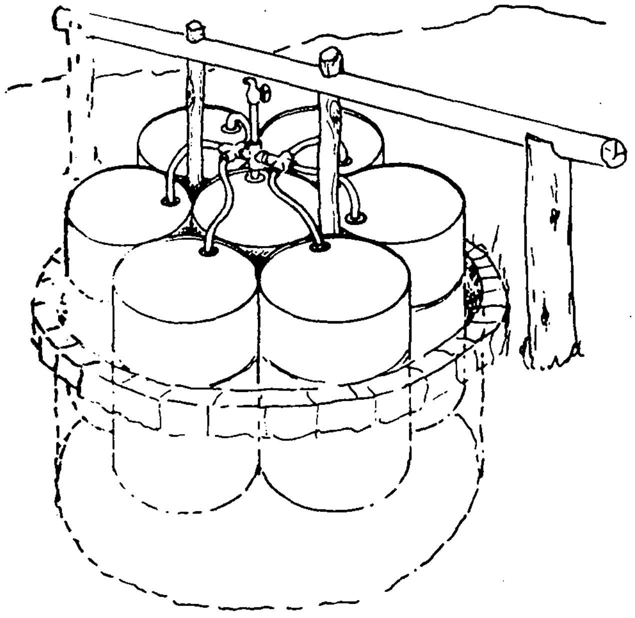


Fig. 5.1: Tanzania Seven-drum biogas digester
(from Roberts)

Where the most important reason for introducing biogas would be fuel substitution, cheaper and less complex means of saving fuel, such as more efficient wood stoves should be considered.

5.4 TANZANIA

In recent years the government has instructed the Arusha Appropriate Technology Project (AATP) to develop and implement biogas digesters in rural areas. It is the intention that the villages will become self-reliant for energy as well as for the construction of the digesters. The increasing deforestation is also considered important.

Temperature, availability of water as well as the number of cattle owned by the average farmer are no constraints for family size digesters. A choice was made for the Indian digester type. The gas holder is constructed from old oil drums. A village welder is able to construct a cover of about 2 m diamater in this way. Problems arose during transport of these gas holders, as they are easily deformed. Threrefore, in a later stage the design of the cover was changed to a unit of 7 connected oil drums (see Figure 5.1). This solution is much cheaper, but about 20% of the gas produced is lost to the atmosphere. An advantage is that in case of severe erosion drums can be replaced individually.

Up to now 3 production cooperations and a number of private firms are producing these digesters commercially . The price of the digester is still an important constraint for the popularization of biogas. Some users at the moment are: medium sized farmers, cooperations, missionaries and local teachers. The main advantage for the user is the reduction in time and effort necessary for collecting firewood. Using cattle dung for increasing soil fertility is not common.

5.5 THAILAND

The first initiative for introducing biogas technology in Thailand came from the Ministery of Public Health with emphasis on latrine-connected digesters. This, despite the existing cultural objections to using cooking gas obtained by anaerobic fermantation of nightsoil.

In a later stage other governmental institutions became interested as a result of increasing energy prices. It is reported that at this moment 3100 family size digesters have been built and 22000 are planned for the coming 5 years. To realize this the government has started all sorts of supporting activities such as training programmes as well as subsidy and credit schemes.

The most interesting seems the program for Community digesters of which type 10 are operational. However, at this moment no information is available as to the social aspects of these digesters. In this programme the Chinese fixed dome type digesters are used in combination with a separate gas holder, the latter for the ease of cleaning and a better control of the gas pressure. According to the National Energy Administration the payback period would amount to only 3-5 years. For the coming 5 years 500 digesters of this type are planned.

Many activities are directed at improving existing designs. The Faculty of Public Health of the Mahidol University has developed a model in which the metal gas holder of the Indian type design has been replaced by a fiberglass/cement gas holder, reducing the costs by 50%. Another, flexible design uses traditional water vessels of cement or ceramic with a volume of about 1 m^3. These vessels function as digesting unit (individually or serially) and are connected to a central gas holder. The system can be operated as a serial batch as well as continuously-fed digester.

Temperature and availability of water are not reported as constraints. Deforestation and erosion in hilly regions are an increasing problem in Thailand, but the national government does not yet take this as a motive for introducing biogas.

5.6 NEPAL

Nepal is, being a country consisting mainly of hilly and mountainous regions, very vulnerable to the effects of deforestation and the ensuing erosion. Scarceties in firewood are severe and, as in India, dung cakes are already substituted for wood to provide cooking energy. To counter these problems, the government has initiated a biogas program together with Development and Consulting

Services (DCS), a subunit of United Mission in Nepal. It is reported that 1000 family size digesters have been built. However, it turned out that for most of the poor farmers this type of digester is too expensive. For this reason programmes have also been initiated to organize groups of small farmers around a community digester.

Climatologically Nepal shows large regional differences, varying from tropical low areas along the Indian border to cold high areas in the Himalaya's. This climatological diversity has led to a large number of different digester types used.

It should be noted that despite the small size of the biogas programme (only 1000 digesters up to now) important innovations have been made which are nowadays also used outside Nepal. Originally the Indian design was introduced, but due to the difficulties of transporting the metal cover, constructed in urban areas, into mountainous regions and due to the lack of insulation of this cover against low temperatures, below ground types are now used, such as the Chinese dome type and the locally developed tunnel (plug flow) type digester.With the tunnel type digester a ditch is dug which is covered with locally constructed concrete elements; problems are encountered with the gas tightness. Plastic foil at the inside of the tunnel has been used to remedy this. This type of digester is much easier and cheaper to construct than the Chinese dome type and can also be used for 'dry fermentation' (see Chapter 2).

5.7 PHILIPPINES

Biogas technology has hardly been introduced in the Philippines. 200 digesters were reported to operate in 1983. One development, connected to Maya Farms, the agro-industrial part of the Liberty Flour Mills Concern, should be mentioned. This purely commercial institution consists of a site for raising pigs and ducks, as well as a slaughterhouse annex meat canning factory. To limit pollution from the pig wastes anaerobic digestion was introduced. Since 1972 experiments with several digester types, depending on the different inputs used, were carries out. At the same time the possibilities of the effluent as feed for ducks, algae and/or fish and cattle, as well as its use as compost were tried.

These experiences directed the research towards integrated agricultural systems. The goal is to maximize yield per unit of land and labour with a minimum of external inputs for the agricultural unit.

A 1.2 hectare try-out farm was started, run by a former farmer now employee of the concern. One hectare is used for growing crops, the remaining area for trees (ipil-ipil), a fishpond (Tilapia), barns, the biogas digester and living quarters. There are 2 heads of cattle, one used for traction, and about 10 pigs.

It is reported that this farmer can, after repayments to the Maya Farms, at current market conditions provide himself with a reasonable income from this farm. Maya Farms have recently started a Bio-Energy Advising Agency to provide information and training on these integrated agricultural systems and the use of biogas therein.

One can, however, seriously question these developments initiated by a commercial firm. The relevance for the rural poor, especially in the Philippines, is minimal and introduction of these systems might just strengthen the position of the large farmers.

On the other hand, the experiments with integrated agricultural systems including the biogas technique, might be useful elsewhere, the more since integrated agriculture is already practized in large areas in South-East Asia.

REFERENCES

BORDA (1981): Biogas and Waste Recycling at Maya Farms. Biogas Forum 81/7.

Coussement, I. (1984): Insertion du Biogaz dans le Milieu Rural Africain. Report for AIDR (Association Internationale de Développement Rural), Gent, Belgium.

Haan, W. de: Biogas Development in Nepal. AT-News.

Kijne E. (1984): Biogas in Asia, Inventory Field Study on the State of Development of Biogas Digesters for Household Use in Tropical Rural Communities. Consultants for Management of Development Programmes b.v., Achter Clarenburg 25, 3511 JH Utrecht, the Netherlands

Roberts, R.S. Jr.: Biogas Technology in Tanzania. In: Evans, D.D. (ed): Appropriate Technology for Development.

6. Synthesis, Conclusions and Recommendations

6.1 INTRODUCTION

As should be clear from the subtitle, this book has been written from a definite point of view, held by the authors and largely coinciding with the point of view of the Agromisa Foundation. It should be noted, however, that this view is not only the choice of the small and marginal farmer as well as the landless labourer as the target group, but originates from a more general view on the way the problems of development and underdevelopment should be handled.

In the first part of this synthesis we will give an outline of this point of view and the consequences of this on development aid. More schematically we will discuss:

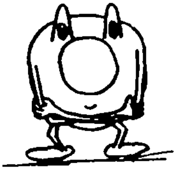
- review of some current theories of development and underdevelopment and our resulting choice of development objectives.
- choice of technology transfer versus organization as development strategies, their interrelatedness and local prerequisites for appropriateness.

It should be emphasized that in development work the development objectives and the choice of strategies are hardly made explicit. This often results in a confusion of objective and means (goal-displacement). Choices are often made based only on the technical background of development aid workers. These tend to place too much emphasis on techniques and have unrealistic expectations of the role technology transfer can play in solving development problems.

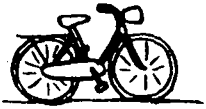
This first general part will provide us with a point of reference for a more detailed discussion of the theme of this book, using material from chapters 2 to 5. We will discuss the motivation for and the relevance of biogas on a national and individual level, the relations between existing social structures and biogas programmes and the consequences of introducing biogas for the target group. After drawing a parallel between the Green Revolution and the introduction of biogas, we will formulate some conclusions and recommendations.

THE COUNTERPART QUIZ by HANS MARTIN FISCHER

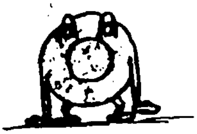
QUESTION: WHAT SHOULD I DO WITH A COUNTERPART AND A BICYCLE? CHECK THE RIGHT ANSWER.



THIS IS ME, THE COMPETENT DEVELOPMENT WORKER, THE "EXPERT".



THIS IS THE BICYCLE.



AND THIS IS THE COUNTERPART

continued

6.2 SHORT REVIEW OF SOME DEVELOPMENT THEORIES AND STRATEGIES

Modernization theories:

These originated shortly after World War II and are still a very common point of view in development aid activities. Some of the basic assumptions are:

- All societies will eventually evolve following the model of the rich countries. Underdevelopment and development are seen as consecutive stages in this process. This also implies that underdevelopment within developing countries is an internal problem and will solve itself after some time.
- On a national level there is a harmony of goals between rich and poor countries.

Strategies are directed at those 'bottlenecks' which are considered to hamper the development of the poor countries. Western technology will play a major role in removing these 'bottlenecks'. This transfer of technology takes place via multinational corporations and large scale foreign investments. Some 'bottlenecks' and their 'solution' during the last two decades were: overdependence on the export of raw materials (rapid industrialization), low agricultural production (Green Revolution), energy shortages (introduction of windmills, biogas plants etc.).

Dependencia-theories:

These theories also originated shortly after World War II, mainly in Latin America. Although there are many variants, the basic ideas behind these theories can be formulated as follows:

- Underdevelopment and development are not considered as consecutive stages (contrary to the modernization theories) but rather as two sides of the same phenomenon. This implies a clear relation between the social structures in developing countries and the structures of international dependency, both being the main causes of underdevelopment. Consequently, underdevelopment is not an internal problem of developing countries.
- There is no harmony of goals between rich and poor countries, c.q. rich and poor groups within countries.

Strategies are on the one hand directed at reducing dependence on an international level by trade negotiations, organizing kartels for raw materials or by 'self-reliance', a strategy proposed from within the Third World. On the other hand, the theory would imply a strategy aimed at the emancipation of the poor masses within the developing countries to enforce a change in social structure before any real development can take place.

However, the majority of Third World countries seem to have quite stable social structures, although their political elites may change frequently. This implies that the emancipation strategy is at least a very long term strategy.

A third approach for the problem of underdevelopment was proposed by the International Labour Organization (ILO). In this approach employment plays a major role. Investments should be made in such a way that maximum employment is created. Production should be directed to the basic needs of the masses and not as in the modernisation strategies, for the happy few or for export. Increased employment opportunities would alleviate the situation of the poorest. In the original formulation (on paper!) the "basic needs strategy" implies a social and political dimension, and includes " the participation of the people in making decisions which affect them, through organizations of their own choice". However, in practice this social/political dimension and some of the condition such as land reform and freedom of organization which are required for successful implementation of the basic needs strategy, are easily 'lost from view', and the strategy boils down to a purely technical and economical one.

6.3 FORMULATION OF DEVELOPMENT OBJECTIVES; TAKING A STAND

After the review in the preceding paragraph, the following remarks can be made:

The modernization approach of the last two decades, with its associated huge transfer of western technology, has undoubtedly increased dependence of countries as a whole as well as between groups within countries. This motivates an approach directly aimed at the development of a specific target group, i.e. those groups still showing a strong dependency on national and local elites. These are most often small and marginal farmers and landless labourers. Experiences with target group-directed development work have, however, shown that many organizations have confined themselves to isolated aspects related to the material needs of the target group. This resulted in badly formulated strategies and only temporary, if any results.

Therefore we will first formulate our development objective: The structural development of the target group, which means increasing the possibilities and capacity of the target group to solve their own problems and choose their own direction of development.

This formulation seems rather vague, but two remarks can directly be made to clarify some aspects:

- there is no 'trickle-down' approach; starting point are needs and wishes of the target group; this implies a proper identification of the latter as well as maximum participation of the target group in any activity undertaken.
- possibilities for the target group to solve their own problems are often hindered by dependency relations; this implies that these dependency relations should be reduced in a structural way, often by initiating some form of organization.

6.4 CHOICE OF STRATEGIES

In the preceding section we have stated our reasons for taking sides with the poor. Furthermore, we have stated our development objectives. An appropriate development strategy will be (as already pointed out in the introduction) a strategy initiating and/or consolidating a structural development (see paragraph 6.3). A further specification of such a strategy could be:

1) initiate an activity
2) organize around this activity

re 1) The activity will be a mean to reach the target group. It should, however, follow from the needs of the target group and can be undertaken at technical, economical, social or political level.

re 2) The organization will be a means to consolidate the benefits for the poor of the activity and will enable the target group to break through their dependency relations from overrulers/exploiters and achieve structural development.

Two extra prerequisites can be mentioned:

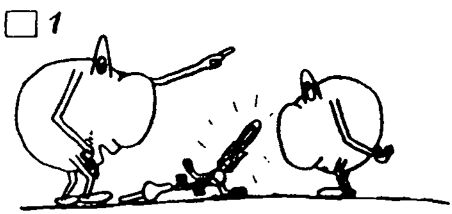
- The activity needs proper identification to be sure it relates to the needs of the target group. Note that for a structural development the activity should also be analysed in its socio-political context.
- activity and organization should be participative since this form ensures maximum emancipation of the members, and because new power concentrations as well as new dependency relations can be avoided in this way. Participation takes place at decisional and implementational level.

Remarks:

1) Technology transfer is a popular development strategy. The strategy starts an activity, often directed at some direct need of the target group (such as increasing income), but it should be pointed out that this activity is often poorly identified (especially within the economical/social structure) resulting in only short term positive effects and often in a later stage in increased dependency for the target group.

- The needs mentioned by the target group will often be rather 'down-to-earth', such as a more secure income; those identifying these needs (the 'change-agents') have the responsibility to ensure the proper organizational structures to make the benefits to the poor of an activity long term.

As should be clear from the previous, technology transfer and organization are not at all mutually exclusive strategies; transfer of technology also needs an organizational structure, while organization needs an activity. The appropriateness of both strategies will be discussed in the next section.



I TAKE THE BICYCLE AWAY FROM HIM, HE SHOULD WALK.

6.5 CHOICE OF TRANSFER OF TECHNOLOGY VS. ORGANIZATION AS A DEVELOPMENT STRATEGY: THEIR APPROPRIATENESS

INTRODUCTION

Traditional technology and social structures, as in fact the whole of a culture, must be seen as an answer to the problems which a specific group faces. In modernization theory and the development strategies based on this, the existing technology, social structures, and culture is often seen as a hinderence to development (bottleneck) following the Western model. We conclude otherwise:

1. The traditional culture,social **structures** and technology is the basis of a society, and has developed over the years as the best method of living, given the local situation.
2. Technology and social structures are an integral part of the society and cannot be seen separate from a society's:
   - values and norms
   - vision of the role people are seen to occupy in their world
   - social contacts and relations
   - jurisdiction, equalization and regulating mechanisms meant to insure the acceptability of a society for all members.

Society and culture are not rigid, but adapt to changes in the surroundings and continue to develope the best methods for survival of the group. Changes can also be caused by contact with other cultures and the ensuing transfer of values, knowledge and habits.

It is not our intention to imply that the existing culture, technology, and social structures always represent the best solution for a group. Local technology and organization can become insufficient, especially in fast-changing societies which are influenced by external sources. Changes in a society are not neutral but usually benefit the ruling group (rather than the target group).

Various aspects of this transfer of technology and organization will be discussed in the following chapter as both make up an important part of our development strategy.

Technology and organization are closely related in a society and must not be separated in a development strategy. The various aspects and effects of technology transfer and organization will be treated separately. It will be seen that nearly identical reasoning for the appropriateness of the technology and the organization will result.

TRANSFER OF TECHNOLOGY

POSITION AND FUNCTION IN THE SOCIETY

It was already stated in the introduction that technology is linked and partially determined by other facets of the society, especially that part which is called by some the "technological system" , and is:

- A system of development, adaptation, and improvement of the technology, ideally based on contacts with the society via schools, extension systems and feedback experiences and wishes of the users.
- A system for the control of the technology in the society. In many cases only rulers and specialists can be said to have control of the technology used by many.

It is important to realize that technology is not neutral, but can be adapted to the wishes and goals of the ruling group. Technology is power.

From the above we can explain many cases of the problems and negative effects resulting from the technology transfer of development aid projects. These are:

1. The transferred technology is not accepted, or does not have the desired effect for the target group. Some reasons for this are:
   - The technology was not developed for the target group, but for a Western society (and its ruling group). It is foreign and not neutral to the target group.
   - The transferred technology was given without the associated knowledge, experience, and organization. It can be questioned whether it is possible to successfully trans-

fer a technique which is neither understood or controllable by the target group.

2. The transferred technology directly causes negative effects for the target group. Those able to accept and use a new technology can then distance themselves from the rest of the society and its rules, as these are not adapted to the new technology. Possession of technology gives power, and possession of a foreign technology especially can lead to new levels of power and wealth for a small group. A result of Western technology in developing countries is the general trend towards individualization by the new technicians and the commercialization of production means and social relations (work relations).
3. Transfer from a powerful and imperialistic culture to a less self-secure culture can "overwhelm" the later. While in the past a culture had the chance to choose among the elements and to adapt, the present culture imperialism is often too quick and strong to be resisted or controlled. The foreign culture cannot supply a useful alternative for the lost culture, social structure, and technology; this alternative must be developed by the group itself. Ikoku (1977) reasons that self-reliance is the only way for a society to determine its own development and to be able to choose selectively among the new influences and techniques.

Dispite these problems we think that the transfer of technology can be useful where the target group is given the time, the possibilities, and the power of decision necessary to be able to select, adapt and finally absorb the technology into its own situation.

What are the prerequisites for a successful transfer of technology?

How can we avoid the negative consequences described above?

1. Transfer of technology and the closely linked organization of people must have an emancipating effect by:
   - organizing to make the group stronger.

- providing a technology which makes the group more independent.

Besides considering and attempting to predict the direct often economic effects of the proposed technology,it is important to consider as well:

- What are the risks which the user must make? What will be the results of other, unexpected situations (for example poor yields, bad weather). Can a farmer still return to the previous situation?
- Is the dependence truely less than before, or merely replaced (or increased) by other dependencies (for example dependent on market prices, means of production, extension training, or infrastructure)? How can people protect themselves against this?
- Are social relations affected (for example within families, households, traditional groups or organizations)?
- Can a socially and/or economically higher class benefit from a new technology and will this be to the disadvantage of the target group?
- Can the members of the target group who do not accept the new technology loose position to those who do?

It should be clear that a detailed knowledge of the existing social structures is necessary before it is possible to accurately estimate the above-mentioned effects of a transfer of technology (see section 6.4)

2. Organization is needed to avoid the problems and effects described above. The organization must take care of the following:
   - It must accompany the adaptation of a technique.
   - It must reduce risks and strengthen competition.
   - It must develop rules to control the technique and the possible dependencies which may come with the technique (for example specialization, buying and selling).
   - It must contact the suppliers of the necessary imputs and

guarantee the availability of these (credit, subsidies).

3. The choice of an "adapted" technique can improve the chance of success of a transfer of technique. However, such criteria or qualities of a technique do not guarantee its "appropriateness". Some of these qualities are:
   - small-scale, simple
   - able to be made with local materials
   - few imputs necessary
   - labor intensive
   - aimed at subsistance rather than incorporation into the local market system.

Techniques which do not meet these criteria demand more extensive plans for preliminary studies, organization, and extension training.

(It is always useful to ask oneself before attempting to introduce a new technology why the population hasn't already chosen for this technology. The answer may very well show new and unexpected (for the planners, not the target group) impediments to the proposed plans.)

ORGANIZATION

In section 6.4 it was already concluded that participative organization of the target group (with or without transfer of technology) can help achieve the desired development objectives. Participative organization must break the existing power structures and dependencies which inhibit the further development of the target group.

Organization must be adapted to the local society. It is therefore first necessary to understand the existing organizational forms and "blocks" in the society.

The place and function of social structures in a society:
- Family and clan relationships
- Traditional cooperative agreements (horizontal, vertical, as in employer-employee, and at a societal level)

- Existing organizational structures at village level
- Rights of ownership of means of production
- Ruling powers and dependencies (patron-client)
- Governmental structures and controls

There are vast differences between the role of organizational forms in different societies and in the history of a single society. The above-mentioned structures and relations function in a society (division, coordination) to make it more "livable". This occurs by:

- Preventing the excessive concentration of power. Social controls and interdependencies insure equalization.
- Providing security and support. This can be via family and horizontal bonds, but also by employer-employee relations.

Although the entire society profits by these structures, the more wealthy and powerful tend to benefit more by such forms of organization than the others. In fact, they can often influence these forms to a far greater extent than the others can.

Changes in these social structures occur due to both internal as well as external (contact with Western culture) factors. These changes can lead to:

- Incorporation in larger systems (markets, governments)
- Differentiation
- Individualization and commercialization
- Increased stratification and decreased social concern
- Decreased family bonds, social control, and mechanisms of interdependence

These changes will only benefit those in possession of power and wealth.

The plans for participative organization therefore must be carefully weighed against the prerequisites necessary for achieving the desired goals. Organization of the target group should give the group the chance to:

- Increase its social and economic power
- Develop a "claim-capacity" to be able to fight for their own rights

- Decrease risks to be undertaken
- Begin new activities which will increase the possibilities (credit, technique, education, etc.)

During the actual organizing on a local level the following must be considered:

1. Who to organize?

To insure that all members participate without power being concentrated in the hands of a few, it is important to organize a homogenous group.

Is it possible to keep wealthier and more powerful persons out?

Is it necessary to break or change existing ideas concerning differences among people (families, castes, sex, trades) or can a new organization be built onto a traditional one.

2. Why Organize?

The reasons for a development worker to attempt to organize a group have already been enumerated. Reasons for the participants to organize are usually much more practical and less ideal. The potential participants will consider whether:

- The organization will be useful to them.
- There are risks that powerful members in the village will influence the group.
- There is a chance that a small group in the organization will profit.
- There is a risk that the organization will endanger existing economic relations (vertical, and other) without offering something better in return.

Especially the poorest in a village will be the most difficult to reach and involve. The possible negative effects and the risks they are asked to take are greater for them than for all other village groups.

3. What are the possibilities for an organization?

Can it fit into the system (local and national)?

Are there existing traditional organizations which can be built up or affiliated with, and do these meet the requirements for structure, democracy, and homogenity?

4. What type of organizational structure is used?

Should men choose one based on traditional and familiar methods, or one using new structures which better encourage all members to participate. If the latter, can this lead to problems with traditional social relations (young-old, family), and can the uneducated target group fully understand and use such a new structure themselves?

5. Which activities will the organization undertake?

Begin by chosing a problem common to all members, and such that the solution will involve all members. The first activity should not be too complex and should give quick and sure results. Activities can be chosen to reach certain groups. For example the very poor cannot join in an activity requiring inputs, and the wealthier will not be interested in activities which offer only small profits.

6. How can the organization maintain the necessary homogenity, solidarity, and level of participation while avoiding power groups, unequal benefits, or new dependencies from forming? Some methods to help the target group "take over" are:

- Begin with a small organization
- Rotate functions and tasks
- Train all members, not just leaders
- Set rules, especially those pertaining to the growth, the specialization, and the contacts with external relations (buying and selling, credit, related organizations)
- Insure continuity and involvement by regular activities, group responsibilities, and individual contributions. Solidarity is important.

How can one better understand the wishes and possibilities of the target group? In many cases the group will not have a spokesman or own organization, or it will be difficult to discover power plays in an existing situation. In most cases then a promotor or "change agent" will be needed to start and accompany the process of identification, decision making, etc. Who should this be, and how does he influence the process?

This leads to a weak point in the strategy, where "paternalistic " thinking can also be seen. The evaluation of the situation and from this, the formulation of the needs and the stimulation of activities are strongly dependent on:

1. The background and ideas of the person.
2. His or her relation with the target group and others.

re 1. The promotor relates what he sees and hears with his own experiences and judges the needs of the target group by his own background and interests.

- His training conditions him to see certain problems and solutions. Problems for which there are no solutions known are often "forgotten" or not recognized. (This tendency exists in the group as well).
- His social background and motivation also determine:
  - How to reach and relate to the target group.
  - Which problems he will rate as important.
  - Which goals he sets for the target group.

re2. A member of the target group itself can more easily be trusted by the others, and will have better insight into the existing structures.

- Existing relations (ex. family) can affect or limit the work and possibilities to be done.
- An outsider may be seen as more neutral, and may be more easily able to contact different groups, and even to bring these groups together, where this is necessary. A neutral person can more easily be accepted as an advisor.
- As outsider, he will have a background (origin, language use, training) which will always affect the relations with the others:
  1. In a tendency to mix with people of his own level.
  2. In the distance the poor see existing between themselves and others; this distance can limit the trust and identification needed.
  3. In the relation of the promotor with his employer organization and others (informal relations with more powerful in the region, local governments, traditional leaders, etc.) can affect his possibilities and actions.
  4. Existing cultural restraints between men and women, and the often subordinate position of women makes it difficult to have women participate in mixed organizations.

How much will this affect the whole process? While the goal is participation and, finally, an independent organization belonging to the target group itself, the influence of the promotor is very large, especially in the beginning (many times larger than that of individual members).

A certain dilemma exists in the role of the promotor:

- He must stimulate the development and contribution of others in the group.
- He must assist the whole process of transferring knowledge and experience (and technology) to the group. The desire to insure that this goes well, and to protect the group often leads to an excessive influence and too central a role.

From the above it is clear that the influence of the promotor is very important, and that success is based on very subjective qualities. Still, an organization can affect its own future. Small, private organizations have more possibilities to do this than governmental or large, coordinating organizations. A small private organization can do this by:

- Practicing a stricter selection for motivation, capabilities, and vision in its cadre (although the choice will naturally be limited).
- Training its own local youth (broad training, less biased).
- Providing active accompaniment and support of its members.
- Stimulating work for the target group through social controls and value systems.

A disadvantage which small groups have in relation to large, governmental organizations is that they don't have the capacity for large-scale growth or to balance the delivery system (often governmental) with the needs. However, it can be questioned whether governmental and large organizations which do have these capacities can ever reach the target group in the way needed.

6.6 BIOGAS TECHNOLOGY, AN APPROPRIATE DEVELOPMENT STRATEGY? CONCLUSIONS FROM CHAPTERS 3,4,and 5

note: Remarks concerning Africa are of necessity rather generalized and superficial due to the scarcity of information and for this reason will be limited in length and value.

MOTIVATION FOR AND RELEVANCE OF BIOGAS

1. NATIONAL ECONOMIC VS. INDIVIDUAL INTERESTS

Motivation for a country as a whole to introduce biogas can be other than those for the individual potential users. Motivations of the latter can differ according to their wealth and their role as men and women in society.

National economic motives for biogas are:

China: Production of fertilizer
Improvement of hygiene
Fuel substitution has less priority

India: Fuel substitution to save foreign currency and existing forests.

Africa:Fuel substitution, mainly for ecological reasons.

Individual interests and relevance for biogas are:

China:

Biogas is relevant for a large percentage of the Chinese population because:

- Most people live sedentary lives,
- Within a commune the distribution of wealth is fairly equal. While some communes are very poor, it seems that the standard of living of many is high enough for them to consider biogas.
- This interest is met by the existing organizations which reduce the individual risks and accompany the introduction, making biogas more easily attainable.

The gas is the main motive for individuals. The Chinese have been able to unite the motives of country (commune) and individual, although some discrepancies can exist, such as the periodical use of all the effluent by the commune, which temporarily stops gas production until the tank is fully recharged.

India:

The relevance for the target group is limited because of:

- Part of the target group consists of migratory workers or tribals.
- Biogas has low priority since it does not earn money. It is seen as a luxury, and thus only interesting for those above a certain minimum level of existance.
- Interest by the target group can in some cases be increased, such as when fuel needs compete with the fertilizer needs of the land to such an extent that yields are severly limited. However, in such cases the possibilities for the target group for biogas are constrained by financial problems, lack of credit, materials, and training. The risks are greatest for the individual small farmer.

Motivation for larger farmers and others to install a digester are less clear. Factors such as the work saving, ease and hygiene can be important. Economic motives play a smaller role. Although decreases in family costs and labour can be expected, biogas does not directly increase the productivity, as would investments for irrigation or the purchase of a cow.

Africa:

The general impression is that in areas where biogas is relevant because of ecological danger of deforestation and the ensuing shortage of firewood the possibilities for biogas are limited. In other areas biogas has low priority because firewood is not (yet) limiting. There is a lack of integration between cattle raising and agriculture in large areas of Africa. This is due to ethical differences, but also to the climate, which in the wet tropics limits cattle raising by disease, and in the dry Sahel areas limits agriculture and necessitates migration for the cattle. While integration is increasing due to population and land pressure, and by the activities of development organizations (for example the introduction of ox traction) the above-mentioned factors influence the possibilities for biogas by:

1. There is no tradition of using manure, either for compost, as in China, or for fuel, as in India.
2. Collecting the manure presents greater problems with the present method of grazing than with more confined methods. This could mean that the time needed to collect manure would be equal or nearly so, to that needed to collect firewood.
3. The imputs for a biogas generater, especially in the ecologically endangered areas, can often be seasonal and scarce due to:
   - The previously mentioned problems of collecting. The cattle may only be seasonally present. There are also efforts being taken to decrease the number of cattle, especially nearby villages.
   - Irregular supply of plant wastes from fields (crop-related).
   - Limited seasonal availability of water.

It is clear that in both India and Africa a discrepancy exists between the governmental and individual motives. While ecological motives are also important for the target group, who will be the hardest hit by these, the question remains whether biogas can solve these ecological problems. Deforestation is due to the increasing pressure on land for agricultural purposes, to lumber company operations, and to the demand for firewood. While the relative importance of these vary from area to area, and a decreased demand for firewood can be important, the effect biogas can be expected to have is clearly limited. In addition, large-scale adoption of biogas cannot be expected as long as it is only relevant for a small group, rather than the whole of the wood burning population. Credit schemes to lower the costs of a biogas generater will not be expected to increase the relevance for the target group, since this is only partly dependent on financial aspects.

2. THE RELATION BETWEEN EXISTING SOCIAL STRUCTURES AND BIOGAS INTRODUCTION

The authors have some reservations about this section. We do not pretend to provide a complete analysis of the social structure in China, India, and Africa, but merely point out some factors which can affect the relationship between organization and technology, as previously described.

China:

In rural China economic inequality within a commune is limited, but wealth can vary greatly between communes. Differences between communes are based on the local agricultural conditions and on the personal capacities and motivation of the production team leaders, backed by the existing commune organization, delivery systems, etc. Should a leader decide to stimulate the construction of biogas digesters, he can depend on receiving technical assistance, materials, and credit via the commune. The present decline in the powers and influence of the commune can lead to greater inequality within a commune. The speed and the extent of this change, and the effect this will have on the existing social services can only be guessed at.

India:

The existing social relations are strongly polarized:

- Traditional relations and cooperation between groups, which previously offered a degree of security and support, are now under attack by the increasing capitalism. The Green Revolution has further commercialized these new, more impersonal, relationships.
- Landless, marginal and small farmers are not, or only loosely, organized (outside family relations).

As a result of this:

- Poverty is seen as an individual problem.
- All risks must be borne by the individual (or a family).

Via participative organization we can attempt to achieve:

- A team relationship and shared risks and problems. The importance of the promoter is comparable to that of the team leader in China. However, his work will be more difficult because:

- There are no existing organizations or delivery systems to depend on.
- The group is unprotected from power struggles and profiteers, both inside and outside of the organization.

Africa:

While great differences exist in such a large area, some general lines can be pointed out, and partly compared with India.

- Organization is traditional and strongly based on family and clan groups.
- While existing structures offer decreasing security to the individual, they can still hinder the development aid or governmental workers from introducing new types of organizations.
- Governmental policies are not directed at self-reliance of the villages.

3. PROGRAMS FOR BIOGAS INTRODUCTION

China:

Introduction started from the bottom upwards in some areas based on:

- Local motivation
- Experiences with composting
- Possibilities to experiment

The first initiative for a top-down approach was for:

- Community plants
- Externally developed models

Introduction of these was a complete failure.

The second initiative was for:

- Individual plants with communal assistance.
- Models tested under local conditions and built with local inputs and materials. Emphasis was on simple, understandable models, rather than on top-performance.

The top-down approach in new areas gave more problems than in areas where a bottom-up development has taken place.

There was a strong increase in the use of biogas after this second push; however, some poorer communes are still not able to incorporate it.

India:

Introduction was mainly via governmental organizations. This meant that:

- A standard model was offered without local adaptation or working experience; many problems resulted.
- The digester was not built from local material. This led to long delays in delivery and high costs.
- Supporting organizations and delivery systems were inadequate.

The government is not able to reach the poorest in the society (for whom biogas is also irrelevant) nor can it protect them against risks or competition, as the Chinese government has done. In addition use of imputs is made more complex by:

- An involved manure economy with private ownership of feed material.
- Taboos on the use of nightsoil.

Africa:

The introduction has mainly been through private organizations. Existing plants are most often owned by institutions (schools, hospitals) rather than by private persons. Feed materials are gathered by hired labour or bought, which adds to the cost of operating the plant.

4. CONSEQUENCES OF THE INTRODUCTION OF BIOGAS FOR THE TARGET GROUP

China:

The target group is here taken to be organized groups, and especially the poorer communes. The results for this group seem to be very positive because:

- Biogas is relevant and obtainable for a large percentage of the population.
- The decreased labour requirements and increased hygiene, as

compared to composting in the traditional way are valued.
- Negative effects such as excessive risk and increasing inequalities are guarded against.

The effects on the relationship between poorer communes without biogas and wealthier ones with biogas is not clear.

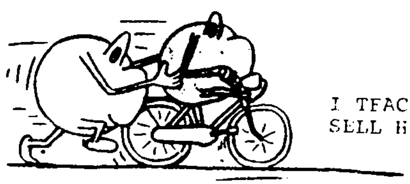
Dispite this the future development of the system is unclear. As already stated in chapter 3, biogas has proven especially time-saving for women, who now have begun new productive activities such as raising small animals, vegetables, etc. These activities are aimed at the private sector and have been stimulated by biogas, where the system permits.

India:

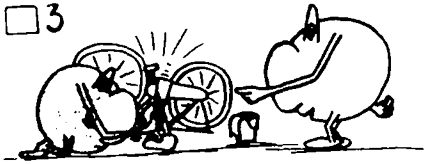
Positive effects for the target group are not expected. It seems that better ways to help the target group develop can be found by organizing them around a more relevant problem. Better ways to solve the fuel and ecological problems can also be found; lumber exploitation should be stopped. These two remarks are also relevant for the African situation.

Negative effects for the target group may occur, although it is very difficult for us to make realistic predictions concerning this. These effects will probably be related to the dung economy and/or the employment situation. See section 6.7.

□ 2



□ 3



continued

6.7 COMPARISONS BETWEEN BIOGAS TECHNOLOGY AND THE GREEN REVOLUTION

In this section we draw a parallel between the introduction and consequences of biogas and the Green Revolution. If we look upon the introduction of biogas digesters and High Yielding Varieties (GR) as it took place in most developing countries with the exception of the People's Republic of China, we can find some similarities. Both were introduced from the top-down and were completely strange for those who had to work with them at the local level. Large institutional systems were set up to disseminate the techniques. These systems delivered the necessary knowledge and inputs, cement and steel in the case of biogas (see chapter 4) as well as pesticides and fertilizer in the case of the HYV's. Both technologies required access to the necessary inputs, which were often limited, especially for the poor.

In China the GR was introduced from the bottom-up. Local varieties were locally improved but using modern techniques. The same can be seen in the case of biogas digestion, where the Chinese tradition of composting has developed into a technology for biogas digestion, for fertilizer and fuel production. HYV's as well as biogas digesters are within the reach of a greater part of the Chinese population.

Before introduction in most countries there was little identification of the needs of the poor for HYV's and for biogas. National objectives are the most prevailing reasons for dissemination. Possible negative consequences for the poor were overlooked. But as far as the consequences are concerned we are aware that this parallel only partly holds. The introduction of the HYV's led to a strong dependence on factors lying outside the new technique itself. With this we mean the dependence on the market for complementary inputs (chemical fertilizer, pesticides and irrigation water) and the dependence on the output market for the selling of the crop. Both the output and input market are difficult to control. The small and the marginal farmers are at the mercy of the marketing forces and this has driven them into the hands of those who are in power, that is landlords and middlemen. This also applies for the landless labourers. Their labour became a commodity, like capital, because of the growing commercialization. In general one can state that the Green Revolution has brought about a change in the production relations resulting in a widening gap between the poor (powerless) and the rich (powerful). On the other hand one has to admit that the Green Revolution has contributed greatly to the increase of the food production. Also biogas has the potential to increase the energy production considerably, but we have to be prepared for the negative consequences it might have for those who cannot afford a biogas plant, generally the poor.

The nature of the biogas technique is such that it is not as strongly connected with the market as in the case of the HYV's. Nevertheless, some effects similar to those we noticed in the Green Revolution might show up. As already stated in chapter 4, the commercialization of firewood and dung cakes may arise. Although the implications of the introduction of biogas might not be as far reaching and as structural as those in the Green Revolution, a note of caution for governmental and non-governmental institutions (including western AT-organizations) who are considering introducing the "Brown Revolution" is advised. Introduction of biogas can have negative consequences for the poor, certainly in the case where biogas plants are becoming common practice.

6.8 LESSONS TO BE LEARNED FOR PRIVATE DEVELOPMENT AID ORGANIZATIONS

Is biogas technology a solution for the problems of the target group, and is its introduction an 'appropriate' strategy for our development objective?

- Biogas has a low priority for the target group (the importance of the proper identification of needs is stressed again at this point).
- Biogas places great demands on the organization of the users and on the delivery system. Can a private organization protect the target group from the additional risks and from profiteers? Can the national government guarantee a useful delivery system?
- What can be learned from the comparison India-China?
  1) The importance of a grass-roots organization and the role of the leader/change agent
  2) A clear method of participative development through the in-

troduction of biogas cannot be pointed out looking at the Chinese experience. Identification and participation are not obvious. Especially during the more recent top-down introduction, the production team leader carried the initiatives and responsibilities. Besides, homogeneous groups with reasonably uniform interests (with the possible exception of women) already exist through the Chinese social system. The lack of participation is thus partly replaced by the system itself. Note, however, the failure of community digesters versus the success of family digesters. Concerning the technique itself, room should be given for experimentation by starting with simple models which just work, only in a later stage emphasis should be put on performance. For realization of the latter, the target group should get possibilities (in an economic and/or technical sense).

It seems that local private organizations in a country itself will be the ones that are most able to help the target group develop (identification!). They alone have the possibility to organize their fellow citizens to determine their own future. Large effects should not be expected; a large-scale approach to emancipating the socially/economically weakest is impossible. Participation strategies demand much time, and governments and foreign organizations often get impatient for results. Large-scale support of many small, simultaneous participation projects is however possible.

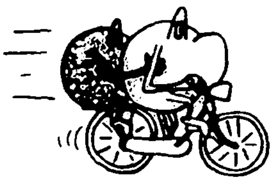
While this method cannot offer dramatic results, it is the only way that real positive effects on the development of the target group can be achieved. A consequence for foreign Appropriate Technology Organisations is that they should concentrate less on the development of techniques but more on:

- Establishing contacts with local organizations which are actively organizing and supporting the target group
- Adapting their research to the pinpointed problems and needs
- Collecting information and data on techniques and experiences relevant for the target group, as support for the local (and therefore isolated) organizations.

REFERENCES

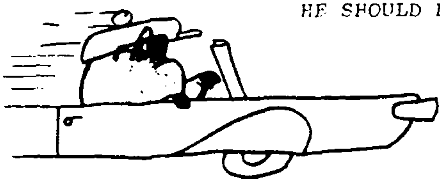
Appropriate Technology, a Studium Generale Course, Technical University, Eindhoven, the Netherlands, 1977.
Baark, E. and J. Sigurdson (Eds) (1981): India-China Comparative Research, Technology and Science for Development. Curzon Press.
Darrow, K. and R. Pam (1977): Appropriate Technology Sourcebook, Volume One. Volunteers in Asia.
Derde Wereld en Wetenschap (Third World and Science, in Dutch), Studium Generale, Utrecht University, the Netherlands, 1981.
Galjart, B. e.a. (1982): Participation of the Poor in Development. Contributions to a seminar, Leiden University, the Netherlands.
Hommes, E.W. (1982): Appropriate Technology and Development Strategies. In: Appropriate Technology for Developing Countries. W. Riedijk (Ed), Delft University Press, the Netherlands.
Pearse, A.: Seeds of Plenty, Seeds of Want.
Young India Project (1981): Participation in Education and Organization of the Working Classes, Penukonda, Andra Pradesh.

☐ 4



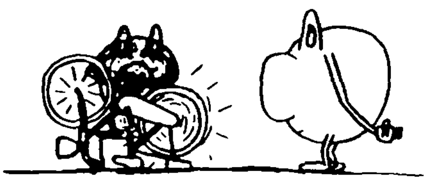
I WILL RIDE AND HE CAN SIT ON THE BACK. HE'LL NEVER RIDE AS GOOD AS I DO.

☐ 5



WHY A BICYCLE? THAT'S OUT OF FASHION. HE SHOULD DRIVE A CAR.

☐ 6



I GIVE THE BICYCLE TO THE COUNTERPART AND LET HIM DO WHATEVER HE WANTS WITH IT.

THE SOLUTION TO THE QUIZZ WILL BECOME CLEAR AFTER THE NEXT DEVELOPMENT DECADE.

COLOFON

This book took shape as a result of the very personal points of view and the often intensive discussions of a small group of members of the Agromisa Foundation (SA) and the Holland-China Friendship Association (VNC) who organized the study day with the same title. It should be noted that the point of view in this book is not necessarily the same as that of the speakers invited to contribute on the study day. Those responsible for the contents of this book are listed in decreasing order of importance:

- chapter 1: Introduction: Jos Hendrik , Huub Nilwik (both SA)
- chapter 2: Biogas technique and its potential applications: Wim Bloemen (student Technical University Twente)
- chapter 3: Biogas technology in the Chinese People's Republic: Peter Evers, Han The (both VNC)
- chapter 4: Biogas technology in India: Joost Roks (SA)
- chapter 5: Biogas technology in some other countries: Wim Platteeuw (SA)
- chapter 6: Synthesis, Conclusions and recommendations: Jos Hendrik , Huub Nilwik, Joost Roks (all SA)

Special thanks to Margery Koch for correcting and translating the text as well as typing and lay-out.

Acknowledgements to:

The Directorate General of the Ministery of Public Health and Environmental Protection for their substantial financial support.

The Commission Subsidy Activities of the Agricultural University for their financial support.

Joost Meulenbroek and Karel Chambaille of the Studium Generale of the Agricultural University for their organizational support.

THE AGROMISA FOUNDATION

The Agromisa Foundation attempts to provide useful agricultural information to the socially and economically marginal people in the Third World. This is mainly done by providing answers to questions received from local organizations, development aid workers and missionaries working directly with our target group. The publication and sale of low cost books and training via a study week for field workers are other activities which are meant to help provide the knowledge necessary for development at grass-roots level. Agromisa also attempts to encourage awareness of development problems among the Dutch people by discussion courses and study days. Agromisa is a non-profit organisation, composed mainly of students and graduates of the Agricultural University of the Netherlands. For more information: Agromisa Foundation, Postbus 41, 6700 AK Wageningen, the Netherlands.

HOLLAND-CHINA FRIENDSHIP ASSOCIATION

The Holland-China Friendship Association considers itself to be a link between the Dutch and Chinese people. The VNC wants to contribute to the mutual understanding between the two peoples. To realize these goals the VNC is active in many areas: science, culture, travel, trade etc. A film festival with Chinese feature films, an exhibition of paintings in traditional style, a tour of the Beijing opera or a group of acrobats as well as organizing various language courses are a few of our activities. In Holland members of the VNC receive the quarterly magazine China Now (in Dutch). The VNC has many official and unofficial contacts with China; every two years a delegation visits China to make arrangements for new activities and to strengthen the cooperation with the Chinese Association for Friendship with foreign countries (Youxie). Associated with the VNC is a travel foundation organizing tourist as well as scientific tours to China. For all further information: VNC, POB 79, 3500 AP Utrecht, the Netherlands, tel: 030/510974.