Mobilization of renewable energy sources in developing countries

The Biogas Programme of the Federal Government

by Uwe Lorenzen.

Few events in the last 30 years have resulted in such far-reaching economic upheavals as the end of mineral oil as a dependable and safe source of energy. The price explosion on the oil markets hit the developing countries, with their lack of foreign currency, especially hard, and plunged many nations into financial and economic hardship. An added factor is that wood is the primary source of energy for most developing countries and the increasing rape of the forests has led to a fuelwood crisis of immeasurable proportions. The search for solutions has resulted in cooperation with the developing countries in the field of energy becoming the lynchpin of German development aid policy.

Conservation of energy, and the exploitation of renewable energy sources, has become the focal point, to which very great importance is attached.

In addition to the development pilot projects undertaken since 1975 the Federal Government, after the World Economic Summits in Bonn and Tokyo in 1978 and 1979 and following the recommendations of the conference on renewable energy in Nairobi in 1981, has introduced projects worldwide in the form of an integrated and coordinated programme set-up. These are known as the Special Energy Programme (SEP).

No separate budgetary item was created for the Special Energy Programme; i.e., this is not a financing programme. Rather, the nature of the programme is a conceptual one - the Special Energy Programme is financed from a variety of sources.

Test of the Special Energy Programme

The Biogas Programme is a separate, technology-oriented sub-programme of the Special Energy Programme. Like the Special Energy Programme, it is a concept-oriented programme and should not be degraded to a financing programme.

Satisfying energy requirements from renewable energy sources, above all by exploiting biomass, is
major importance for all developing countries. Commercial energy sources account for only 25 per cent of total energy consumption in these countries; 75 per cent of the energy used is produced from non-commercial energy sources such as firewood, charcoal, animal and vegetable waste produces, wind and water power, and animal and human muscle power. Two thousand million people continue to rely almost entirely on wood and other traditional fuels. In many developing countries industry satisfies a high proportion of its energy requirements from firewood. In some countries, such as Mali, Burkina Faso, Tanzania, Nepal, Ethiopia, and Haiti, over 90 per cent of all energy needs are satisfied with traditional fuels. In rural regions up to 95 per cent of the energy consumed is provided by these kinds of fuel.

In many developing countries the use of biogas is still little known, despite the fact that conditions are more favourable than in the industrialized nations, because the gas is created by bacteria which are sufficiently active at temperatures of over 20°C; and because most of the developing countries are in tropical and subtropical zones they fulfil the necessary climatic requirements for biogas technology with unheated plants.

The Special Energy Programme has the following aims: energy conservation and the development and use of renewable energy sources, especially to supply the rural population living outside the urban centres. These aims are also the aims of the Biogas Programme.

With a comprehensive coordinated approach the following measures are to be taken in the Special Energy Programme: rational use of energy; identification and localization of renewable energy sources; development, adaptation, and dissemination of systems for economic use of renewable energy sources such as small-scale water power, wind energy, biomass, solar energy, and human and muscle power. Over and above this, the setting up or reinforcement of local counterparts for utilization, production, distribution, and maintenance of the systems; scientific, technical, and administrative training, and the development of regional supply concepts.

Measures to be taken in the Biogas Programme:

1. Identification of locations where it is possible to use biogas;

2. development, adaptation, and dissemination of biogas technology with the aim of economic utilization;

3. setting up or support of local counterparts that can carry out the production, dissemination, and maintenance of the technology and supervise utilization;

4. mobilization of scientific, technical, and organizational knowledge about the use of biogas;

5. development of concepts and strategies for decentral supply of biogas to the population at suitable locations.

The Biogas Programme is intended to make a practicable contribution to the development policy objectives laid down by the Federal Government, i.e.:

• assuring an appropriate and lasting development;

• strengthening the technological capabilities of the developing countries in the energy sector;

• reducing the dependence of the developing countries on imported sources of energy;

• improving the employment situation;
Mobilization of local resources

Since the 1970s the energy situation in the developing countries has deteriorated further. Oil prices have temporarily dropped, but the environmental damage caused by consumption of fuelwood has increased dramatically. The development of local energy-producing potential continues to be an urgent task for most developing countries. For a number of them renewable forms of energy, and above all biomass, represent the only energy sources locally available. But it is precisely here that there is a great potential for supplying rural regions. A programme for exploiting renewable energy sources, including the Biogas Programme, is in line with national and international discussion on development policy. It helps to reduce the economic and political dependence of the developing countries and to mobilize their own resources. The Biogas Programme can make a major contribution towards improving the energy situation in rural areas, conserving natural resources, and meeting basic needs.

Even if, quantitatively speaking, the Biogas Programme is only small, and its contribution to resolving the problems of energy supply, balance of payments, environmental damage, and unemployment is correspondingly small, the exploitation of local potential and mobilization of local resources is of such fundamental economic and political importance for the developing countries that the Biogas Programme is highly appreciated both nationally and internationally. The Biogas Programme is one of the projects in which local potential can be exploited and local resources mobilized successfully in the developing countries, by sector-specific measures and with relatively modest means.

Permanent adaptation and continuing development are required for the Biogas Programme concept, i.e., with regard to the technology of the plants, the management-related and overall economic assessment and evaluation of the socioeconomic effectiveness of the biogas systems, as well as the work of organizations, institutions, and target groups. The organization and efficiency of the Biogas Programme is exemplary as a typical sector programme of German development aid.

Abstract

The Biogas Programme is part of the Federal Government's Special Energy Program. The objective of this program is to identify and localize places where the exploitation of biogas is feasible, and to develop, adapt and promote this technology. A further objective is to establish and support local counterparts, and to develop concepts and strategies for decentralized supply of biogas to the population at appropriate points.

Résumé

Le programme relatif à l'utilisation du biogaz fait partie du programme spécial pour l'utilisation de sources d'énergies renouvelables du gouvernement de la République fédérale d'Allemagne. Le but de ce programme réside dans l'identification et la localisation des lieux d'implantation sur lesquels l'utilisation du biogaz est possible, ainsi que le développement, l'adaptation et l'extension de cette technologie. Un autre but de ce programme est de constituer des organismes locaux et de leur apporter le soutien correspondant, de mettre au point des concepts et des stratégies permettant un approvisionnement décentralisé de la population en biogaz sur des sites appropriés.

Extracto

El proyecto de biogas forma parte de/ programa especial para el aprovechamiento de fuentes de energía renovables del Gobierno Federal. Los fines de este proyecto consisten en la identificación localización delugares, enlos que sea posible el aprovechamiento del biogas, así como el desarrollo,
adaptación y popularización de esta tecnología. A estos fines, hay que anadir la creación y ayuda a entidades y organizaciones locales y el desarrollo de proyectos y estrategias para una descentralización del abastecimiento de la prosalción con biogas en emplazamientos apropiados.
The second GATE Biogas Seminar was held in Oberreifenberg from 26 to 30 August 1985. It was attended by almost all of the GTZ biogas experts from Third-World countries, members of the staff at GTZ headquarters, representatives from the BMZ (Federal Ministry for Economic Cooperation), and outside specialists from other institutions and consulting organizations.

The purpose of the seminar was to work out furtherreaching conceptual principles for the introduction and dissemination of biogas technology.

The emphasis was on interchange of information and experience, in particular in the following areas:

- refinement of the design of biogas plants;
- assessment of operating and overall economics;
- socioeconomic effects and acceptance by target groups;
- analysis and promotion of counterpart institutions.

In addition to "talking shop", the teams of the GATE Biogas Extension Service (projects in Burundi, Nicaragua, Tanzania, and the Caribbean), the workers on other GTZ biogas projects (Burkina Faso, Ivory Coast, Kenya, Columbia and Thailand), and the external participants took advantage of the opportunity to work out proposals for new concepts and strategies.

A detailed presentation of the projects currently in progress revealed the following picture: so far over 100 biogas plants have been built and countless others have been repaired. Additionally, gas-burning appliances adapted to local conditions have been developed and modified. A large number of specialists (decision-makers, disseminators and artisans) have been trained and qualified. Last but not least, in some projects a start has been made on building up appropriate organization and counterpart structures.
In the total of 14 working groups, a very great deal of work was done; among other things, questions of plant and appliance technology, use of sludge, promotion of local skills, information and training, advisory work and acceptance were covered - and there was some lively debate.

The principal results of the work of the working groups are presented in brief in the following:

- Biogas technology has to be regarded as a complete system. As such, it includes target group-oriented identification of the location, the method of production of the substrate, especially in animal husbandry, the technology of the plant itself, the use of the gas, repair and advisory services, and financing procedures.

- The technology of family or respectively small-scale biogas plants has been developed into a system capable of being disseminated.

- The plants are economically viable if they can provide the user with a substitute for commercial sources of energy and commercial fertilizers, and if additional energy can be produced with them.

- The provision of light has advantages that cannot always be assessed in terms of money; effects which incidentally were judged to be very important were the improvement in hygiene, the reliability of the energy supply, and the saving in labour.

- The energy produced is mainly used for cooking and lighting; many of the appliances developed have proved their suitability in practice. The gas produced in large biogas plants is distributed profitably.

Although the individual stages of development in the various projects differ widely, because local and infrastructural conditions are often completely different, it was possible to decide on the principal targets of future work:

- Further development or respectively consolidation of self-supporting national and regional dissemination structures, involving local manufacturing, distribution, and maintenance facilities, in particular those of the craft trades;

- Greater involvement of women in the biogas programmes (both local and foreign workers), since women represent a special target group in development aid policy, and the running of the plants and utilization of the gas are tasks which very often fall to them;

- The training of local specialists in the areas of planning, construction, and service, to assure continuation of the project in the long term, and thus to encourage independent identification of locations, development, and use of their own sources of biogas;

- Intensification of the evaluation of sludge analyses both in the project and accompanying it, since the use of sludge as a fertilizer is of major importance for an economic appraisal of biogas plants, and not enough attention has so far been paid to this question in practical project work.

All of the participants agreed that the socioeconomic environment is every bit as important as the technical refinement and adaptation of biogas plants.

In Oberreifenberg it was also apparent that an intensification of information interchange in the context of a further training seminar of this kind can be of very considerable importance for the planning and conception of promising sector programmes in Technical Cooperation.
Abstract

Biogas technology must be considered as a complete system. This applies especially to identification of suitable locations, animal husbandry, installation technology, exploitation of the gas, and advisory and financial arrangements. In future, attention must be paid above all to the further development of self-sufficient national and regional bodies and to the training of local experts in the fields of planning, building and the provision of services.

Résumé

La technologie du biogaz doit être considérée en tant que système général. En particulier en ce qui concerne l'identification des sites, l'élevage d'animaux, la technologie de l'installation, l'utilisation du gaz ainsi que les modalités d'information et de financement. A l'avenir, une attention particulière devra être accordée à l'évolution des structures d'extension nationales et régionales ainsi qu'à la formation sur place d'un personnel qualifié dans le domaine de la planification, de la construction et de la maintenance.

Extracto

La tecnologia del biogas debe contemplarse como un sistema global, sobre todo en lo que respecta a la identificación del lugar de ubicación, explotación de ganado, tecnología de las instalaciones, uso y aprovechamiento del gas, así como formas de asesoramiento y financiación. En el futuro deberá dedicarse especial atención al perfeccionamiento de estructuras de difusión autónomas nacionales y regionales, así como a la formación y capacitación de expertos locales en los sectores de planificación, construcción y mantenimiento.
Standardization of biogas units

by Alexander Schlusser

About a year ago we began a systematic study of the Arumeru District, which covers 3,000 sq.km. In the Arusha Region, where we work. This district itself can be subdivided into five small zones. One of them, known as the Coffee Banana Belt, covers 200 sq.km. and has a population density of 192 inhabitants per sq.km., which is very high. There is sufficient water all year round and agriculture is correspondingly intensive (mainly coffee and bananas); livestock is usually kept inside. The majority of the 7,000 small-farming households have between two and six cows, and often a few pigs, goats, or sheep as well.

The average-sized family here has five to seven members, so that all in all one can speak of ideal conditions as far as biogas technology is concerned. As a realistic estimate of the potential, we believe that 700 plants have to be built without any financial assistance. Faced with such a large number we soon realized that we would first need an appropriate marketing strategy if we wanted even to begin to satisfy the demand for this potential market. So we would need many trained artisans familiar enough with construction methods to build a biogas unit with just a small subsidy. To negotiate with the customers and advise them we would also need technicians who knew everything about biogas technology, and who would assure the required construction quality. Last but not least we would need private contractors who would come in on this technology in order to earn money with it.

The second important point is that standardized units should be used rather than the custom-built models, which are admittedly optimized, but expensive and time-consuming.

However, before we could decide on standard sizes it was necessary to calculate mean values from the economic, ecological, logistical, agronomic, and sociocultural determining parameters. We finally opted for the low-priced dome-type unit in standard sizes of 8 m³, 12 m³, and 16 m³.

What does the term "standardization" cover?

In Tanzania, transport and the procurement of materials are particularly expensive and time-consuming. To obtain a \( \frac{1}{2} \)" elbow you may spend a whole day chasing around town and then
pay about 20 DM. Cement is only available sporadically. So by the time we had built a few units it was clear to us that not only the size of the unit would have to be standardized.

We needed a strategy to get away from every kind of individual consideration, individual supply, and individual building - from the sale of a unit to the connection of the appliances.

On the technical side, this means that today, we only make the pipe system from ¾” pipes and accessories, and according to a precisely defined plan. Piping with the same bore is used for burners and lamps. All stopcocks for burners, lamps, and the unit are identical. In future the burners and lamps are to be made of materials that are readily available locally, e. g., for a lamp: a plate, a pot, a gas supply line of ¾” pipe, som wire, and the glass from a Petromax lamp, which is also available in Tanzania.

An example of standardization on the administrative side: we have worked out a graph from which the technician can read off the appropriate standard size immediately when the relationship of livestock owned to the size of the family and the way the gas is used is known. The materials required can then be calculated immediately from a table. In this way all the building materials can be provided before building work is started.

Finally there is a special form the enables a quite accurate quotation to be prepared for the customer, taking into account any work he may do himself.

How it works in practice

1st step:

Either Chris, or I myself, or a counterpart go to a customer. There are already waiting lists; the basic details (size of the family, number of animals owned) are known. Agreement is reached with the customer on the location of the unit. In the folder we take with us we have the papers mentioned above, from which we can determine the standard size, materials required and the total cost of the unit.

Before building is started the customer makes a down-payment of 40% and before the unit is put into use a further 50%. The remaining 10% is paid when it has been established that the unit works properly.

2nd step:

The technician then tells the artisan which location has been chosen and where everything is. For his part, the artisan has a folder containing the standard drawings and when all the building materials have been delivered he carries out all the work himself, from tying the plumpline to connecting the lamp and burner.

Ideally, the technician's only job is acceptance testing, i. e., checking the gas-tightness of the pipe system and the unit itself.

Advantages and prospects for the future with standardization

One only becomes aware of the huge advantages of standardization when one plans the practical work in complete conformity with it.

This can be shown by another example. Two of our units cracked immediately after being filled. But since all the units are similar thanks to standardization, the fault parameters can be analyzed relatively easily using a special matrix. If different degrees of importance are assigned to the
individual parameters it is relatively easy to identify the possible causes. This is illustrated in much simplified terms in the following:

We built units of the various standard sizes in both the dry and the rainy season, and filled them immediately after completion. However, only units built in the rainy season cracked. We discovered that the two parameters 'rain' and 'initial filling' play an important role. After a thorough analysis of the cracks we came to the following conclusions: firstly, the initial filling technique would have to be changed, and secondly the design of the units was modified to prevent cracks from extending into the gaslight part.

This is just one example among many. What I want to point out with it is this: if you have standardized units you can develop technically perfected models, that is, you can

• adapt the unit exactly to requirements, from the stable to the gas consumers;
• specify tolerances to the artisan, because you know the units down to the last detail;
• develop standardized test methods and incorporate corresponding test points in the system;
• make fault-finding checklists (like the ones used for checking cars).

It is only by virtue of standardization that our dissemination strategy- via village artisans and private contractors - can become effective at all. Because the artisans do not have to be so highly qualified and can therefore be trained in a relatively short time. They can act as teachers in training programmes and teach the building method to other artisans. They can carry out servicing and repair work alone and, thanks to standardization, manage with a minimum of spare parts and tools.

And with perfected standards the technology also becomes profitable for private contractors, because calculations and design work are eliminated, supervision and administration are minimized, the transport costs - in fact all costs - can be calculated, and when serving several customers in one region they can be considerably reduced.

Our next article, which deals exclusively with the diffusion of family-sized biogas units, describes possible methods of selling standardized units of this kind.
Abstract

The basic aim of standardizing biogas units, which is now normal practice in Tanzania, is to save time and money. However, it also involves the training of suitable artisans, the setting-up of a service system, minimization of administrative procedures, and an attempt to interest contractors in building biogas units. To this extent, standardization means more than simply providing units of a certain size. And only with standardization is marketing possible on a large scale.

Résumé

Le but de la standardisation des installations au biogaz, telles qu’elles le vent entretemps couramment en Tanzanie, est une économie de temps et d’argent. Ceci dépendant évidemment aussi de la formation d’ouvriers qualifiés; de la mise en place d’un service d’entretien, de la minimisation des démarches administratives ainsi que de la tentative d’intéresser les entreprises pour la construction d’installations au biogaz.

Dans cette mesure, la standardisation est plus que la simple mise à disposition d’installations de taille donnée. Par ailleurs, seule la standardisation permet un marketing à grande échelle.
El objetivo perseguido con la standarización de las plantas de biogas, como las instaladas entretanto en gran número en Tanzania, es, por una parte, el ahorro de tiempo y costes. Pero también esta relacionada con la formación y capacitación de personal adecuado, la organización de una red de servicios, la reducción a un mínimo imprescindible de los procesos y medidas administrativas, así como despertar el interés de los empresarios en la construcción de estas plantas de biogas. En este sentido la standarización es algo más que la puesta a disposición de plantas de un determinado tamaño. Y edemas, la standarización es lo que permite un marketing a gran escala.
The diffusion of family-size unit biogas plants

by Christopher Kellner

In 1974, a first attempt was made in Tanzania to make biogas plants attractive to farmers. This first attempt failed because local conditions were not taken into account, because the plants were faulty in operation and because, last but not least, the technical knowledge required to operate such plants did not exist. Then last year CAMARTEC (Centre for Agricultural Mechanization and Rural Technology) took up the matter once more and is now trying to learn from the mistakes of the past.

For, to aid the breakthrough of biogas technology on a wide front, the corresponding basic prerequisites have first to be fulfilled. High density of population, the possibility of indoor stock-keeping all year round (zero-grazing is the key word here), intensive arable farming resulting in the need for manure containing nitrogen and, last but not least, the ability to handle the building materials concrete and brick.

The Tanzanian solution

But to be really successful meant more than just copying what had succeeded in other countries. What was required was a Tanzanian biogas plant that would satisfy the requirements of its future users. And this individual Tanzanian solution is the standardized biogas plant.

CAMARTEC developed three standardized fixed dome biogas plants dimensioned for 8, 12 and 16 cubic metres. The following table shows the material required and the costs involved. Costs which are bound to vary from farmer to farmer are the building costs for the necessary stable as, to keep work to a minimum, the biogas plant and the stable are directly linked to one another. It should also be said that the stable must have a concrete floor, for only this will guarantee that the entire faeces-urine mixture will reach the biogas plant unadulterated by foreign bodies.

Method of diffusion

In order to interest as many farmers as possible in the construction of a biogas plant, and in order to simultaneously train local artisans in the construction of such plants, a course of action that may, at first sight, seem somewhat complicated was chosen. So let me begin by describing it. First of all a
survey is conducted to estimate the potential of farms suited to operate a BGP. With the help of a questionnaire the energy situation, the farming system, the availability of digestable material, the availability of water and the financial situation need to be established.

Then, if the results of the investigation show that a demand for BGPs can be expected, the technology will be introduced to the village administration and interested farmers. This will be done either by setting up a small transportable unit which supplies a small amount of gas or by a site visit to an operating BGP.

The third step is then the selection of a suitable site where the first unit of the particular village is installed. The construction is done by two artisans from the village and supervised by CAMARTEC Biogas Extension Service who will be conducting job training. Experience has shown that demand follows initial construction.

The farmer who has the required building material already at the premises will get the next plant built by the same artisans. The supervision input can be reduced after each plant. The village artisans are the main suppliers to satisfy the demand. To ease and accelerate for the individual farmer the process of purchasing the requested building material, CAMARTEC is establishing a material supply store.

It also supplies lamps and burners. A step in the future will be also to produce these in the country. The other task of CAMARTEC, within this strategy, is to advise on individual biogas problems e.g. planning, construction, feeding, gas production, gas consumption, use of sludge, and maintenance.

The region of Tanzania in which we gathered our experience has already been described by my colleague Mr. Schlusser in his contribution, and our first findings show that ten percent of the farmers in the Coffee-Banana Belt are seriously interested in a biogas plant as well as having the necessary finance at their disposal.

Table: List of Requirements for the Three CAMARTEC Fixed Dome Standard Biogas Plants (BGP).
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit small family BGP</th>
<th>Standard Digesters medium family BGP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>big family BGP</td>
<td>big family BGP</td>
</tr>
<tr>
<td>8 m³</td>
<td>12 m³</td>
<td>16 m³</td>
</tr>
<tr>
<td>amount</td>
<td>costs</td>
<td>amount costs</td>
</tr>
<tr>
<td>required</td>
<td>required</td>
<td>required</td>
</tr>
<tr>
<td>Bricks 8×11×22</td>
<td>pieces</td>
<td>750</td>
</tr>
<tr>
<td>Cement</td>
<td>50 kg bags</td>
<td>2000</td>
</tr>
<tr>
<td>Lime</td>
<td>25 kg bags</td>
<td>600</td>
</tr>
<tr>
<td>Sandstones</td>
<td>kg</td>
<td>2500</td>
</tr>
<tr>
<td>Plastic pipe &gt;4&quot;</td>
<td>6 m</td>
<td>500</td>
</tr>
<tr>
<td>Hole to be dug</td>
<td>cbm</td>
<td>20</td>
</tr>
<tr>
<td>Mason</td>
<td>Lump sum</td>
<td>1800</td>
</tr>
<tr>
<td>Helper</td>
<td>Lump sum</td>
<td>1400</td>
</tr>
<tr>
<td>Other material</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>Total</td>
<td>10550 TSH</td>
<td>14370 TSH</td>
</tr>
</tbody>
</table>

1 All prices relate to 2/85

2 The price for sand can differ extremely

3 Other material e.g. kerosene and wax for gaslight sealing, clay for lid sealing, reinforced gas-outlet pipe, handles for lid.

Costs and benefits

Before I describe why farmers request BGP, I will compare the costs with the benefits. There are many ways to calculate this. The crucial points arise when the benefits are mainly an increase in the quality of life. The traditional cooking fuel (wood) is unlikely to be commercialized yet and the supply of kerosene for lighting is very unreliable to obtain. But calculating the money saved on energy, the investment costs are comparatively high.
However, converting the produced and used amount of gas into commercial energies which finally represent the families' newly achieved standard of living, we come to a break-evenpoint of 3-4 years, including running costs and common interest.

However, the usual customer does not calculate this in advance. I did the same when I decided to buy a refrigerator - I did not consider whether it would save me money; I knew it would cost me money to run - but nevertheless I bought one. It has made my life easier and that makes it important enough to have it. The farmers and especially the farmers' wives who are demanding BGPs, react in a similar way, and arguments that were used for the decision were many.

- The increasing difficulty of getting firewood and kerosene,
- Quick and reliable preparation of small things like tea etc.
- Light in the evening.

We found that the farmers who are interested in obtaining BGPs are innovative and business oriented. This was our experience with the first four farmers who started to convert surplus energy in marketable food products e. g. they brewed local beer, baked bread or pancakes or roasted their own coffee in order to sell it. It is apparent that the most feasible target group for BGPs are farmers who have more gas than they require, so that the surplus energy can be used for some business activity. The graph on this page shows what preconditions must exist to expect an excessive supply of gas with the various types of standardized plants CAMARTEC recommends.

The fertilizer

The overflowing sludge from the BGP is a very good fertilizer. It is not mentioned among the benefits of the biogas technology as it is a problematical material and its advantages are hardly utilized. These advantages can be described as follows.

- In no other stable system but zero-grazing on concrete floors are all the nutrients delivered by the animals collected.
- The overflowing sludge from the digester contains the same amount of nitrogen as the original manure, whereas the common way of storing manure before it is applied to the fields causes big losses of nitrogen.
- Digested manure can be applied to growing plants without any danger of chemical damage. The fertilizer is easily assimilated.
- The fertilizer does not smell and does not attract flies at all.

Nevertheless only the minority of BGP owners utilize this fertilizer in such a way that the advantages are brought to bear. It seems that the disadvantages are major:

- The liquid form of the material makes transportation on wheelbarrows or in buckets difficult.
- The material runs downhill and easily pollutes surface water.
- The fertilizer has its best effects if it is applied to the plant roots, under wet and cloudy conditions, in the stage of intensive plant growth. These preconditions occure on the farm only occasionally, while sludge is produced continuously.

A biogas extension programme has to incorporate the discovery of recommendations for practicable
fertilizer application methods.

Steps in the future

A biogas extension programme which aims in spreading the technology requires a long term strategy. CAMARTEC has started in the Arumeru District and will extend its development activities to other suitable areas. For a success of the programme, the following aspects need further stress. Involvement of private entrepreneurs in plant and accessories construction. Surveys to estimate the potential number of farms suitable for biogas plant operation.

• Development of teaching aids for the further training of artisans and technicians.

• Regular training of artisans and technicians.

• Establishment of a maintenance team.

• Expert advice on all fields involved in the technology with the help of appropriate booklets and well equipped advisers.

• Continuous reassessment and improvement of standardized plants.

• Development of prefabricated building materials.

• Development of methods and instruments for the appropriate use of fertilizer.

Abstract

In the Arumeru District in Tanzania the procedure used for dissemination of biogas units is that requirements are first determined with a questionnaire. At the same time potential users are familiarized with the technology. They are not left to their own devices when it comes to building the units, either: they are advised by the CAMARTEC biogas specialists. Local artisans are also trained in the building of biogas units. All these things, plus the use of standardized units, are intended to help make the success of the programme. The use of digested sludge as a fertilizer is one thing that has not yet been satisfactorily dealt with in all cases. In future, efforts should be concentrated on the advisory side and on developing accessories.

Résumé

Dans le district tanzanien d'Arumeru, on procède à l'extension des installations au biogaz en établissant tout d'abord les besoins grâce a un questionnaire et en familiarisant simultanément les gens avec cette technologie. De même, ils ne vent pas livres a eux-memes lors de la construction, mais conseillés par les experts de CAMARTEC. Des ouvriers vent également formes sur place pour la construction d'installations au biogaz. Tous ces éléments doivent, outre l'utilisation d'installations standardisées, permettre d'aboutir a un succès du programme. L'utilisation du limon organique en tant qu'engrais n'a pas encore été résolue de façon satisfaisante dans tous les cas. A l'avenir, il faudra prêter une attention particulière a l'apports de conseils et a la mise au point d'accessoires.

Extracto

En el Distrito de Arumeru, en Tanzania, antes de instalar una planta de biogas se analizan primero las necesidades locales de una planta de estas características con ayuda de un cuestionario de preguntas, y al mismo tiempo se procure familiarizar a los futuros usuarios con esta tecnología. Luego, en la fase de construcción, tampoco se les deja solos, sino que se les asesora a través de los expertos de CAMARTEC. Asimismo los artesanos y pequenos industriales locales son instruidos en el manejo y
construcción de las plantas de biogas. Todas estas medidas, junto con la standarización de las instalaciones, contribuirán al éxito del proyecto.

Todavía no se ha resuelto satisfactoriamente el empleo del cieno de pudrición como fertilizante. En el futuro deberá prestarse especial atención al asesoramiento y la creación de accesorios.

Means for first estimate to attach the appropriate standard unit to the given preconditions. All figures are related to the described unit and the cooking habits of the people in Arumeru District of Tanzania.

View this page in text format
Biogas technology and site-oriented agriculture

by Ulrich Hoesle

The aims of site-oriented agriculture under "low external output" conditions are to achieve high and sustained productivity while at the same time conserving or restoring balanced ecosystems, with active participation of the target groups.

From the many different measures that can be taken in the sphere of production technique, the following examples may be mentioned, directly or indirectly related to biogas technology: erosion prevention and watershed management; linking of animal husbandry and arable farming; compost and mulching; biological nitrogen fixation (cultivation of leguminous plants); and the use of locally available means of production.

The focal point of interest is the process within the target groups, which must develop from an improvement in decision-making to a sustained improvement of the group's social and economic status when an innovation (such as biogas technology) is offered.

This process is decisively influenced by ecology (soil, plants, animals, environment), the economy (market, land, finance, work), and the social sphere (health, education, religion, family, tradition, state); these are linked to one another by a variety of widely-differing flows of materials (foodstuffs etc.), energy, or money.

When the innovation offered is biogas technology, the factors of the system affected by it have to be identified and evaluated, by way of a partial analysis. With regard to production, and also ecological and economic considerations, both gas utilization and sludge utilization must be carefully analyzed to determine whether they might compete with and/or complement each other.

Because this depends to a very large extent on the specific situation, ranging from the fodder the animals are given to the transport of the material, it is difficult to assess the effects of the sludge; it can only be done at the location in question, by appropriate tests and analyses.

On the basis of examples it can be proved that the fertilizing effect of digested sludge can certainly be inferior to untreated material and that the nitrogen losses during storage may be much higher...
Since the feces only contain about half of the total quantity of nitrogen, the animal's feces and urine should be putrefied together if possible.

Although a biogas unit can also be regarded as a kind of fertilizer storage facility, subsequent storage of the sludge is often essential. It should therefore be investigated what techniques can be used to prevent further nitrogen losses during storage. One possibility would be a combination of compost and sludge storage. Since most of the nitrogen in the sludge is in dissolved form, drying should be avoided and attention concentrated on possibilities of extracting liquids. This often presents smaller farms, in particular, with unsolvable problems. In addition, a liquid fertilizer with quickly available nutrients should not be turned into the soil before sowing; the seedlings should already have roots if possible.

With regard to the problem of losses during storage, and bearing in mind the combination of measures in site-oriented agriculture mentioned above, it should also be pointed out that the cultivation of leguminous plants offers ways of fixing the nitrogen biologically.

Digested sludge is a nitrogen fertilizer with side-effects. On erosion-prone surfaces these side-effects, such as the improvement of soil structure, for example by increasing the humus content or encouraging soil life, can quickly become more important than the direct fertilizing effects. These long-term effects should not be ignored, either in studies relating to the utilization of sludge, nor in economic appraisals of the biogas unit as a whole. The use of digested sludge with its long-term effects, together with the saving in firewood, the reduction in over-grazing by stabling and cultivation of fodder, can make biogas units a valuable element in a site-oriented agricultural system.

Abstract

If biogas technology is used in site-oriented agriculture it should be borne in mind that it is particularly difficult to assess the effect of the sludge. Above all, the sludge should be removed while it is still liquid to obtain the full fertilizing effect of the nitrogen. Leguminous plants are especially suitable for fixing the quickly available nitrogen. However, the side-effects that can occur when digested sludge is used should always be taken into account.

Résumé

La mise en oeuvre de la technologie du biogaz dans le cadre d'une agriculture adaptée au site implique qu'il faudra tenir compte du fait que les effets du limon organique vent particulièrement difficiles a évaluer. Le limon organique doit surtout être en/eve dans sa phase liquide afin d'obtenir un engraissement maximal par l'azote. Les légumineux vent particulièrement appropries pour obtenir une fixation de l'azote rapidement disponible. Ce faisant, il faut toujours tenir compte des effets secondaires résultant éventuellement de l'utilisation de limon organique.

Extracto

Si la aplicación práctica de la tecnología del biogas se realiza en el marco de una explotación agrícola en una ubicación apropiada, deberá tenerse en cuenta, sobre todo, que es difícil analizarlos efectos del cieno de pudrición. Sobre todo debería esparcirse en su fase líquida, a fin de aprovechar todo el valor fertilizante del nitrógeno. Para la fijación del nitrógeno rápidamente disponible son muy apropiadas las leguminosas. En estas aplicaciones hay que tener siempre en cuenta los efectos secundarios que puede tener el empleo del cieno de pudrición.

Complements and Alternatives to the Biogas Unit
<table>
<thead>
<tr>
<th>Gas</th>
<th>Sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>wood from environment (forest)</td>
<td>fallow land mixed cultivation</td>
</tr>
<tr>
<td>- planted forest</td>
<td>mulch</td>
</tr>
<tr>
<td>- planting <strong>of</strong> wood</td>
<td>green manure</td>
</tr>
<tr>
<td>- living fence</td>
<td>fresh manure</td>
</tr>
<tr>
<td>- green manure</td>
<td>compost</td>
</tr>
<tr>
<td>petroleum or grass from the market</td>
<td>mineral fertilizer</td>
</tr>
</tbody>
</table>
Fermentation of poultry excrement/rice chaff mixtures

A Report from Nicaragua

by Sofia Bonilla Garcia, Rolf Georg, Reimund Hoffmann and Günter Ullrich

Apart from the village 'Criollo' chickens, that run free in and around houses, poultry keeping is the most widespread form of intensive farming in Nicaragua. It is practiced in the following way: the empty coop is strewn with a 5-10 cm layer of rice husks, and then, according to the size of the coop, occupied by between 500 and 200 young hens of the same age. On average, laying hens remain in the coop for about 13 months, which is not cleaned during this period. In this way, a mixture of poultry excrement and rice chaff results. When laying capacity diminishes, the hens are sold to be slaughtered, more or less all at the same time. The stall is completely cleaned and disinfected. Up to the present, the resulting litter has, as a rule, been thrown away unused.

The authors were confronted with this situation in two schools with adjoining farms, which had asked for support in the construction of biogas units. After consultation with both headmasters it was decided to ferment the poultry excrement/rice chaff mixture. Because of the above-mentioned type and amount of biomass, it was decided to build two batch or respectively semi-batch units with a volume of 15 m³ each.

The initial filling contained 16% dry matter: both digestors produced between 10 and 19 m³ of good quality biogas (with a CO2 content of less than 30%) daily.

By contrast, the short decomposition period between 45 and 60 days was unsatisfactory, especially as manual emptying with a bucket (1,500 buckets per digestor!) is very time-consuming.

An attempt was therefore made to prolong the decomposition period by increasing the proportion of dry matter to 33%. This attempt failed: gas production did not take place, and the unit evidently remained in an acid phase. It had to be emptied completely and refilled (proportion of dry matter: 13%).

Nevertheless, experiments were carried out in barrel units with varying proportions of dry matter: 8%, 10%, 12%, 14%, 20%, 35%. Some results of these experiments are described here in brief:
With a dry matter content of 10% the unit produced 0.18 m³ of biogas per kg of poultry excrement over a period of 24 days. At first, this gas contained 64% methane, increasing to 72% in the third week.

The quality of biogas is a direct function of the pH. With a pH in the acid region between 5 and 6, it is well possible that gas production will be very high but that gas quality, on the other hand, will be extremely poor with a methane content of only 20%. With improvement in pH, which came about automatically, gas quality also improved.

At present, one biogas unit is continuously being refilled with the poultry excrement/rice chaff mixture, thus slightly increasing the proportion of dry matter. The unit is functioning satisfactorily.

In conclusion, one can say that fermentation of these large amounts of biomass is feasible. Our experience has, however, shown that this is an extremely "sensitive" material and that the operator must always be in a position to interface in the process without too much trouble. On the other hand, this easily available and manageable organic material should not be ignored for fermentation in continuously operating biogas units.

Figure
Diagram 2: Production Graph

Gas production in m³

Drum digester 2001, proport
C/N ratio 14.9%, filled without
Gas was combustible after 12

Figure

View this page in text format
Biogas storage tanks of plastic sheet

by Gerhard Kopiske and Heinz Eggersglüss

At the "Biogas Workshop on Community Plants" in Bremen in May 1984 it became evident that in India in particular, transport and distribution of biogas present a problem. A need for portable gas storage tanks was thus identified and a search for new solutions was called for.

The company UTEC GmbH was commissioned by GTZ to collate the technical principles, experience in practice, and results from laboratory investigations into the use of sheet materials; also, to have prototype portable gas storage tanks with a capacity of 1.4 m³ each made, and to have them field-tested in cooperation with the Center of Science for Villages in Wardha, India. These gas bags are so designed that a day's supply of gas can be transported as if in a rucksack. The photo gives an impression of the size and appearance of these gas bags. No results of the field tests are available as yet.

Plastics as a gas storage material

Of the many possible plastics only those are considered which are thus far commonly used for producing sheets and coated fabrics. These are the thermoplastics polyvinyl chloride (PVC), polyethylene (PER), chlorinated polyethylene (CPE) and the elastomers butyl (IIR), chlorosulphonated polyethylene (CSM), chloroprene rubber (CR) and ethylene-propylene-terpolymer (EPDM).

There is no standard governing the recipes for these plastics. The degree of freedom in the composition and production is so great that the different materials can only be described in general terms.

Long-term behaviour

One major criterion when selecting suitable sheet plastics is their long-term behaviour. The principal influences affecting the materials are atmospheric influences and the actions of chemicals, animals, and micro-organisms.
Of these influences, ultraviolet radiation and ozone loading have the greatest effect. The plastics undergo a chemical change and may become unusable, e.g., as a result of a slow reduction in their ultimate tensile strength or sudden failure.

The resistance of thermoplastics to temperature is 65-70 °C, that of elastomers 90-120 °C.

In general it may be said that elastomers have better aging and temperature-resistance properties than thermoplastics.

In the application under consideration here, effects of chemicals only occur to a limited extent; resistance to methane, water, and to a limited extent also to hydrogen sulphide and organic acids. These criteria are satisfied by all materials; however, when PVC is used, biogas-resistant material should be chosen. This resistance is achieved by using special plasticizers which are not named here for reasons of commercial competition. If standard plasticizers are used the plastic is likely to become brittle after a certain time as a result of plasticizer migration.

Sheet material can be damaged by the actions of animals and micro-organisms. Rodents, in particular, may attack the material and make holes in the rolls. The susceptibility of the materials depends to a great extent on their physical properties, their outer form, the thickness of the material, and the chemical composition. Edges or tabs encourage gnawing, and the same effect results, for example, from the use of certain ingredients in PVC to which rodents seem almost addicted. One of these is red mud plastic (RMP), which has earned the nickname "rat mud plastic" because of its popularity with rodents. RMP is a PVC which has a bauxite extract and old oil as fillers and stabilizers.

If a mechanical stress is added to the above-mentioned effects the long-term durability is considerably reduced. For this reason, when, e.g., sheets are used, the limit load applied to them must be less than 10 per cent of their ultimate tensile stress.

Processing of plastics

Sheeting materials have to be treated very differently in processing than when being repaired. Among the possible methods are bonding, welding, and vulcanizing. The possible applications of these methods for producing and repairing gas bags are shown in the table on page 2.

Risk to health and the environment

Plastics may constitute a danger during production, processing, and disposal, e.g., burning, due to the liberation of constituents.

While the plastic product causes no risk in normal use, a certain risk potential does exist in production, processing and disposal. Individual constituents, some of which may be liberated by decomposition, are toxic, cancerogenous, or represent a nuisance.

In processing, for example, these include the solvents of the bonding agents; in welding, evaporating ingredients of the plasticizer and vinyls. In disposal, cadmium, lead, and sulphur in the plastics may give rise to problems.

Gas permeability

In all of the materials studied, the gas permeability of the sheeting and coated fabrics is satisfactory, provided the following points are observed when selecting and processing them:
• the coating of coated fabrics must be thick (more than 0.8 mm on PVC); the coating thickness of cheap truck tilts is not sufficient;

• the coating must be protected from damage, because the fabric is very permeable to gases;

• in making the gas bags care must be taken to ensure that no open layers of fabric extend into the gasholding space on one side;

• with sheeting and coated fabrics the joining method used must not weaken or damage the material cross-section.

Since there is a very great increase in gas permeability as the temperature rises, it is advisable to keep the bags in the shade. The daily gas losses calculated for the above-mentioned gas bags are around 0.5-3 per cent of the bag's capacity. For this reason, gas storage bags made of sheeting must always be stored in a well-ventilated place.

Assessment

The various sheeting materials were assessed on the basis of a list of criteria. A subjective appraisal of their behaviour was required in many cases, since the stresses to which they would be subjected in practice could only be simulated.

It was found that with regard to the raw materials, elastomers were superior to the thermoplastics. In particular, the aging and temperature-resistance properties are better. If weight is an important criteria rubberized fabrics (CR, CSM) are preferable to pure sheets; the material strength is also considerably higher when artificial-fiber fabrics are used.

IIR and EPDM sheets are very labour-intensive and expensive to make up into bags. This is also true in respect of vulcanizing of coated fabrics, though in the latter case bonding with two-component cement is also possible.

In view of their lower resistance to aging and temperature, the thermoplastics are regarded as less satisfactory. PVC-coated fabric is the best among them. It can be processed easily and in many different ways and it is relatively cheap. The probable thermal load can be reduced by opting for a light colour and incorporating a shading device in the design. Biogas-resistant PVC is available in the FRG, though in other countries recourse will probably have to be made to the standard-quality product.

Because of its poor mechanical properties, PE was found to be unsuitable for the application under study. Bags made of PE tend to require very frequent repair. And this is complicated because simple bonding is not possible.

As a raw material CPE exhibits good resistance, but joints which can be subjected to loads cannot be made with it because of its tendency to yield. Gas bags of CPE can only be used completely unpressurized.

Summary

Of the many possible plastics for sheeting and coating fabrics, rubberized fabrics are most suitable for making portable gas bags. Pure rubber sheeting, on the other hand, is considerably heavier and also more laborious to process.

PVC-coated fabric was found to be suitable to a certain extent. Its resistance to aging and biogas depends to a great extent on the recipe. PVC can be processed very simply in many different ways.
However, locally, i.e., in the country in question, the criteria are different from those applicable in Europe. Questions of availability, local production, and repair methods are of paramount importance, while the theoretical suitability of a material becomes less significant because there is no choice.

The use of plastic sheeting for making portable gas storage tanks is certainly a suitable and interesting solution to the problem. The technical possibilities are known; the question of social considerations remains unresolved. The field test, which is still in progress, will provide some answers to this, too.

UTEC GmbH will be glad to answer your questions on this topic. In order to complete our documentation we would ask you to send us details of the experience you have gathered, literature, samples of materials, etc. This will be collected and kept in readiness for answering queries.

Address:

UTEC GmbH, Waterbergstraße 11,

2800 Bremen 21, FRG.

Tel.: 04 21/64 7944.

Abstract

The use of plastic foil in the production of transportable gasholders is a very interesting and suitable solution. Field tests with these gas sacks have not yet been concluded, however, so that final results have yet to be published. At this stage, so much can be said: the material must not be too sensitive to ozone and ultraviolet radiation, and must be proof against micro-organisms and rodents. Up to the present, an tested materials have proved to be sufficiently safeguarded against gas permeability. As regards materials, elastomers are to be preferred to thermoplastics.

Résumé

L'utilisation de feuilles synthétiques pour la réalisation de réservoirs a gaz mobiles apparait comme étant une solution intéressante et appropriée. Les séries de tests réalisés sur place avec de tels ballons a gaz ne vent certes pas encore terminées, de sorte que l'on ne dispose pas encore de résultats définitifs. Cependant, on peut déjà dire que les matériaux ne doivent pas être trop sensible a l'ozone et aux rayons ultra-violets et doivent pouvoir résister a l'attaque des micro-organismes et des rongeurs. Il s'est avéré jusqu'a présent que la perméabilité au gaz de tous les matériaux testes est suffisamment assurée. Pour ce qui est des matériaux eux-memes, les élastomères vent supérieurs aux thermoplastes.

Extracto

El empleo de hojas de plástico pare la construcción de depósitos de gas transportables es, desde luego, una solución interesante y apropiada. Las pruebas practicas con estos „sacos de gas“ no han concluido aun y no se dispone, por lo tanto, todavía de resultados definitivos. No obstante ya se sabe que el material no debe ser demasiado sensible al ozón y a los rayos ultravioletas y debe ser resistente a los microorganismos y los roedores. Hasta el momento ha quedado demostrado que todos los materiales comprobados ofrecen suficientes garantías en cuanto a la permeabilidad a los gases y que los elastómeros y termoplásticos son los materiales mas apropiados.

UK Farmers Support Practical Aid
Farmers throughout England and Wales are rallying behind a new scheme that will bring practical agricultural help and know-how to their counterparts in the Third World.

The campaign is being organized by Britain's biggest agricultural organization: the NFU-(National Farmers' Union), in conjunction with Voluntary Services Overseas (VSO), the UK charity which sends people with specific skills to work in the developing world.

Each county in England and Wales has its own localised branch of the NFU, and 14 of these county branches have pledged to support VSO candidates working on two-year agricultural projects in such countries as Kenya, Nepal, Nigeria, Papua New Guinea, Tanzania, Thailand, Tuvalu and Uganda.

These VSO volunteers, all of whom will be working for subsistence wages only, will work in individual communities in local schools and institutes or on projects-funded by aid agencies, with the aim of training colleagues in basic agricultural skills relevant to conditions in the area.

Among the specific areas of agriculture of which they have specialist knowledge are food crop production, seed multiplication, forestry, fisheries, livestock production, ox traction, irrigation and soil conservation, and farm management. (LPS)
Economic and socio-economic evaluation of biogas units from the users' point of view

by Ulrich Stöhr and Uli Werner

The majority of biogas units in developing countries are integrated in small and medium-sized agricultural enterprises. The following is intended to help advise farmers with small and medium-sized farms looking for an analysis of the cost/benefit effects of a biogas unit appropriate for their farming situation. For this purpose a useful life of 10-15 years for a biogas unit is generally assumed.

The analysis which follows, which is intended for unit operators, does not take overall economic effects of biogas units into consideration, such as effects on regional development, promotion and diversification of local craft trades, the net effect on employment, the conservation of natural resources, especially by reducing deforestation and/or sewage, and savings in foreign currency expenditure on imported energy and mineral fertilizer. Seen realistically these secondary effects are only relevant when there is global dissemination, and in most countries this will not be achieved in the foreseeable future.

Problems of determining benefit and evaluation at the user-oriented level

It is usually easy to put a figure on the cost of building and operating a biogas unit. The capital investment and the costs of spares are mainly money expenses. Operation and maintenance are primarily a question of working time.

Determining the benefits of a biogas unit is more difficult. Apart from clearly quantifiable effects, some which can also be expressed in terms of money, there are a number of non-quantifiable factors. Economic appraisals based on cash flow only cover some of the factors which are important for unit operators in reaching a decision regarding the investment.

Because on the one hand it is also important to take the effects in the socio-economic and consumer sector into account when evaluating the benefits of biogas units, such as smoke-free cooking, increased prestige, or being able to read in the evenings. On the other, the problems of carrying out
an economic appraisal on the basis of the flow of payments are all the greater, the less the small farm is integrated in the monetary economy and commercial energy markets.

Therefore, an appraisal of biogas technology that takes both business management and socio-economic considerations into account have three levels of evaluation, which are of corresponding importance in advising small and medium farmers. They have to be regarded as analyses which complement each other. The order of their importance and their individual importance may vary depending on the region or locality in question.

1. Monetary economic appraisal

All the outlay/income flows connected with the biogas unit as an investment object are taken into account. On the expense side these flows are, in particular, all investment expenses, the costs of spare parts, e.g., for the metal gas dome. Then there are repair and maintenance costs and possibly the costs of raising capital, as well as wage and ancillary wage costs.

On the income side there are:

• cash savings due to the substitution of commercial energy, the net sales proceeds from the production of superfluous energy or respectively the goods produced with it;

• cash savings due to the substitution of mineral fertilizer previously bought, the net sales proceeds from digested sludge fertilizer or respectively the net sales proceeds from increased agricultural yields;

• real income gains from savings in working hours due to the biogas unit enabling the users to do paid work or increase the output of marketable produce on their farms.

At the individual economic level the economic appraisal gives the investor an aid in deciding whether the project will bring advantages, or what relative advantages it offers compared to other farm investments. For direct information and advice for small and medium farmers a calculation of the investment amortization time and a simple profitability calculation are likely to be particularly relevant.

The calculation of the amortization time tells the potential unit operator whether he can recover the capital he will have to invest within the technically feasible working life of the unit. Small farmers operating with little personal capital, and in many cases with uncertain economic prospects, are justifiably interested in minimizing the risk, i.e., keeping the amortization time as short as possible. The static profitability calculation gives a rough idea of the likely interest on the invested capital per unit of time. By abiding by certain rules about methods it is also possible to choose the investment alternative - among several - which is likely to be the most favourable.

The two investment calculation methods outlined here, and their results, have the advantage that they can be communicated to the target group relatively easily. This applies especially to static calculation methods.

However, the biogas adviser should check the statements he makes on the basis of static calculations against the complicated dynamic methods, which take the uncertainties of future development into account. This is necessary because payments for biogas units extend a relatively long period of time.

2. Working time accounts

Keeping comparative working time accounts, expressed in hours and relating to family members and employees, is especially important for small and medium-scale farmers. This balancing also includes
the monetary effects associated with expenditure or respectively savings in working time on the farm.

Additional work caused by the biogas unit on the farm and in the household includes:

• the work involved in building the unit;
• continual filling of the unit and collection of the dung;
• transport and removal of the digested sludge;
• the time spent by the operator on repairs and maintenance.

As a rule the biggest saving in working time is in cooking, because it is not necessary to gather and chop wood, cooking times are shorter, and it is no longer necessary to clear out or remove fresh and liquid manure.

It is not only advisable to keep working time accounts for the farm and household because they bring clarity; there are other reasons, too, because in many cases there is no real opportunity locally for the members of the family to do paid work. A further reason is that it does not always lead to additional yields which can be measured in monetary terms, even if the working time thus saved is invested in the farm. However, subsistence production can be increased. It could also happen that an excessive emphasis on the possible reallocation of saved working time, e.g., of women, to other agricultural work, associated with corresponding expectations of a higher yield, would lead to overwork for the women (this has also been found in practice).

3. Non-quantifiable effects

The third level of an analysis for unit operators is that of the numerous secondary effects of the biogas unit, which cannot be expressed in terms of money, but which are also hardly or not at all quantifiable.

These include, for example, the fact that the soil structure is generally improved by fertilization with digested sludge, without it being possible to prove this quantitatively. Or that the condition of the livestock improves as a result of improved housing conditions. In the consumer or respectively socio-economic area the benefits are above all in the improved reliability of the energy supply, the prestige value and the convenience of lighting in the evening, as well as in the general improvement in health and hygiene.

On the other hand, a negative factor that can hardly be quantified is the aversion of unit loaders to handling faeces and excrement.

None of the three levels of assessment alone will be decisive in the investment decision for or against a biogas unit, or the final assessment of it in everyday use. However, in practice they recur in all packages of reasons for exploiting biogas technology, with varying degrees of importance attached to them, independent of local conditions. This is also shown by the examples of two family units.

Mascoll's Farm, St. Vincent, Caribbean

Static amortization calculation

The 11 cubic-metre family unit on a 20-acre farm with 4 head of cattle cost the family, who built it themselves, $ EC 2,730 (for materials only). The annual costs of materials for repairs and maintenance amount to about $ EC 200. On the credit side there is an annual saving of $ EC 400 for kerosene and fertilizer. With a static calculation this results in an amortization period of almost 14
years.

Working time accounts

The actual advantage of the unit for the Mascoll family is in the considerable saving in working time for gathering and preparing wood and in shorter cooking times (at least 3 hours a day); altogether, the saving in working time amounts to 120 days a year. This compares with time spent for filling the unit and removal of digested sludge amounting to about 20 minutes a day. Together with the time spent on repairs and maintenance this amounts to about 27 days a year.

If the members of the farm community could reap the full benefit in cash from the considerable net savings in working hours, by doing paid work for average local wages, the amortization time would be considerably reduced, to about 2½ years.

As benefits of the unit that are not or not yet - quantifiable the Mascoll family mention the reduced smoke nuisance when cooking and the relatively bright light of the biogas lamp, as well as the resulting more pleasant evenings. In addition, the family have plans to become advisers and unit builders, and thus to tap new sources of income.

Zakaria Family, Miovaro, Tanzania

This family cultivates coffee and bananas and owns three cows, two calves, and eight sheep and goats.

Static amortization time

The investment cost of the "turnkey" unit (including gas-utilization apparatus, paving of the stable floor and connection to the biogas unit) was 11,000 THS. To this must be added the replacement of the burning-points, necessary every three to four years, costing 400 TSH. The unit supplies cooking energy for a 1 2-headed family; previously, "free" wood was used. The only tangible monetary benefit for the operators is the baking of about 100 flat loaves a week with superfluous biogas, and selling them. This is a completely new field of activity for the family, yielding a net profit of approx. 200 TSH a week. The amortization time (static) of the unit is thus about 1¼ years.

Working time accounts

The family statistics are similar to those of the Mascoll family: the net annual saving in working time is also between 90 and 100 days.

Additional beneficial effects of the biogas unit in the family's opinion are that the stable floor is kept clean, so that flies are less of a nuisance to both people and animals, and the greater taken of the animals; furthermore, obvious - though not quantified - fertilization successes in the coffee plantations. And at the same time vegetable fields are being laid out near the biogas unit.

These two examples of family biogas units make it clear that especially when "freely" cut wood, i.e., wood that costs nothing, is replaced by biogas the amortization of the biogas unit can hardly be guaranteed during its economic life. Only by turning savings in working time into money (Mascoll) or commercial activities (Zakaria) - on the basis of using superfluous biogas - can result in a favourable amortization period for the capital invested in these two cases.

However, both unit operators consider the saving in working time, even without any money income, very important; they usually invest the time saved in their farms. The other non-quantifiable benefits
are similarly appreciated.

Abstract

Economic appraisals help users to estimate the value of individual biogas units correctly. They are therefore a valuable advisory tool and can be applied in various ways: as a monetary economic appraisal or, e.g., in the form of working time accounts. In contrast, it is difficult, or completely impossible, to quantify the effects of a biogas unit in the area of consumption.

Résumé

Des calculs de rentabilité permettent une évaluation exacte de la valeur de chaque installation au biogaz. Ils vent donc un instrument précieux pour l'apport de conseils. Il y a la plusieurs possibilités: d'une part, le calcul de rentabilité monétaire, d'autre part, l'établissement du bilan du temps de travail. Par contre, les répercussions d'une installation au biogaz dans le domaine de la consommation vent difficilement quantifiables, voire pas quantifiables du tout.

Extracto

Los cálculos de rentabilidad son una ayuda pare analizar correctamente el valor individual de las instalaciones de una planta de biogás. Constituyen, por lo tanto, un instrumento de asesoramiento muy valioso.

Existen varias posibilidades; por una parte, el calculo de la rentabilidad económica y, por otra, el balance de las horas de trabajo. En cambio, es difícil, incluso, imposible cuantificar las repercusiones de una planta de biogas en el sector del consumo.

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