

## **Adding value to the residue from biogas plants**

### **Summary**

Vivekananda Kendra - Natural Resources Development Project (VK- NARDEP) has sold and installed 2,000 biogas plants in southern Tamil Nadu, India, to provide clean biogas for household cooking and fertiliser from the biogas residue.

The southern part of Tamil Nadu is hot and humid. Most people work in agriculture and grow rice, sugar cane, mangoes, coconuts and a range of vegetables. The biogas plants sold by VK- NARDEP use cattle manure to produce biogas which saves fuelwood, allows cleaner cooking and gives a healthier environment, with reduced air pollution and fly-borne diseases. VK- NARDEP has also recognised the significant potential of the output residue from biogas plants. This is normally used directly as a fertiliser and weed suppressor which gives significant benefits in a rural agricultural environment. The value of the residue can be increased by using it to grow Azolla, a nitrogen-fixing fern used as animal fodder or green manure. Alternatively, the residue can be made into an improved fertiliser using vermin-composting techniques. The financial savings from avoiding the purchase of wood and chemical fertiliser allow the cost of a biogas plant to be paid back within two to three years.

VK-NARDEP has obtained a thorough understanding of the problems which exist amongst many current biogas installations in India through detailed field studies. It has developed a well researched low cost design as a result and is also able to specify the design of plants in accordance with a customer's needs.

### **The organisation**

VK-NARDEP is an integral part of Vivekananda Kendra, a uniquely Indian combination of spiritual centre and research institute, based at Kanyakumari in southern most India. VK-NARDEP is engaged in popularising rural technologies in energy efficient construction, watershed management, holistic health, sustainable agriculture and renewable energy. It also coordinates networks of self-help groups among the villagers in the region.

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## Technology and use

Biogas systems take organic material such as cattle dung into an air-tight tank where bacteria break down the material and release biogas – a mixture of mainly methane with some carbon dioxide. The biogas can be burned as a fuel, for cooking or other purposes, and the solid residue can be used as organic compost.

Part of the work of VK- NARDEP is the construction and sale of biogas plants. The main plant it uses is the deenbandhu ('poor man's friend') model. The digester tank is constructed from bricks and concrete in a shallow pit and has a fixed brick dome built over it. The structure is finished with mortar to make it gas tight. Cattle manure is blended with an equal volume of water in a mixing tank (in order to make it flow easily) before it is added to the digester tank. Here it decomposes, producing biogas (typically 60% methane and 40% carbon dioxide) which is tapped off via a pipe in the centre of the dome and used for cooking in specially-designed stoves. An outlet tank receives the residue that is displaced when new feedstock is added; the residue is collected and used to make compost. VK-NARDEP has installed around 2,000 of these plants since 1986 and is currently installing about 70 per year. This digester design is approved by the Indian Government and is eligible for a subsidy.

VK-NARDEP was also commissioned to design a plant by the Ministry of Non-conventional Energy. It designed a biogas plant with a hydraulic retention time (the average time needed for the slurry to digest) of 30 days rather than the normal 40 days. It also brought out a design of 1 m<sup>3</sup> biogas plant. This contract also enabled VK-NARDEP to research and write a manual on repair and maintenance of biogas plants as well as six other publications in different languages which have been distributed all over India for both biogas users and plant maintenance personnel. VK-NARDEP has also developed its own innovative biogas plant design known as VINCAP.

Through this long-term experience with biogas plants, VK-NARDEP has realised the potential for the output residue and the key focus of its current work is to develop ways to maximise the value of this residue. One approach is to grow Azolla, a type of fern that fixes nitrogen from the air. It is grown on a mixture of soil, biogas residue and water either on a polythene substrate or between crops such as rice or coconuts and produces its first yield after only two weeks. It can be fed to cattle and poultry, mixed with soil as a source of nitrogen or sold. VK-NARDEP gives a free starter kit of Azolla with each biogas plant that they install.

Another approach is to process the biogas residue using a vermi-composting system. Coconut fibre is spread on a plastic mat, followed by a thin layer of partially decomposed biomass and biogas residue. Specially selected earthworms are placed on this layer and sprinkled with a mixture of water and cow's urine and are then covered by a thicker layer of biogas residue and green waste. The heap is kept moist for a period of four to six weeks during which time the worms digest the organic matter. A very high quality solid compost results and the liquid that drains out can be sprayed onto the fields to improve productivity and to kill certain pests.

The biogas residue is also incorporated in a traditional liquid fertiliser, "Panchagavya", which consists of residue, cow's urine, milk, ghee and other liquids such as sugar cane juice, banana juice or coconut water. This is stirred and allowed to decompose for about 20 days then diluted and sprayed near plant roots. VK-NARDEP is currently experimenting with other mixtures to suppress agricultural pests and with seed cakes from oil-bearing plants as feedstock for biogas.

## How users pay

The government-approved biogas plants (the deenbandhu model) that VK-NARDEP supply cost from R 10,000 to R 35,000 (£130 to £470) depending on size. The purchasers pay 80% of the cost and the remaining 20% is paid as a subsidy by the government on the condition that they engage an approved installer. VK-NARDEP assists the customer to arrange credit from a rural development bank or co-operative society. It also ensures that the loans are used for the intended purpose and that the customers re-pay promptly.

VK-NARDEP's VINCAP plant is not currently eligible for government subsidies, but 40 have been sold on a straight commercial basis and a further 60 were supplied as part of the research and development programme.

## **Training and support**

VK-NARDEP is careful to ensure that users really want to have a biogas plant and understand how it works. To do this, it requires the purchaser to buy the materials (to the VK-NARDEP specification), provide food and lodging to the installer and insists that at least one member of the family helps with plant construction.

The government pays VK-NARDEP a fixed annual service fee of R 700 (£8) for three years after the installation is completed. During this period, VK-NARDEP services the plant free of charge and provides any additional training to the customer. After three years the organisation provides the owner with a checklist for maintenance and its contact details. Thereafter VK-NARDEP continues to provide advice free on request but payment is required for any work on the plant.

VK-NARDEP has also carried out a thorough analysis of more than 2000 existing biogas plants across India in order to identify their current status and to define best practice. The organisation has used the findings of this analysis, and its own experience, to publish seven guides to biogas and farming in a range of languages which are distributed via the government and NGOs. A key finding was that some plants were too large for the amount of cattle dung available and failed as a result. This, in part, due to the provision of a government subsidy that gave more return to installers for larger plants; the failure of the plants was a bad advertisement for biogas.

## **Benefits of the project**

The biogas produced is used as a fuel for cooking which usually replaces fuelwood but sometimes LPG. Wood was previously purchased or collected by poorer people from forest areas. The 2,000 biogas installations save an estimated 14 tonnes of wood per day.

Using biogas saves considerable time both for collecting wood and for cooking. The kitchen stays much cleaner, there is less smoke and soot, and the stove is more controllable. Women suffer less from respiratory diseases. In a household without a biogas plant, animal dung is often stored in the back yard, making the area smelly and a breeding ground for flies. Where biogas plants are used, the incidence of fly-borne diseases has decreased substantially and the release of methane (a greenhouse gas) from stored dung is avoided.

The solid residue from biogas plants can be used directly to replace chemical fertilisers in the paddy fields thus reducing the run-off of nitrates into ground water and the release of nitrous oxide (another greenhouse gas). The residue also suppresses weeds and reduces the need for chemical herbicides which also contaminate water supply. The various composts derived from the biogas residue give even greater agricultural benefits increasing crop yields by 20-30%. One sugar cane farmer claimed that his yields have risen by 62% since began using biogas derived compost rather than applying chemical fertiliser. In addition, his requirement for irrigation water reduced by 40%.

Azolla, grown using the biogas residues, reduces the need to purchase livestock feed concentrates and has led to better quality and prices for both milk and eggs. People are prepared to pay 50% more for 'Azolla Eggs'. There are anecdotal reports of improved health in Azolla-fed cattle and poultry which VK-NARDEP is following up with a more formal study.

Financial savings are significant. VK-NARDEP estimates that the owners of a 4 m<sup>3</sup> plant can save Rs 26 on fuelwood and an additional Rs 14 on fertilizer each day. This means that their 80% contribution to the plant cost is paid back within 24 months through savings or the total cost within 30 months.

Over 2,000 biogas plants have been constructed directly benefiting around 12,000 people (five people per household plus those involved in construction) and indirectly benefiting many more through agricultural opportunities and plant maintenance work.

## **Management, finance and partnerships**

VK-NARDEP is financed by grants, paid work and charitable donations from supporters. It has developed good links with the national government, especially the Ministry of Non-conventional Energy which supported the VINCAP design. It engages actively with the government to implement best practice in the promotion of biogas, for instance persuading the government to apply a fixed subsidy regardless of the size of biogas plant in order to discourage people from applying for larger plants than they need which may then fail due to lack of feedstock. VK-NARDEP has also lobbied for the biogas subsidies to remain, so long as LPG is also subsidised, but would prefer both to be free of subsidy. It is currently lobbying for the benefits of the fertiliser from biogas plants to be promoted more actively in government programmes. Key VK-NARDEP personnel include Sri Vasudeo, secretary, Dr Kamalasanan Pillai, leading Azolla scientist, Mr. Muniswaran, biogas supervisor, Mr Ram Krishna, engineer and Mr. Kathiresan master mason.

## **Use of the Ashden Award**

VK-NARDEP will use an Award to study further the integration of biogas plants and biofuel crops. It is also planning to set up a mobile centre to service biogas plants after the three-year support period. This could also be used to resurrect plants installed by other organisations that have failed.

*This report is based on information provided to the Ashden Awards judges by Vivekananda Kendra and findings from a visit by one of the judges to see their work.*

*Dr Anne Wheldon, Technical Director of the Ashden Awards Jeremy Rawlings, Technical Assistant July 2006.*

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