SKG Sangha, India
D Vidya Sagar

the **Ashden Awards**
for sustainable energy

Clean cooking and income generation from biogas plants in Karnataka

Summary

SKG Sangha (SKG S) is a non-profit organisation that supplies biogas plants to households in rural areas of South India. The 'Deenbandu' design plants are built on-site by local masons and labourers trained by SKGS, with very high quality standards. Plants produce biogas by digesting cow dung, replacing all the fuelwood used for cooking. Using biogas saves a woman two or three hours per day from collecting wood and cooking. The avoidance of wood smoke is a huge benefit to health and welfare, with decreased incidence of respiratory and eye problems, and kitchens and cooking equipment are cleaner. Children benefit from better food, and more time and money can be spent on education. Each plant saves about 4 tonnes/year of CO_2 by replacing use of unsustainable wood. The plants installed by SKGS to date benefit over 210,000 people in 43,000 households.

The output residue from a biogas plant can be used directly on nearby land as a fertiliser. SKGS has enabled biogas owners to produce a better quality and saleable fertiliser from the residue, by including vermicomposting units with biogas plants. Using these units, women make compost from biogas residue and fibrous organic material, which is then re-digested by earthworms. The resultant vermicompost improves the quality of family crops (such as rice, ragi, coconuts and vegetables), and the liquid output from the vermicomposting unit can be used to suppress insect pests. Women can earn about Rs 12,000 per year from selling about half the vermicompost that they produce, which nearly doubles the family income. There is growing demand for such organic fertiliser in India.

The organisation

SKG Sangha is a non-profit organisation, founded in 1993 by Mr D Vidya Sagar. It is run by a team of 20 permanent staff, based at the office in Karnataka. They are supported by a team of masons and supervisors in each area and around 100 volunteers. Turnover was £212k in 2005/06, of which over 80% was related to biogas work.

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Context

Statistical information	
Population (2004)	1,087.1 million
Urban population (2004)	28.5%
GDP per capita US$ (2004)	$ 640
- at purchasing power parity	$ 3,139
Population living on less than $1 a day (2004)	34.7%
Population living on less than $2 a day (2004)	79.9%
Population with access to grid electricity (2000)	43%
Annual electricity consumption per person (2003)	594 kWh
Annual CO_2 emissions per person (2003)	1.2 tonnes
Population undernourished (2001-03)	20%
Population with access to an improved water supply (2004)	86%

Sources: UNDP, World Resources Institute

Although the state of Karnataka in Southern India has thriving, affluent cities like Bangalore, most of the rural population are subsistence farmers, growing rice, millet, vegetables and coconuts in the monsoon-watered land. Sale of any surplus food crops, and cash crops such as betel nuts, spices and tobacco, give a typical household income of only Rs 14,000 (£160) per year. The main fuel for cooking is firewood, used on smoky open fires and stoves. Wood is traditionally collected from common land, but pressure on land is making it increasingly scarce.

The biogas programme of SKG Sangha was set up to replace fuelwood with biogas for cooking, and also to increase household income by making a saleable fertiliser from biogas residue and other unmanaged agricultural organic waste.

Statistic	India	Karnataka
Urban population *	281,582,376	17,919,858
Rural Population *	737,283,492	34,814,100
Total population *	1,018,865,868	52,733,958
Number of cattle	28,800,000	4,240,000
Potentiality for bio gas plants #	24,000,000	700,000
No. of biogas plants installed so far #	3,370,000	270,000
Investment required for achieving full potential in £	3,403,950,000	70,950,000
Potential for vermicompost units ⊗	25,000,000	800,000

Relevant statistical data on India and Karnataka
Sources: * 2001 census # 2002 data MNRE ⊗ SKGS

Technology and use

Biogas systems take organic material such as animal dung and kitchen waste 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.

Since 1993, SKG Sangha has built and supplied over 43,000 biogas plants in rural South India to produce biogas from cow manure. The plants are of the well-established *Deenbandhu* design, which consists of an underground brick-built vessel with a ground level inlet for new feedstock and outlets for gas and residue. Each digester is built at the customer's site, starting with the excavation of a 4 metre diameter hole, about 2 metres deep in which a concrete floor is cast. A brick outer wall is built up, with each circular row of bricks gradually leaning inwards to form a dome. A gas pipe made of galvanized steel is held in place in the centre by pieces of brick and mortar, and takes the gas to the biogas stove in the kitchen through a HDPE pipe. The feedstock, which is mainly cow manure mixed with an equal amount of water, some of which is kitchen wastewater, (and sometimes with other organic waste such as residues from silk worm farms) is collected in an inlet tank at ground level, and flows under gravity into the digester vessel. As the feedstock flows in, an equal volume of digested residue is displaced into a ground level reservoir at the outlet. All materials used are available locally, except for the gas burners and HDPE piping which come from elsewhere in India.

It is also possible to run a lamp from the biogas supply, which consumes about 0.23m^3 of gas per hour to provide light equivalent to a 40 W light bulb. Most biogas plant users do not have a lamp, due to the additional gas demand it creates.

The SKGS digesters use 'mesophilic' bacteria, which operate best at temperatures between 28 - 36°C. Such temperatures occur without external heating. It is important that the bacteria have sufficient time to break down the feedstock, and the size of a digester is chosen so that the slurry is held for an average retention time of 40 days. SKGS makes models with 2, 3 and 4m^3 /day gas production capacity, corresponding to manure from 50 to 100kg per day and 2 - 6 cows.

About 36 to 72 tonnes of output residue is produced each year, from an input of about 18 to 36 tonnes of wet cow dung. The residue can be used directly as an organic fertiliser on nearby land, but it is too wet and bulky to transport to other users. SKGS encourages users to process the residue using vermiculture (worms) and make a better quality fertiliser in a suitable form to sell. This processing takes place in a purpose-built unit adjacent to the biogas plant. The vermicomposting unit has two brick chambers each about 1 m^3 in volume built on a ground-level concrete floor, and usually has a thatched roof. The residue is mixed with fibrous material such as straw, green leaves and dried leaves and the mixture allowed to compost for 25 days with frequent turnings: the bacteria in the biogas residue accelerate the composting process. Worms are then added to the top of the mixture, and covered by leaves or straw and a jute mat to keep them moist and dark. Each day, the top layer of worm casts are scraped off and stored for use as vermicompost. A small amount of water is added daily to the mixture, and the 'vermi-wash' liquor that drains through is used as a plant feed. SKGS has constructed 85 vermicomposting units so far.

Each plant needs about 30 man-days construction and 8 days man-masonry, with an additional 4 man-days for pipe fitting and curing. 10 further days labour are needed to construct the vermicomposting unit.

How users pay

£1 = Rs 85 [March 2007]

A typical 3 m^3 plant costs about £190. The national, district and local governments in India all subsidise biogas plants of approved designs. (LPG is also subsidised as a domestic fuel.) The amount varies between districts but is typically 60% of the total cost. The customers usually pay

the remaining 40% in kind by providing sand, gravel and bricks for the construction, taking part in the construction and providing food from the construction workers and their supervisors. SKGS administers the process of claiming subsidies, which are granted once a government official has inspected the plant. No credit facilities are arranged for the purchasers of biogas plants.

The vermiculture system adds an additional £130 to the cost of a plant.

Training, support and quality control

When a customer orders a biogas plant, an SKGS technician co-ordinates the work, arranges for materials to be delivered, organises training of the owners and checks the quality of the construction. The supervisor for that area will help the new user to become familiar with the plant operation, and gives each user a maintenance manual.

For SKGS, the use of trained, local installation staff is essential to ensure the long-term reliability of digesters. SKGS engages supervisors and masons from the local area to do the installation. New recruits are often unemployed young people from families with biogas plants, so they come with practical experience of plant operation. They initially help the trained masons in their work, until they have sufficient experience to work independently. Both men and women are trained as maintenance technicians. Use of local construction workers gives local knowledge of the operation and maintenance of biogas plants.

SKGS emphasises high installation quality, and gives a 100% guarantee on its plants for five years – if a plant fails then it will be replaced. Each plant has a unique serial number, which is recorded electronically and on paper at the local and central offices. Plants are visited regularly to check their performance, and the earliest plants are still operating well 14 years after commissioning, and are expected to last for a minimum of further 10 years. Only about 1% of plants fail to work well.

SKGS regularly meets suppliers to review and improve the quality and suitability of system components.

Benefits

One of the most important benefits that biogas brings to villagers in Karnataka is more time. Two to three hours per day that were previously used to collect wood and to cook are released for income generation and other purposes.

Producing and selling vermicompost is a significant income generation activity, usually for women. Vermicompost sells for around Rs 90 per 30 kg bag. Women can earn about Rs 12,000 a year by selling half their compost, and still have enough for their own land. Typical household income for small farmers in Karnataka is about Rs 14,000 per year (£160) so producing vermicompost nearly doubles this. With their own source of income, women have been able to get small loans for the first time.

The vermicompost is used for rice, ragi (a type of millet), ginger, potatoes, vegetables, coconuts and betel nut trees, and reduces the use of inorganic fertiliser. SKGS is working with the Agricultural University of Bangalore to independently test the value of the fertiliser, but reports from users are very positive. It has been found that vermicompost increases crop yields by at least 20% and possibly more for cereal crops. The quality of the crops is better and ginger grown with vermicompost fetches a higher price. Other vegetables taste better, grow bigger and can be sold for up to 20% more. One farmer visited by an Ashden judge found that his coconuts no longer fall before they reach maturity when the tree is fertilised with vermicompost.

Cooking with biogas instead of wood brings significant health benefits, especially for women. The reduction in smoke and soot reduces the incidence of respiratory complaints eye problems and headaches. Young women told the visiting Ashden judge that they had assumed that it was normal for women to cough, until they used a biogas plant. The cookware is easier to clean and the house

does not become so dirty. Easy disposal of kitchen waste and animal manure means that the village environment is cleaner.

Biogas brings significant educational benefits for children, and parents think that grades have improved. It takes about 75% less time to cook with biogas than with wood, so parents have time to cook breakfast for their children before they go to school. Previously children would walk for up to three hours to get to school without having eaten properly. In some cases, parents are paying for additional private tutoring for their children from the money earned through selling vermicompost.

Without biogas, a family in rural Karnataka uses an average of 3.5 tonnes/year of firewood on a traditional stove. Firewood is getting scarce because of pressure for land, and a biogas digester replaces all the use of wood. A study for a Clean Development Mechanism (CDM) project estimated that, in general, an average biogas digester saves 4 tonnes/year CO_2 from the replacement of unsustainable firewood.

Assuming that each biogas digester produces on average 3 m^3/day of biogas with an energy value of 23 MJ/m^3, then 43,000 plants supply about 3,000 GJ/day. If the stove efficiency is 65%, then the useful energy output is about 1,900 GJ/day.

The SKGS biogas programme has created work and given training to local people who might otherwise migrate to the cities in search of employment, including 1,000 masons, 60 supervisors, 800 maintenance technicians and 20 administrative staff.

Potential for growth and replication

The demand for biogas systems is very high in rural Karnataka. The main bottleneck is the availability of funding. Though the demand and need for this system is very high in rural areas, the rural people are poor and cannot afford to have a system without financial help from outside. The national subsidy for this programme is being reduced year after year. The present available subsidy for the number of units is very low, and cannot meet even 5% of the demand. To tackle this situation SKGS is trying to acquire funds from different sources, along with creating a revolving fund. Generally people wait for a subsidy but some are willing to obtain low interest loans since the vermiculture operation will cover their repayments.

Anaerobic digestion is well established across India but vermicomposting is not. Vermicomposting units could be added to village biogas plants of any design, with considerable benefit in producing better quality fertiliser and a saleable product. Some food exports from India have recently been rejected because of chemical contamination, so there is increasing interest in the use of organic fertiliser.

Courses, field visits and radio programmes raise awareness of the biogas programme, and SKGS intends to establish a permanent training centre to enable the work to be extended to new areas.

Management, finance and partnerships

SKG Sangha is run by a governing body, which is responsible for decision making and planning. Mr D Vidya Sagar, founder and President has overall responsibility for the organisation and Mr K Kiran Kumar, Secretary, is responsible for project implementation. 20 full-time staff run the biogas programme, with supervisors and masons employed on a piece-work basis.

Unusually for an NGO in India, SKGS was initially financed through a bank loan (now repaid). Subsidies on biogas plants are essential to the current business model, but other funding sources such as CDM finance are being investigated.

SKGS works with the Ministry of New and Renewable Energy who supply the government subsidy and with state Governments and district councils who supply additional subsidies. SKGS co-ordinates with other NGOs to publicise the benefits of biogas and identify potential users.

This report is based on information provided to the Ashden Awards judges by SKG Sangha and findings from a visit by one of the judges to see their work in Karnataka, India.

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