



# Producing Biodiesel Fuel from Local Seeds to Boost Livelihoods, Agro-Services, Water Pumping and Power Generation in India

This project began in February 2004 with a pilot plant for biodiesel production at Mohuda in the Ganjam district of Orissa, set up with seed-funding from the World Bank Development Marketplace. The activity was initiated by CTXGREEN, a Canadian non-profit organisation, in partnership with Gram Vikas, a local NGO with 25 years of community development experience in Orissa.\* The pilot plant acts as a resource centre for testing processes and equipment, and for training village technicians.

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*Women from the Self-Help Group in Kinchlingi learning about soap-making as a business.*

A small pedal-driven processor is used to produce biodiesel in batches of 5 or 20 litres. Biodiesel is produced through transesterification: mixing oil with alcohol and lye. In total, the production process takes about four hours, and involves one hour of pedalling. The process also produces glycerine, which has a higher density than biodiesel and separates out within two hours, and which can then be used to make soap.

Adding value to under-utilised local resources is a key objective of the project. In this case, vegetable oil is extracted from locally available, but so far under-used, seeds using a small, hand-operated oil press. Once the oil has been expelled from the seeds, a residual oil cake remains. This makes a good organic fertiliser or, if edible seeds are used, a low-cost, highly nutritious feed for livestock. Currently, the required lye and alcohol are purchased but, in the longer run, these could be produced from local waste fruit and wood ash.



The focus of the project is thus on local biodiesel production for local uses. The project also focuses on embedding gender and women's empowerment issues within the overall intertwined context of local value addition, sustainable jobs and adaptation to climate risks. As such, the project's approach is linked to the Millennium Development Goals, but it could as easily be applied in industrialised countries where it would link to global climate change issues and emission reductions. Again, the emphasis would be on local production for local emission reduction, and for productive uses such as powering tools and equipment.

### Approach

The project took a three-pronged approach to village-level biodiesel production and use, seeing it as being able to deliver:

- Renewable energy fuel to meet local energy needs.
- Increased agricultural productivity through increased soil fertility from using oil cake as fertiliser.
- Income to local entrepreneurs from the sale of biodiesel services (lighting, irrigation, oil expelling, etc.) and secondary products from the production of biodiesel fuel (oil cake, glycerine and soap).

Village installations in Kinchlingi, which has 16 households, and in the twin villages of Kandhabanta-Talataila, with 31 households, have used the biodiesel fuel produced with these pedal-driven processors to run water pumps and to generate electricity. A tiller running on biodiesel has been demonstrated for use in ploughing, irrigation and threshing rice paddy. Detailed feasibility assessments and business demonstrations have been carried out in the Tumba cluster of 50 villages, with about 1500 households, and work is under way to organise financing for biodiesel entrepreneurs there.

Over the past four and a half years, the demand for biodiesel in Kinchlingi has ranged from 11 to 13 litres per month, which is produced in two or three batches. It was used to power a water pump for three years until a gravity flow system was introduced in April 2008. Previously, women had had to carry water from a stream. In January 2009, a hybrid electrification scheme was introduced. A biodiesel generator provides one hour of compact fluorescent lighting per day through a 220V mini-grid, and also charges a battery bank for extended hours of LED lighting. Grid electricity reached Kinchlingi in August 2009, and the next transformation is afoot: accessing raw materials from the cluster of neighbouring villages to expand biodiesel production to 200-400 litres/month and to provide oil cake, biodiesel and biodiesel-fuelled agro-services to the entire cluster in a profitable manner.

The project has tried three management models:

- 1 In Kinchlingi, villagers opted for a volunteer-driven model, where everyone in the community shares both the work and the results of their labour.
- 2 In Kandhabanta-Talataila, self-help groups were

strengthened to operate and manage the entire biodiesel system, from collecting seed and producing the oil and its by-products, through to using machines fuelled by the biodiesel.

- 3 An entrepreneurial model is leading the way in Tumba and in the Kinchlingi cluster. Examples of entrepreneurial activities include the production of biodiesel and the provision of agro-services based on a biodiesel-fuelled power tiller, mobile irrigation, charging batteries and LED lighting using a biodiesel-fuelled generator.

Currently, a lot of local land is fallow because men have migrated and women are unable to plough the fields. Women are starting to be trained in running a biodiesel-fuelled tiller so they are able to do timely ploughing and sowing themselves to ensure good productivity. Agro-service centres are needed to provide timely inputs such as seeds, oil cake fertiliser and tilling services for small and marginal farmers. Women who have been trained in the use of the tiller will need to be supported by the community in the management of these centres so that the additional work is shared.

The technology was developed with inputs from women in the community, and the micro-energy plans were also developed with community participation that gave due emphasis to gender issues. Women were involved in micro-energy planning to identify available resources, the identification of suitable energy options for various end-uses, participatory technology development for inputs into the machine design, consultations on the type of illumination and the placement of lights, and training in machine operation.

**Rural entrepreneur: biodiesel-operated rice huller** The first barefoot biodiesel technician, trained by the project to run the systems in Kinchlingi, has now become an entrepreneur and set up his own rice hulling mill. He opted for a diesel-operated machine over an electrical alternative in the hope of being able to use biodiesel in the future. He is confident that he can purchase biodiesel from the local Self-Help Group and that, in the long run, biodiesel will be cheaper than petro-diesel and also help his local economy. Before this rice hulling enterprise was opened, the women of Kinchlingi had to carry their grains at least 12 km for processing.

The pedal-powered biodiesel processor has benefited from inputs from women through improved gender-sensitive ergonomics. Quick-release bolts allow the seat to be adjusted to a convenient pedalling position, and sari guards and easy handling features for pouring liquids into the system have made the machine more amenable to women.

However, gender-sensitive plans do not always translate into gender-sensitive implementation and engagement of women when it comes to decision-making regarding managing and operating the system. It is our experience that, even if women are involved in the planning process, men make the decisions during implementa-



PHOTO: EMILIE PLESSIS, CYRGREEN

#### *Biodiesel-fuelled tiller training, July 2008.*

tion. It is therefore critical to strengthen women's groups in decision-making.

Involving women in decision-making generally requires a process that goes beyond technical training and one that permeates into their everyday life. It demands a paradigm shift in their male-dominated lifestyle, and is achievable only gradually. One step in this direction is the training of young village girls as technicians. Young girls from the village are now trained as future 'barefoot technicians', skilled in quality control and the operation of machines. They, in turn, can catalyse the process of demystifying the technology.

Since women are traditionally the ones who gather the seeds from the forest, value-added activities that allow them to sell oil and oil cake rather than unprocessed seeds can increase their income. However, the women need training in business aspects of enterprise development. In Kinchlingi, women have been introduced to the idea of running an enterprise for converting glycerine, a by-product of biodiesel production, into soap.

#### **Main challenges**

Some of the challenges the project faces include:

- The steady supply of seeds for local use could be threatened if the seeds start to be sold to external traders, or large-scale processors and oil mills. In addition, legal and policy frameworks regarding access to the forest and its minor products could limit the ability of villagers to collect seeds.
- Current excise laws affect access to some ingredients, such as the alcohol needed to make biodiesel. A forum of Orissa-based NGOs has been working on a 'barrier-mitigation roadmap' and a 'replication strategy', and have entered a dialogue with Orissa Government officials about this. The latter are now starting to look favourably at waiving permit fees and excise duty for the procurement, production, storage and use of absolute alcohol as a raw material in the 'village-level biodiesel, local production for local-use, model'.
- Sometimes, the learning curve facing self-help groups for capacity building appears to be dauntingly steep due to the relatively low level of literacy in the community, the need to raise awareness, and the hesitation about taking the first steps in new initiatives. Exposure to other successful groups is helpful in building a spirit of enterprise and interest in new livelihood patterns. Further, the long-term viability of 'local production for local use' biodiesel is likely to be enhanced if self-help groups play a lead role in ensuring raw material security by buying the seeds from the collectors (instead of allowing traders to buy them), by leveraging their savings and using their micro-finance working capital.

#### **Conclusions**

The objective in introducing village-level biodiesel production and use in an entrepreneurial manner is to ensure sustainability through local participation. Benefits will not only accrue to the entrepreneurs running the hand-operated oil mills, the biodiesel production centres, biodiesel-powered livelihood activities and the by-product value addition services, they will also benefit the community as a whole, in terms of increased agricultural productivity, progressive reversal of shifting agriculture, more local jobs, capacity building and a reduced cash outflow for purchasing edible oils. Unfortunately, because there has been no systematic data collection to monitor the impacts on a gender basis, there is no information available on how women have benefited from this project.



*Self-Help Group women teaching each other how to pedal the biodiesel reactor at Kandhabanta-Talataila.*

In the case of Kinchlingi, it has been shown that the provision of basic services such as water and lighting is better achieved (cheaper and more convenient) through the grid, and the real value of a local biodiesel project is through the access it provides to oil cake and liquid fuel to increase agricultural productivity.

The project is now developing a platform for collaborative partnerships: nationally through a framework offering policy support for village-level biodiesel service delivery (including procuring and manufacturing alcohol locally); and internationally through a framework to

support a fair trade in carbon credits between village-level biodiesel enterprises and Northern community partners.

The CTXGreen biodiesel project case study is but one example of potentially replicable models for biofuels projects. The project established that, in the Tumba cluster of forest villages, the currently available 375 tonnes of seeds was adequate to fully support the estimated local consumption requirements of 150 litres per day for lighting, oil-expelling and irrigation. Policies are needed that support such livelihood models rather than focusing on the development of biofuel plantations to serve the transportation sector. Also, monetary investments are required at the local level to support local validation studies to develop context-specific replicable models that support the various aspects of the entire biofuel livelihood chain. This chain includes seed collection, oil expelling, biodiesel production and use, as well as by-product synergies and value addition, and sustainable agricultural practices besides biodiesel-fuelled livelihoods. Unfortunately, the challenges of implementing this model within a local context - with low literacy levels and limited exposure to entrepreneurship - have made progress slow. More players are needed to support this effort, which is why a partnership with a local Rural Enterprise Management School is under development, including the seeking of state government funds.

#### NOTE

- Additional partners include the University of Waterloo and the KW Working Centre in Canada, and the Indian Enviro Legal Defence Firm, Regional Centre for Development Cooperation, and OUTREACH organisations. The Shastri Indo Canadian Institute and the Swiss Agency for Development and Cooperation have supported different stages of the project.



**Geeta and Ramani** are co-founders of CTXGreen, a Canadian not-for-profit organisation, that aims to translate their vision for 'local food and fuel security for global environmental security' into practice through local production

for local use biofuel models implemented in a manner that enhances the quality of life in communities while benefiting the environment. Ramani has a PhD in Metallurgical Engineering from McGill University, Montreal, Canada, and over 25 years of experience as a process engineer and consulting engineer on issues ranging from process efficiency and innovation to by-product synergy and sustainable development. An architect by training, Geeta recently completed her PhD at the University of Waterloo, and has over 20 years of experience working with communities in livelihood-enabling activities including renewable energy implementations.

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