

Biodiesel for rural livelihoods

# Pedal power - fuelling an evergreen revolution

How local production and use of biodiesel  
creates sustainable livelihoods and  
enhances food and fuel security  
in rural India



Pushing the pedal to the metal with bare feet  
to accelerate development without fossil fuels

AN INITIATIVE BY :



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with

Gram Vikas, India



This brochure has been funded by a generous grant from the



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Confédération suisse  
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Swiss Agency for Development  
and Cooperation SDC

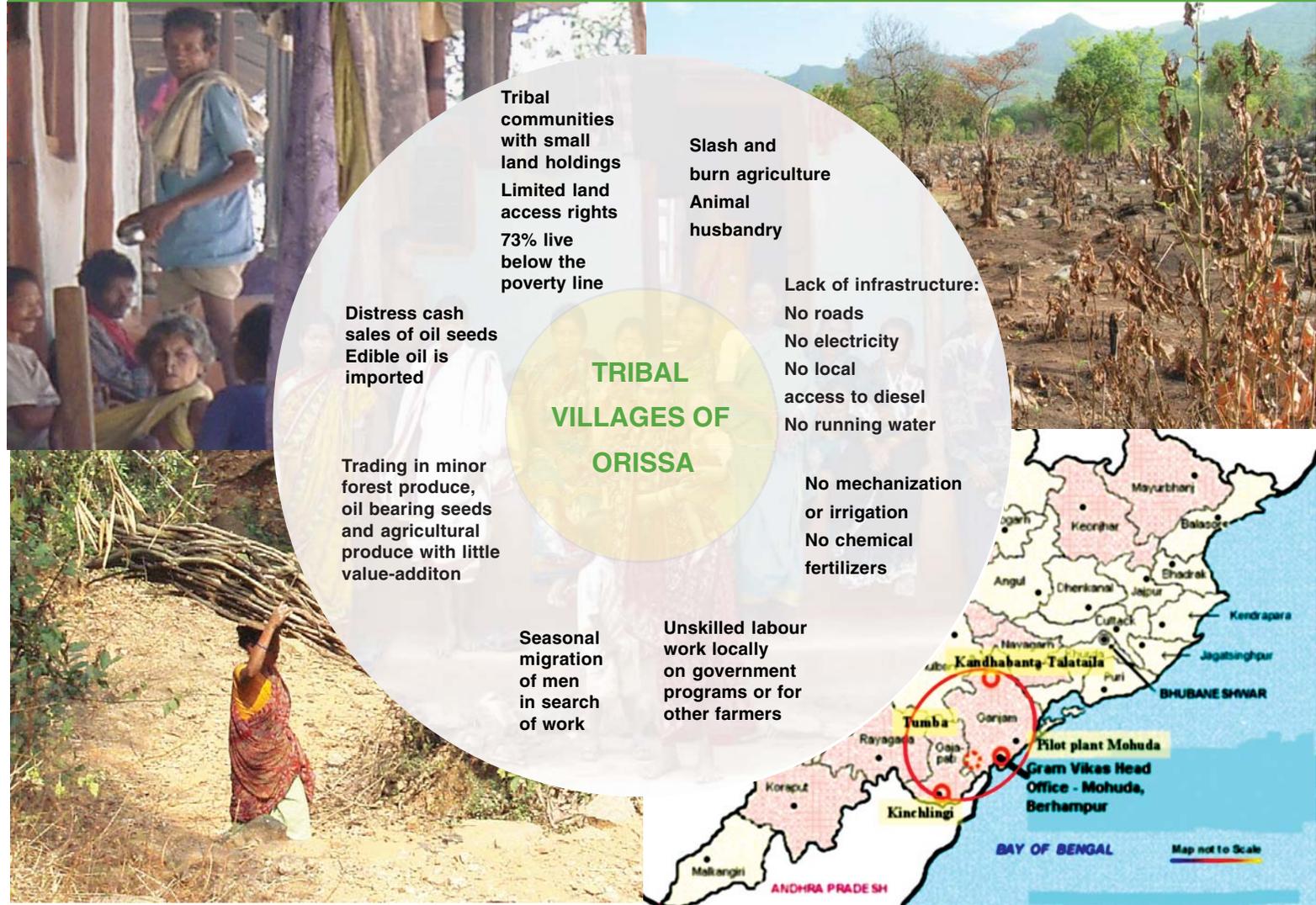
## CONTEXT

The state of Orissa is one of the poorest in India in spite of being a net exporter of power and its abundance in natural and mineral resources.

Isolated rural communities are characterized by chronic poverty, indebtedness, lack of secure livelihoods, ill health and illiteracy.

Eighty-seven per cent of the population lives in rural areas. In these rural areas 40% live below the poverty line (revenues less than US \$1.00/person/day) and less than 20% have access to protected water.

## TRIBAL COMMUNITIES IN SOUTHEASTERN ORISSA



**B**iomass plantations needed to produce biofuels for transportation on a large scale create competition for land and water resources.

CTx GreEn believes that **food and fuel security** for isolated rural communities in India can best be achieved by keeping the production of food and fuel at the village level. The production and use of **biodiesel** fuel at the local level can provide:

- Renewable energy without impinging on food security: **fuel for a multipurpose tiller** which facilitates all types of land cultivation; **fuel** for secondary crop irrigation; **fuel** for essential daily water needs; **fuel** for electrification
- Income to local entrepreneurs from the sale of biodiesel services (irrigation, oil expelling, lighting *etc.*) and secondary products from the production of biodiesel fuel: oil cake, glycerin and soap
- An increase in agricultural productivity through increased soil fertility by using biodiesel oil cake as fertilizer. This will reduce the need for slash and burn cultivation and permit the regeneration of local forests

**As a result, local economies will improve**

**THE MULTIPURPOSE TILLER**  
**Agro-service on wheels**  
**at your door-step in your village**

Designed for a multitude of uses, this walk behind tiller, when fuelled with biodiesel, can transform a rural community. Rear attachments permit tilling, seeding, harvesting and threshing. Front attachments will power a pump, generator, seed huller, winnower, sprayer and oil expeller. In addition the multipurpose tiller can be driven and pull a wagon with 2000 kg of weight.



**The benefits of village-level production and use of biodiesel fuel**

**Local Value Addition**

- Manual pressing and sale of edible oil vs sale of oil seeds
  - Oilcake as fertilizer and animal feed
  - Production and sale of glycerin soap

**Village-level Biodiesel**

**Sustainable Agriculture**

- 2<sup>nd</sup> crop irrigation and cultivation
  - Improved soil fertility
- Soil and water conservation watershed development
  - Forest regeneration
- Re-plantation of native species

**Biodiesel-fuelled Livelihoods**

- Biodiesel production and use
- Biodiesel-fuelled generator set, battery-bank and battery powered LED lighting
- Biodiesel fuelled oil expelling
- Biodiesel fuelled pump-sets and multipurpose tiller

## The case for village-level production and use of biodiesel

Our first two tribal village installations in Orissa since 2004.

Village	Kinchlingi	Kandhabanta-Talataila
<b>Households</b>	<b>15</b>	<b>32</b>
<b>Management Model</b>	“Sweat equity” Each household provides one volunteer, one day per month to run and maintain the oil press and the biodiesel reactor with the assistance of a barefoot technician.	Operated and managed by the Women’s Self Help Group (SHG) with the assistance of a barefoot technician.
<b>Biomass source</b> <i>* Niger introduced as new crop. A stop-gap raw material for biodiesel until tree-borne oil seeds become available from forest, after which it will become an edible oil crop.</i>	Volunteers cultivate by rotation, 4 acres of niger* (edible indigenous oilseed) a short duration, 120 day non-intensive crop on fallow land (not cultivated for >3years) + exchange salt with hilltop village for karanja (non-edible oil seed).	Volunteers cultivate by rotation, a 5 acre, 120 day, non-intensive niger* crop in community fallow land, never cultivated before.
<b>Consumption of biodiesel fuel</b>	<ul style="list-style-type: none"> <li>● 11 to 13 litres / month from May 2005 to April 2008 for water supply.</li> <li>● 700 hours of pumping; 470 litres of biodiesel.</li> <li>● 13 litres / month for hybrid lighting: Jan 2009-</li> </ul>	<ul style="list-style-type: none"> <li>● ~13 litres / month Jul - Aug’ 06, Dec’06 - May’ 07.</li> <li>● 150 hours of pumping; 92 litres of biodiesel.</li> </ul>
<b>Equipment fuelled by 100% biodiesel</b>	3.5 HP biodiesel pump-set for water since May 2005. 3.5 HP gen-set based hybrid electrification scheme; since Jan 2009 : 1 hour of 220V mini-grid and charging of a battery bank for extended hours of LED lighting.	3.5 HP biodiesel generator running a 1/2 HP submersible electric pump.
<b>Direct benefits</b> <i>80% of the cost of biodiesel is for seeds and oil expelling</i>	<ul style="list-style-type: none"> <li>● 25,000,000 litres of water supplied over 3 years using biodiesel until gravity-based system was introduced in 2008.</li> <li>● Village Electricity Committee responsible for 60kg/month niger for biodiesel and Rs 30/month/family as tariff for biodiesel-fuelled hybrid lighting with LED+220 volts 15 Watt CFL.</li> <li>● Fuel for a multipurpose tiller to facilitate cultivation. Demonstrated profit &gt; Rs.500/day after paying wages for two semi-skilled people and deducting O&amp;M costs.</li> <li>● Women freed from fetching water are being motivated to run glycerine-based soap making as a business activity in their Self Help Group, Bhairabi.</li> </ul>	<ul style="list-style-type: none"> <li>● 500,000 litres of water supplied over a 7 month period, until gravity flow was introduced in 2007.</li> <li>● Women, freed from fetching water, can now participate in income generating activities.</li> <li>● Niger becomes an edible oil crop locally.</li> </ul>
<b>Future plans</b>	Biodiesel supplied through the Bhairabi Self Help Group could fuel (a) multipurpose tiller for a second yearly crop (b) small post-harvest equipment like rice-hullers and (c) a large oil expeller. This will generate at least 10 direct jobs, enhance the income for self help groups and <b>double the food production</b> . In a cluster of 20 villages, with more than 300 farmers.	Use of a biodiesel fuelled <b>multipurpose tiller</b> , generator charged LED mobile lighting. Niger inter-cropped with a legume or pulse crop on community fallow land, enhancing agricultural income two-fold while improving soil-nutrition.

## PRIMING THE ANKULI / BURATAAL VILLAGE CLUSTER

This pioneering biodiesel project started in 2004 in the hilly regions of Ankuli and Burataal, a cluster of 50 villages located up to 1000 metres above mean sea-level. The emphasis is on developing an **entrepreneurial model** to offer agro-energy-services to surrounding villages. Families were met, land use maps prepared and forest tree-oil species identified and enumerated over a 3-year period. In addition, the financial viability of oil pressing was demonstrated over a 2-month period. The following biodiesel activities were chosen based on the region's natural resources and existing livelihood activities and agricultural practices:

- Manual oil pressing: Potential for at least 3 presses, 9 direct jobs and supporting 5-6 Self Help Groups that can now sell edible oil for household use and non-edible for biodiesel production. The oil press could be paid off within a year
- Biodiesel-fuelled oil expelling to process tree-borne oil seeds: mahua (*Madhuca indica*), karanja (*Pongamia pinnata*), kusuma (*Schleichera oleosa*) from 375 tons of locally collected seeds, creating at least 5 direct jobs and supporting several Self Help Groups. 278 tons of oil cake available as fertilizer, avoiding slash and burn in 750 acres of forested land.
- Biodiesel production and secondary products: biodiesel, oil cake, glycerin and soap. Oil cake in the area can displace the equivalent of 30 tonnes of urea for paddy cultivation. Glycerin and soap making can reduce the cost of biodiesel by 10-20% and augment income for women in Self Help Groups
- Biodiesel-fuelled **multipurpose tiller**: to facilitate cultivation-ploughing, irrigating, threshing, hulling, augmenting food-production through a second crop
- LED light charging using biodiesel-fuelled generator sets and battery-banks
- Biodiesel-fuelled mobile entertainment units for television, film and music

### Mohuda Pilot Plant and Training Centre

CTx GreEn's pilot plant and training centre in India, is located on the Gram Vikas campus in Mohuda Village, Orissa. Since 2004, the pilot plant has been at the heart of all the biodiesel operations. It was originally set up for the design, development and testing of machines and processes and to train "**barefoot technicians**". The strategy for the future is to transform the pilot plant into a resource centre for biofuel-based livelihood strategies. It would also offer support to other NGOs and facilitate the installation and commissioning of new biodiesel units. South-North training sessions, knowledge exchanges, micro-energy research and the development of new collaborative partnerships are also planned.

### Adaptation to climate change and carbon credits

A direct result of using biofuels vs fossil fuels is the reduction of CO<sub>2</sub> emissions; however, the local production and use of biodiesel can transform rural communities by providing **fuel and food security** and improving the local economy. At the same time, the increased soil fertility, with the use of 'oil cake' will eventually result in the reduction of slash and burn and the regeneration of local forests and further reduction in CO<sub>2</sub> emissions.

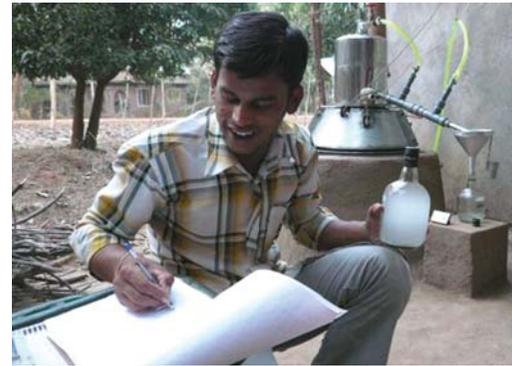
With the exclusive use of biodiesel as a fuel (a likely demand estimated to be ~150 litres/day) and the elimination of slash and burn agricultural practices, CO<sub>2</sub> reduction rates for this cluster of 50 villages has been calculated at 10 tons per day. At going rates, should funds become available, this translates into approximately \$150/day or \$1/litre of biodiesel produced and used. These carbon credits would pay for all of the material costs of the production of biodiesel fuel for these villages and **ensure development without burning additional fossil fuel!!**



## THE VILLAGE-LEVEL PRODUCTION OF BIODIESEL FUEL-FOUR HOURS TO FUEL

Biodiesel is produced by combining vegetable oil, lye and alcohol

- The oil is first pressed from indigenous local seeds using a manual press
- The residue-oil-cake can be used as an organic fertilizer or animal feed
- A bicycle-powered biodiesel reactor then produces biodiesel fuel in 5 litre batches
- Five minutes of pedaling combines the lye and alcohol into a homogeneous mixture
- This mixture is then added to vegetable oil
- An hour of pedaling converts the oil-lye-alcohol mixture into biodiesel and glycerin
- Within 2 hours the biodiesel fuel and glycerin have separated
- The biodiesel can be used in any engine which is powered by standard diesel fuel. The only modification required is to replace rubber fuel hoses with copper or nylon braided plastic.
- The glycerin can be used to make soap at a later date in a separate process

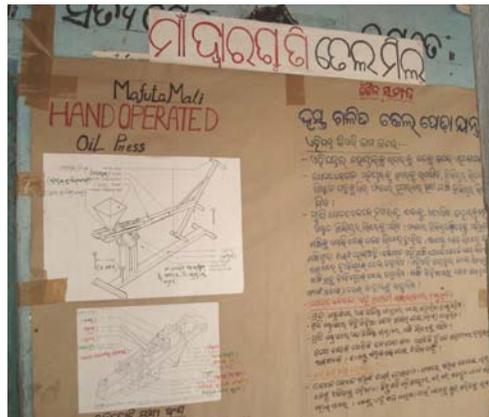


## FUELLING THE REVOLUTION - REPLICATING THE *LOCAL-PRODUCTION-AND-USE* MODEL



has identified the following strategies for replication:

1. Build on partnerships with NGO's in Orissa and in other areas.
2. Business profitability demonstrations of biodiesel-fuelled end-use devices: Genset for 220V and LED lighting, the multipurpose tiller as a multi-use device, the stationary oil expeller and soap making from glycerin byproduct.
3. Develop bankable business plans for each production unit and end-use device/service. Independent assessment of MFIs vs commercial banks, government support/subsidy schemes, carbon credits and green funds (venture capitalists in development).
4. Establish entrepreneurs to own/operate production units (oil press/expeller, biodiesel reactor), end-use devices. Include adequate training in package
5. Demonstrate benefit-cost of oil cake as a manure.
6. **SHG strengthening to play a role in supporting purchase of seeds / marketing of oils and oil cake locally, value-added soaps and biodiesel.**
7. Farmers training school: set-up cooperatives, look for financing of new activities such as growing a second crop using biodiesel-fuelled mobile irrigation pump-set.
8. Institutional strengthening for CTxGreEn to reinforce core team to continue the barefoot technician training.
9. Continue feasibility assessments for replication in other areas with partner NGO's.
10. Stakeholder workshops and Gram Sabha mobilization to bring down excise and other policy related barriers in favour of village-level biodiesel in their Panchayat.
11. Case studies of ongoing work, including policy research of organizational forms, of community-based enterprises to be extended to fair trade of carbon credits.
12. Technology packaging and IP protection for (1) Biodiesel reactor system (2) Village-level oil refining process (3) Ethanol purification and the biodiesel refining systems which require fine-tuning. This will provide some revenue in the future to support organizational stability.





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**OUR IDENTITY:**



Community-based Technologies Exchange fostering Green Energy Partnerships.

Geeta Vaidyanathan and Ramani Sankaranarayanan are the founders of this Canadian not-for-profit organization, which has partnered with grass-roots organizations and field-based NGOs around the world since 2003. Their focus is on renewable energy projects.

**OUR VISION:**

Local food and fuel security for global environmental security.

**OUR MISSION:**

To research, assess, facilitate and implement community-based renewable (green) energy projects in a manner that improves:

- The total quality of life in the community, and
- The environment

**OUR PARTNERS:**

Gram Vikas, Enviro Legal Defence Firm (ELDF), Intercooperation (IC), Outreach, Regional Centre for Development and Cooperation (RCDC), India

Swiss Agency for Development and Cooperation (SDC)

University of Waterloo, Shastri Indo-Canadian Institute (SICI), The Working Centre, Canada

World Bank Development Marketplace 2003

The staff and volunteers at the Mohuda pilot plant and village units

Research funds from International Development Research Centre Canada (IDRC) and Social Sciences and Humanities

Research Council (SSHRC) have facilitated some of our field work

Special thanks to the communities of Kinchlingi, Kandhabanta, Talataila and Tumba cluster for their support and collaboration



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Design : Deckle Edge  
Printed by : Rainbow Graphic Services  
Text : Luyse Groulx, CTx GreEn  
Photo credits : CTx GreEn and its associates, Alexandra Zalucky, Emily Plessis, Hyung Jung Park, Keigan Buck, Marc Laban, Mary Jane Patterson, Pushpanjali Sathpathy  
Dated : 1 March 09