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Community-based Technologies Exchange  
fostering Green Energy Partnerships

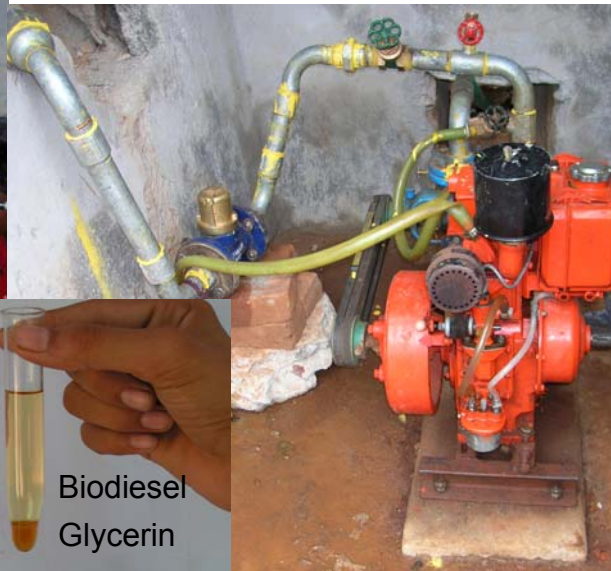


# Village-level Biodiesel Production Technical and Legal Challenges

Ramani Sankaranarayanan, Geeta Vaidyanathan  
Joe Madiath, Urmila Senapati  
Sanjay Upadhyay



SDC/IC-PSU  
ISNRMPO







The project has been developed by CT<sub>x</sub> GreEn, with Gram Vikas as primary partner. DM2003 recognized pioneering and unique aspects of project, and provided seed funding to support field testing/proving. The “*carbon-neutral biodiesel-fuelled energy system*” project was one of 47 winning projects from 2700 applicants to global competition.

### Geographical focus:

Gram Vikas operating areas in Orissa, initially with Ganjam and Gajapati districts as nodal points for pilot implementation.

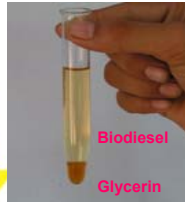
### Project Schedule:

Started as 12-15 month project in Feb 2004, we are now in 20<sup>th</sup> month, with a Jan 2006 projected date for completion of initial mandate.

Several activities, beyond original mandate but critical for sustainability, have already been initiated.

**Consolidation will require additional funding.**





## Why Biodiesel in Gram Vikas villages?

### 1. Long History with Renewable Energy Projects

- Biogas (1982-93; restarting 2005)
- Smokeless Chulas (1985-86; restarting 2005)
- Energy Plantations, Gasifier (May 2003 - )
- Solar water pumping, Micro-hydro (2003 - )



- **Biodiesel (2004-**

- **Carbon-neutral biodiesel-fuelled energy system (DM2003)**

### 2. RHEP – Rural Health and Environment Programme

#### internationally recognized programme promoting:

- 100% social participation
- Gender Equity, Health, Education, Livelihoods
- 150 RHEP projects in first 12 years (1992-2003)
- **Goal: >1500 RHEP projects by 2020 (90% of these are tribal villages that may never have access to grid power)**

#### Key Features of RHEP:

A Toilet & Bathroom in every house  
3 Taps with running water in every house  
Water tank: community asset  
People bear 45% capital & 100% Op/Maint Costs



### 3. ITDP – Integrated Tribal Development Programme

- Tribal Community development
- Food security, Health, Education, Livelihoods
- Gender Equity and Social Inclusion



## Biodiesel Project Features:

### • Local underutilized oil seeds as feedstock for oil

- avoid conflict with food security
- preferably non-edible oil seeds
- oil cake by-product as fertilizer (animal feed...)
- **NTFP, Agriculture & Homestead**

### • Year one plan for ethanol:

- Purchased Ethanol (< 0.5% water)
- Pre-feasibility Basis: Oct. 24 2003 News item in Down to Earth/Centre for Sci. & Env.: “currently Govt. of India offers **Rs.18/L** for ethanol ....”

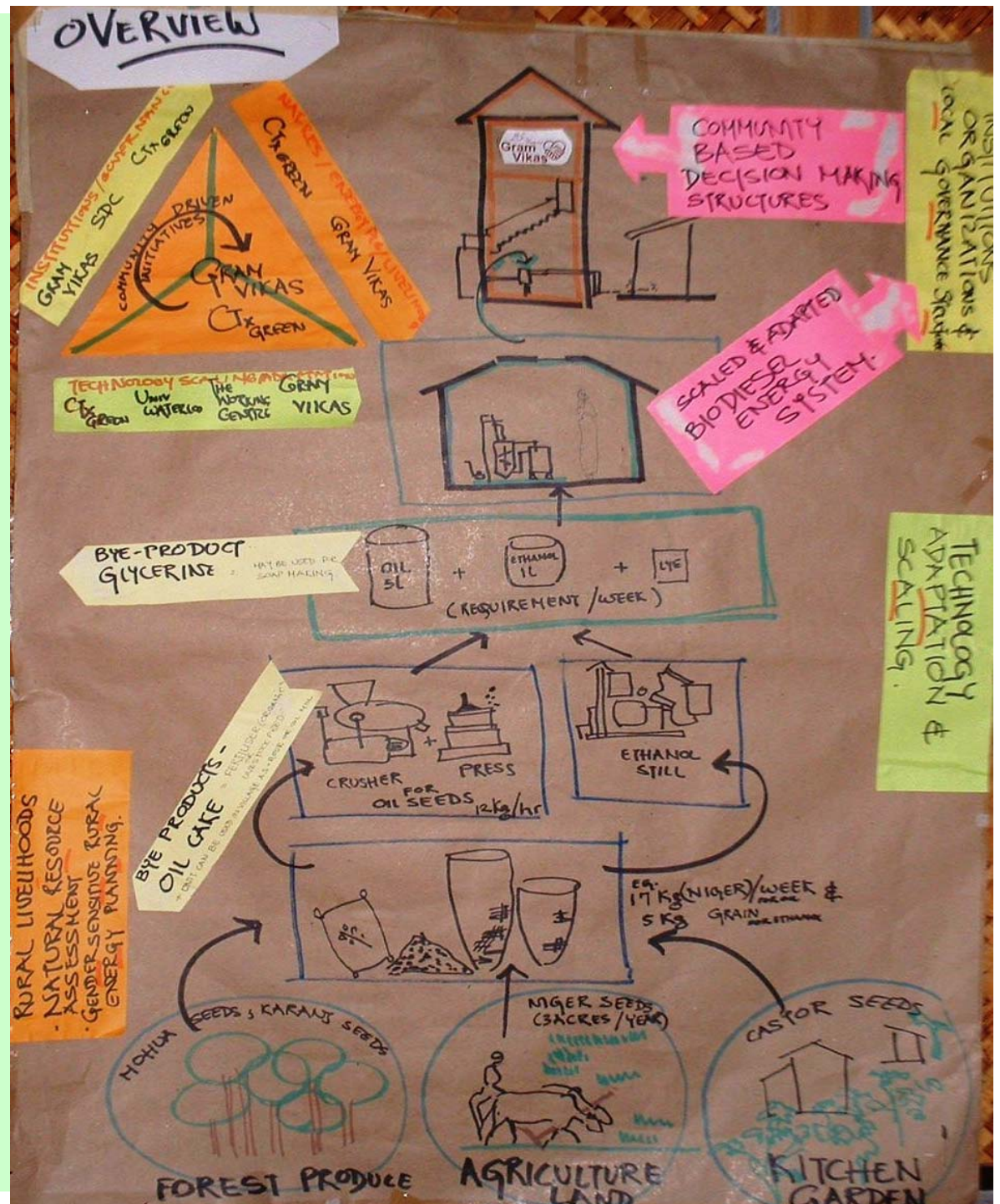
• **Reality:** After 20 months, permit to purchase ethanol and methanol not received (excise duty exemption may be another battle in itself – even though it is clear that it should not be).

• **Reality:** Laboratory grade methanol, purchased at **Rs.80/L** from laboratory chemical stockists, is being used for village-level BD production as stop-gap.

- Long term sustainability will require support to manufacture ethanol at village level using local waste feedstock (e.g. cashew fruit). Lab-proven low-energy technology available for scale-up.

### • Livelihood Opportunities

- Machines needed only 1-2 hrs weekly to make biodiesel for water pumping
- Machines available for other uses rest of time.



**Community/Institutional Structures**  
Village-Community  
Gram Vikas  
RHEP / ITDP

**Rural Energy Planning**  
Current & Future  
Energy Use Patterns  
and Livelihood Systems

**Socio-Enviro-Techno-Economic Feasibility Assessment (SETE)**

Local biomass-based

**Biodiesel Energy System**

for Rural Water supply  
and Power Generation

**Natural Resource Assessment/Monitoring**

State of Land & Water

**Technology**  
Biodiesel Energy System  
and Training

**Permits**

*Uniqueness of our approach is in the balancing of resource base issues with communities' technology needs*

**five**

**Technology is only one among ~~four~~ other aspects critical to project sustainability.**



# All our machines are human-powered



Designed for non-grid villages

- Hand-operated Oil Press
- Pedal-driven Grinder
- Pedal-driven Biodiesel Reactor

Four sets of machines are in operation:

• Two sets at the Mohuda pilot plant

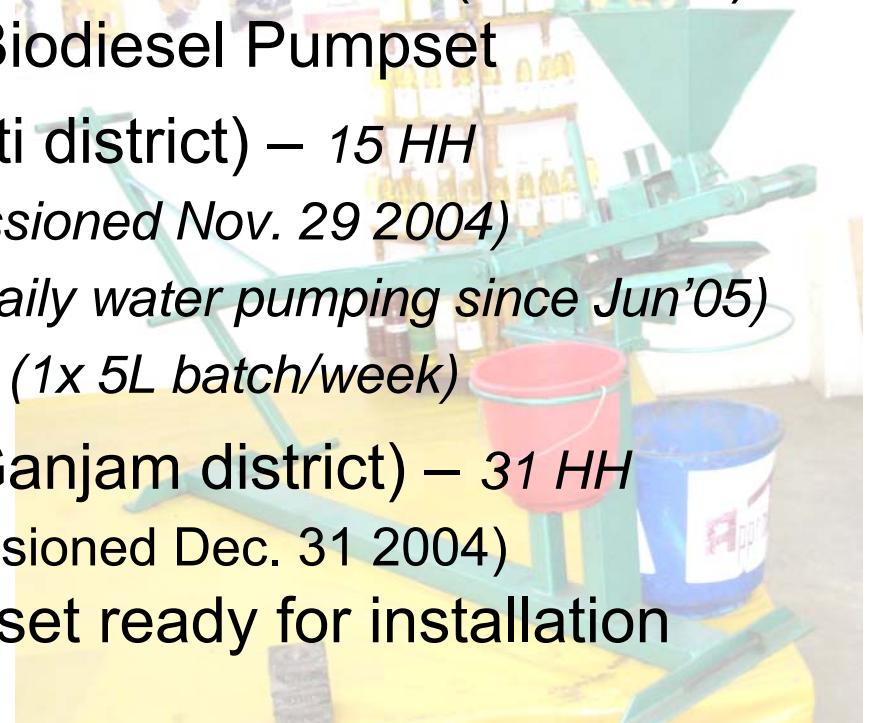
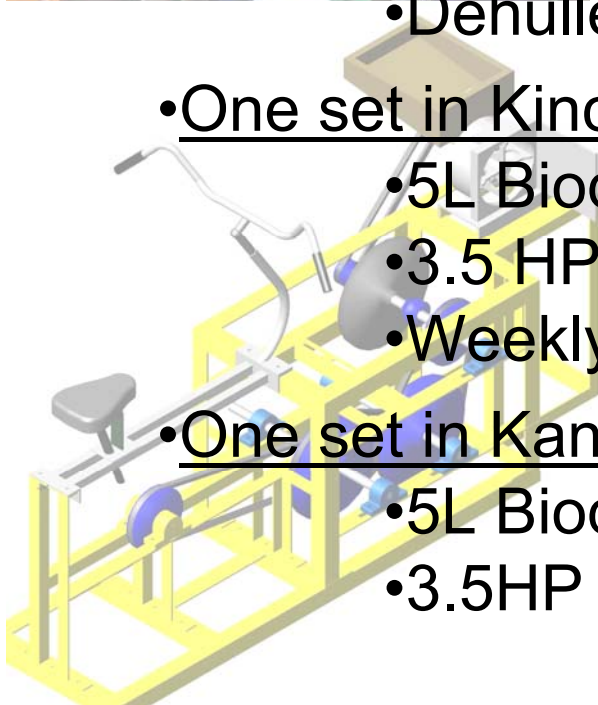
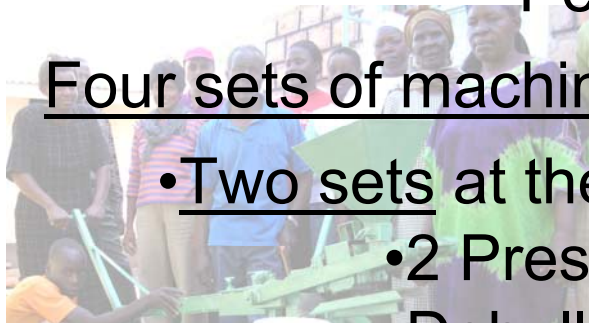
- 2 Presses, 2 Grinders, 2 Biodiesel Reactors (5L & 20L)
- Dehuller, Solar Dryer, 5HP Biodiesel Pumpset

• One set in Kinchlingi village (Gajapati district) – 15 HH

- 5L Biodiesel Reactor (*commissioned Nov. 29 2004*)
- 3.5 HP Biodiesel pumpset (*daily water pumping since Jun'05*)
- Weekly biodiesel production (*1x 5L batch/week*)

• One set in Kandhabanta-Talataila (Ganjam district) – 31 HH

- 5L Biodiesel Reactor (*commissioned Dec. 31 2004*)
- 3.5HP / 2 kVA Biodiesel genset ready for installation



# Foundation / Guiding Principles – Non-Negotiables



## Core Values of Gram Vikas RHEP are sacred

- 100% Social Inclusion (no exceptions)
- Gender equality, Capacity building
- People's contribution (to take an ownership stake):
  - *Capital Cost: unskilled labour and local materials*
  - *100% operating costs / maintenance costs*
- Capital cost recovery is not a goal
  - *Rural infrastructure is just as much as an entitlement as urban infrastructure*
  - *And where the government is not able to provide the infrastructure, Gram Vikas and partners have a role to play*
- *Quality of Life* improvement is the goal: RHEP, toilets, bathrooms and running water is only an entry point.



*Uniqueness of our approach to  
“secure biomass-based livelihoods” is in the  
balancing of resource base issues with  
communities’ technology needs*

- Participatory Rural Energy Planning
  - Current Reality – Energy use patterns in village
  - Future Aspirations – for improved quality of life
- Natural Resource Assessment
  - Forest, degraded forest and wasteland
  - Agricultural Land and Water bodies
- Training / Capacity Building
  - Participatory Technology Development
  - Resource Assessment and Management
- Participatory Livelihoods Assessment
  - Agricultural (bogodo) / Forest access practices
  - Potential to transform current reality through “biodiesel” integration

Findings from Aug.'04  
Bogodo Workshop with  
five farmer families (Tumba)

- Farmers spend 310 days/year (on ave.) on bogodo activities.
- 150 out of 310 days are spent in “shifting” related activities.

**Q.** Why not collect more NTFP seeds, press oil (get oil cake) to enhance soil nutrition, and avoid “shifting” (*slash & burn*) ?

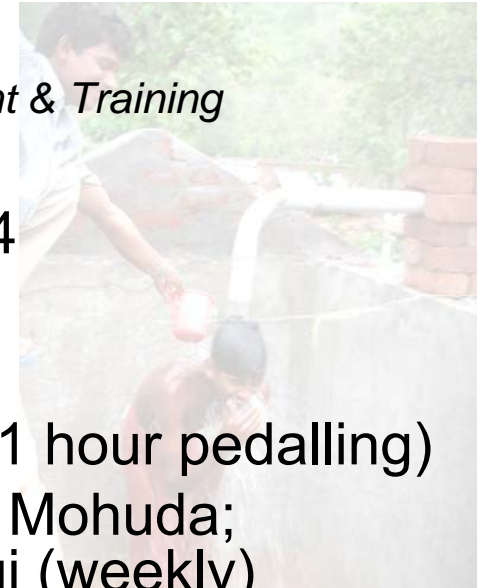




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## **Kinchlingi – Technology Pilot Village**

- Villagers visit Mohuda July '04 - *Participatory Tech Development & Training*
- 5L BD reactor commissioned Nov. 29, 2004
- Weekly 1x5L batches of Biodiesel production Dec 2004
- 3.5 HP biodiesel pumpset commissioned Feb 5 '05
- Daily Water Pumping since May-Jun 2005
- Regular weekly 1x5L BD production since June 2005 (1 hour pedalling)
- Village level foreperson trained in Mohuda (4 weeks in Mohuda; pumpset and bicycle maintenance training) & Kinchlingi (weekly)
- 2 Villagers trained on day-to-day operation of diesel pumpset
- Niger/castor cultivation (2 acres) started August 2005 to compensate for shortfall in seed availability in surrounding forests.
- Integration with watershed, plantation and agronomy issues to begin over the next few months
- Grinder, Press installation pending completion of trials at Mohuda
- Volunteer-driven ownership model taking shape (sweat equity provided by all 15 families in the village; SHG to collect/process seeds)





*Uniqueness of our approach to “secure biomass-based livelihoods” is in the balancing of resource base issues with communities’ technology needs*

## **Kandhabanta-Talataila – Rural Energy Planning Pilot in Twin-Villages**

- Village meetings Mar-July '04 – *Mobilizing SHG members to take up IGA*
- Energy Survey Planning Survey Jun-Oct.'04
- Technology Demonstrations & Exposure Visit to Mohuda – Oct.'04
- SHG/Institutions Workshop & Energy Planning Workshop Nov.'04
- 5L BD Reactor commissioned Dec.31'04 (1 hour pedalling per 5L batch)
- Weekly 1x5L batches of Biodiesel Production / Training Jan.'05
- Forest survey / Natural Resource Assessment w/VSS Dec.'04-Apr.'05
- Village level foreperson trained in Mohuda (4 weeks in Mohuda; genset, pumpset and bicycle maintenance training)
- Niger/castor cultivation (5 acres) started Aug.'05 to compensate for inadequate seed availability in surrounding forests. (Poor yield in 2004)
- Grinder, Press installation pending completion of trials at Mohuda
- 3.5HP 2kVA biodiesel genset ready for installation
- SHG ownership model taking shape (BD prod'n: *viable thriving Income Generation Activity – improved quality of life - members & community*)
- Specific roles are evolving for SHG, VSS, JFM, Village Committee





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## **Tumba – Holistic Approach to Cluster Level Implementation (900m el.)**

- Recruitment/Training of Villagers for Forest Surveys – June 2004
- Forest Resource Assessment in Burataal slope – July-Oct.'04
- Random point forest survey in Raikhal slope – Oct.'04
- Identification / Herbarium mounting of species collected – Jul.-Dec.'04
- Baseline data Report + Monitoring plan – Nov.-Dec.'04
- Understanding “bogodo” agriculture in Tumba – Aug.25-27'04 workshop
- Ethnobiological Survey (lifestyle/habits) in Burataal & Raikhal
- Biodiesel tree species of interest identified
- Counting of trees of interest in Burataal & Raikhal – Jan.-Aug.'05
- Training of Kandhabanta-Talataila VSS – Jan.'05
- Land-use/Land-cover study of Tumba (remote sensed image analysis, validated using “ground truth” data) – Dec.'04-Apr.'05
- Secure Livelihood Planning Workshop with Tumba staff – Mar.3-4'05
- Strategic 5-year Plan for Biodiesel in Tumba: Jun.6-9'05
- Recruit Village Level Trainee to apprentice at Mohuda: Oct.-Nov.'05

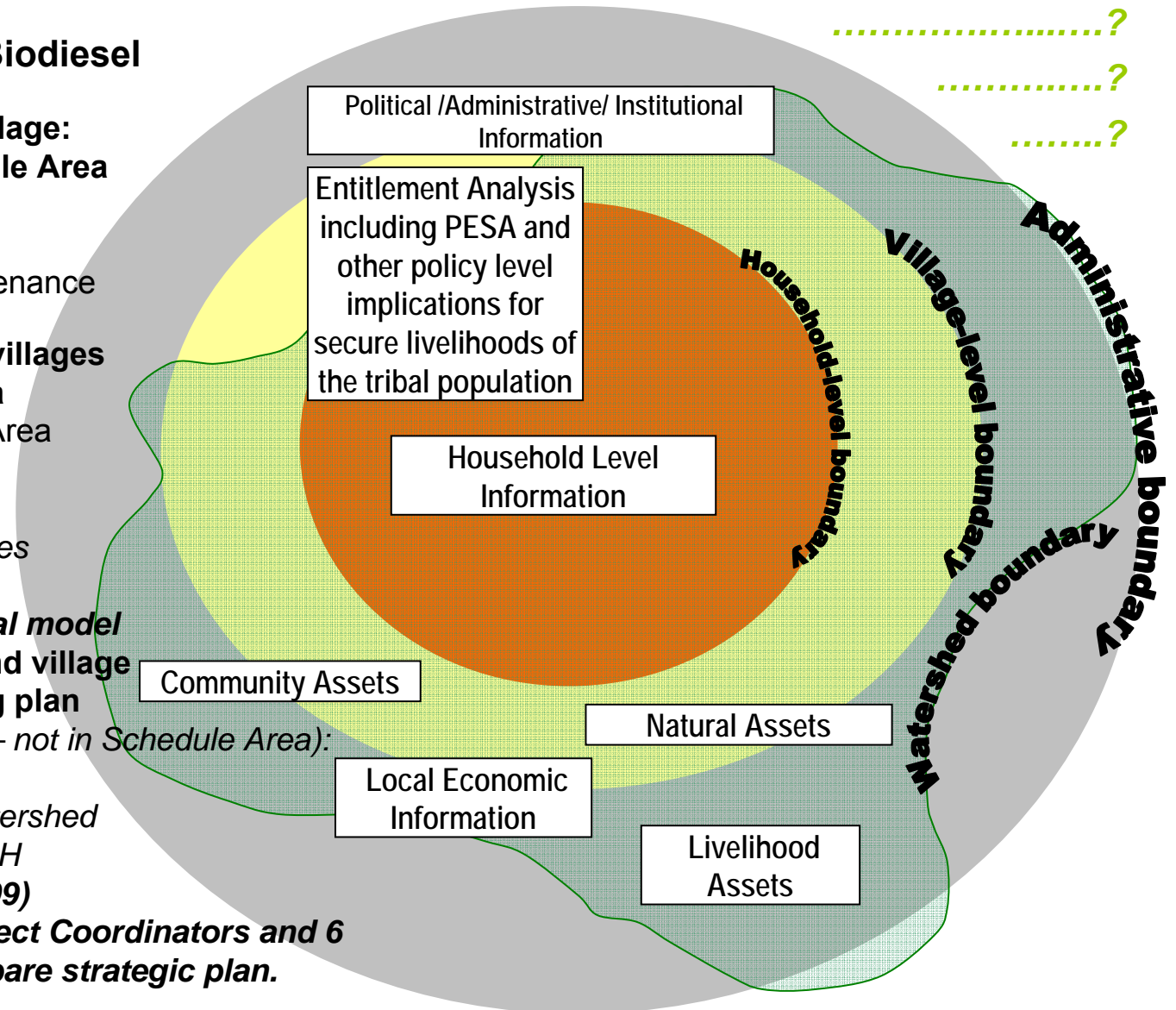
# Socially-responsive Environmentally-friendly Techno-Economic Feasibility



How to reflect in model: *improved “net cash flow” and community well-being?*  
*increased “local value addition” – monetary as well as natural resources?*

## THREE Management Models for Biodiesel

- **Volunteer-driven model for single village:**  
**Kinchlingi - tribal village in Schedule Area**  
*Interesting possibilities through PESA*  
 15 households; each family provides “sweat equity” for m/c oper’n. & maintenance
- **SHG-driven model for a cluster of 10 villages**  
**Starting with Kandhabanta-Talataila**  
 2 All-tribal villages – not in Schedule Area  
 31 Households in KB-TT  
 Over 300 Households in cluster  
 JFM is well entrenched in these villages  
 VSS and the VC will play active role
- **Watershed approach – entrepreneurial model**  
**Tumba: Started w/detailed forest and village surveys, baseline data + monitoring plan**  
*Two major clusters (all-tribal villages – not in Schedule Area):*
  - *Burataal cluster - 16 villages*  
 538 HH, 2289 pop., 600 ha watershed
  - *Raikhal cluster - 8 villages, 157 HH***Five-year plan developed (2004-2009)**  
**4-day workshop - 8 Gram Vikas Project Coordinators and 6 cluster staff visited all BD sites to prepare strategic plan.**







## Technical, Community-level and Legal Challenges

### Frequently Expressed Doubts

- Village-level small-scale Biodiesel cannot be done – too complex.
- Villagers cannot be taught to operate machines and pumps. Machines will breakdown and people will not know how to repair them. And soon it will all be mothballed.
- Villagers will not want to work hard. They are lazy and will want things given to them for free. They will lose interest in being self-reliant very soon.

### Our Responses

- It can be done and tribal people are doing it.
  - weekly BD production
  - daily water-pumping
  - ongoing for the last four months in Kinchlingi (Jun.'05- ).
- Training, well-defined recipes and SOP's are the key:
  - Trained staff at Mohuda/Proj. Off.
  - Trained village foreperson
  - Trained villagers and back-up foreperson (shadows)
  - Motivated SHG members
  - Well-illustrated user and maintenance manuals, and certification programs essential.



## Technical, Community-level and Legal Challenges

### Frequently Expressed Doubts

- It will be difficult to ensure quality control of the biodiesel produced in the village.
- Villagers cannot be trusted to follow instructions and recipes. Too much of this or too little of that, and you will be putting soap into the diesel engine and it will be ruined in no time.
- Dangerous chemicals in the village is a safety and health hazard.

### Our Responses

- Exposure to what could go wrong when Recipes and Standard Operating Practices are not followed properly is critical. Awareness comes with education, Safety follows. No children allowed in biodiesel room.
- Train the foreperson to take charge, maintain log-books and stock registers – accountability.
- Maintain strict quality control by getting biodiesel samples to Mohuda lab for testing. Monitor weekly/monthly production logs.





## Technical, Community-level and Legal Challenges

### Community-level Challenges

- Not enough seeds in the forests around the village
- Not enough working capital to purchase seeds (seasonal availability)
- Cash needed to purchase ethanol and methanol (only real cash outflow from village)
- Once collection/cultivation takes root, traders will come and offer more money for them, and there will be nothing available for biodiesel

### Responses

- Supplement with niger crop (not being a common crop in Gajapati, no market at present).
- Purchase seeds, or barter, from neighbouring villages.
- Operating cost funding was budgeted for 4 months. Must plan for future Working Capital.
- Will the villagers not know to protect the goose that lays the golden eggs? Meeting one's own needs should come first.



# Technical, Community-level and Legal Challenges

## Technical Challenges

- Remote location, difficult to purchase materials and parts
- Inadequate fabrication facilities around Berhampur
- Machines not comfortable to operate (or too difficult)
- Adjustments are too complicated.

## Responses

- Order materials and parts from larger cities – plan ahead.
- Get into collaboration with fabricators in Chennai, Mumbai
- Participatory Technology development with villagers (users) has helped improve designs.







## Technical, Community-level and Legal Challenges

### Technical Challenges

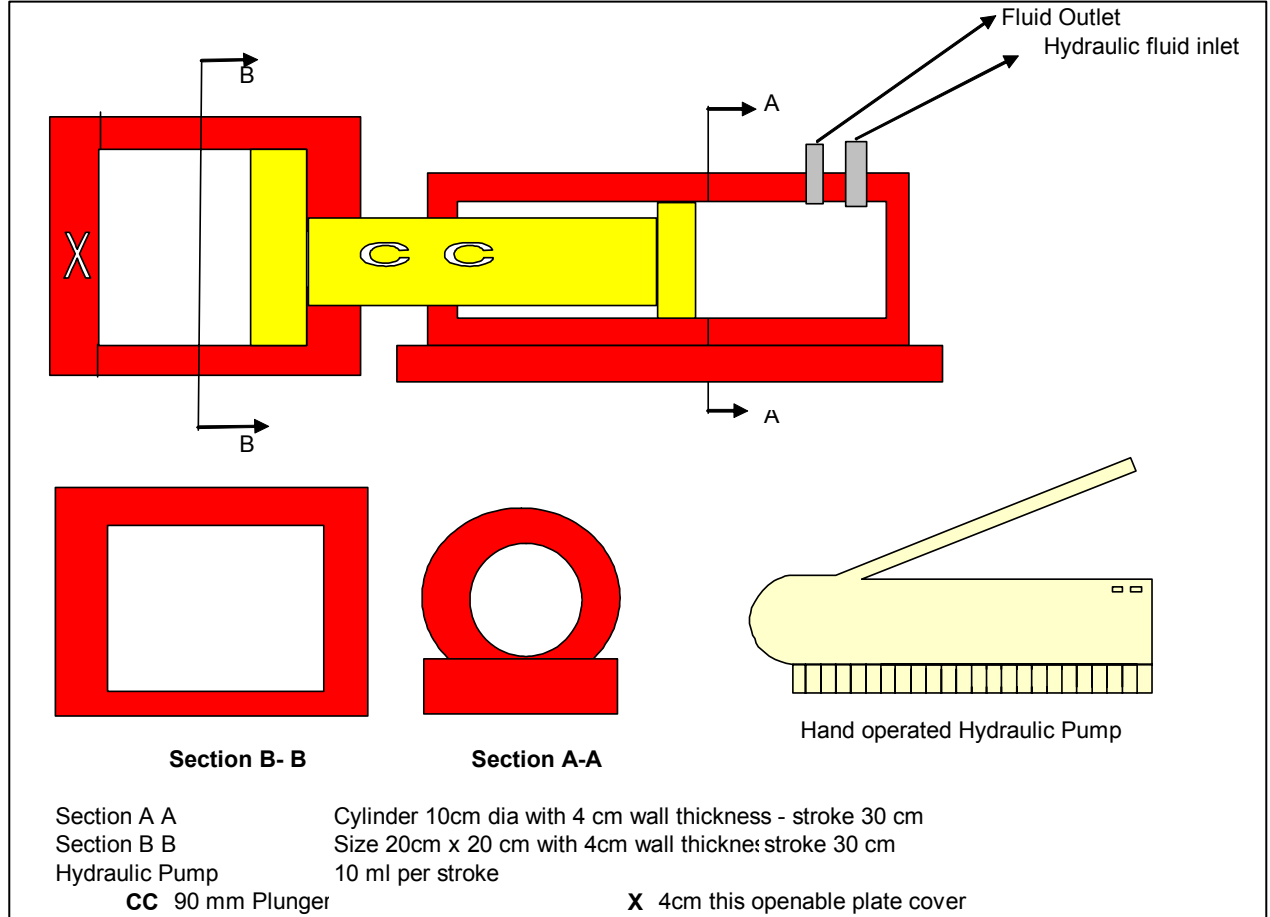
- Oil Press design very cumbersome to operate, and productivity (kg/h oil) is poor. Initial Pilot Plant trials showed promise for higher productivity with larger 180 mm dia. cylinder.

### Responses

- Press was mounted on a raised platform, worm wheel and gear were included. Trials in a 120 ton hydraulic press helped identify min. pr. needed for diff. oil seeds.
- Design briefs led to hydraulic press designs from consultant/ fabricators; (high cost! no guarantees on productivity).
- Sep 3: We purchased the Mafuta Mali Press from KickStart (formerly ApproTEC), Kenya after initial trials. Hand-operated 2.5-3.5 kg/h oil press. Adapting the press to local seeds is ongoing.



Original 51OP  
press on a  
foundation  
with worm  
attachment.  
Hydraulic  
press to the  
right



Schematic of a horizontally-aligned hydraulic press, with some amount of automation on the press-hold-release cake cycle. Cycle time improvement was predicted but couldn't be confirmed. We were not willing to enter into another "round" of pilot testing an untested, higher cost oil press.





Meeting User-group in Kisumu: Multi-Purpose Project  
Sep 2, 2005



Sunflower  
seed cake  
makes fine  
poultry  
feed



Niger, Karanja and Tullu oils  
pressed in Nairobi



Twin Oil Filters in Stand



Initial trials in Nairobi – Aug 29-31, 2005



KickStart's Press Cage

Modified cage fabricated per  
our design/specs. at  
KickStart: Aug 31-Sep 3







# Technical, Community-level and Legal Challenges

510G  
original



Purchased



## Technical Challenges

- Original Planetary Hammer design for grinder was noisy. Also jammed frequently with grinding (softer) tullo seeds due to too fine a clearance between hammer and housing.
- Longer duration trials to establish true kg/h throughput revealed real shortcoming of drive: comfortable pedalling cannot be sustained for over 5 minutes.

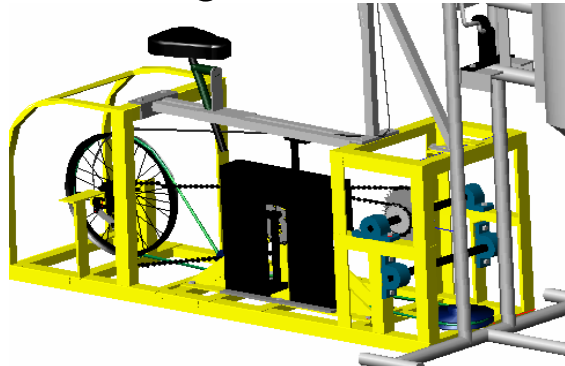
## Responses

- Don't re-invent the wheel. Pin-wheel pulverizers were commercially available in the market. One of these was purchased in Mumbai and fitted to our drive. Practically silent, much less effort to pedal.
- Losses in belt drive are high. Brainstorming with fabricator/consultant has resulted in a promising alternative (modelling shows much lower losses). Fabrication will follow soon after finalization of designs.



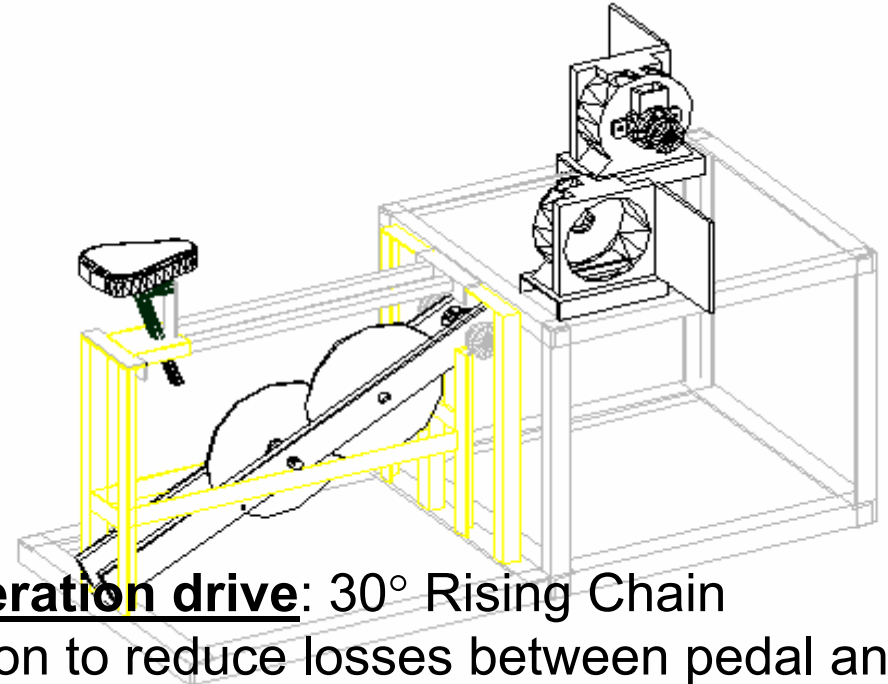
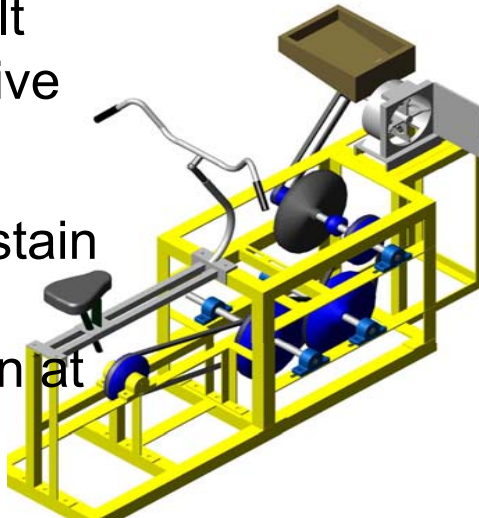
# Grinder – the Next Generation drive

Original bicycle-drive that is the heart of our first three 5-litre Biodiesel reactor systems: 51BD, 52BD and 53BD in Mohuda, Kinchlingi and Kandhabanta-Talataila.



Original V-Belt and Pulley drive for grinders.

Difficult to sustain >5min of pedalling even at low RPM's.



**Next Generation drive:** 30° Rising Chain configuration to reduce losses between pedal and drive-pulley. Next-Gen drive is designed to replace the belt-based drive used in the 51OG and 52OG grinders (where pedalling is barely sustained for more than a few minutes; or drive-rpm is inadequate). Next-Gen drive may also be suitable for use with Biodiesel reactors (w/vertical take-off). The NextGen drive will be simpler to maintain.





# Technical, Community-level and Legal Challenges

## Technical Challenges

- Locally available tullo seed oil has high Free Fatty Acid (FFA) content, which results in
  - Poor separation between biodiesel and soap/glycerin
  - Low yield of refined oil from raw oil (*i.e.*, low biodiesel yield)
- Niger oil has lower FFA than tullo,
  - But, even fresh niger oil has 2-4 times the free fatty acid content of commercial refined oils
  - FFA of “aged” oils is even higher

## Responses

- Village level BD production continues with refined oils pending the finalization of recipes with local oils in the Mohuda micro-pilot plant and laboratory.
- Systematic micro-batch trials to improve the separation, and yield are ongoing. Successful conversion of high FFA-oils into biodiesel is possible. The challenge is in deploying processes that can be easily replicated at village level.



# Technical, Community-level and Legal Challenges

## Technical Challenges

- Stock of glycerin byproduct is increasing at the rate 500-700 g/5L batch. What value-added uses can we find for these?
- Much larger quantities of oil cake has also been stockpiled in the pilot plant and in the villages. Initial tests have shown that all the seed cakes (niger, karanja, tullo, castor) are suitable for use as fertilizers. What are the likely benefits and uses from different varieties of oil cakes?

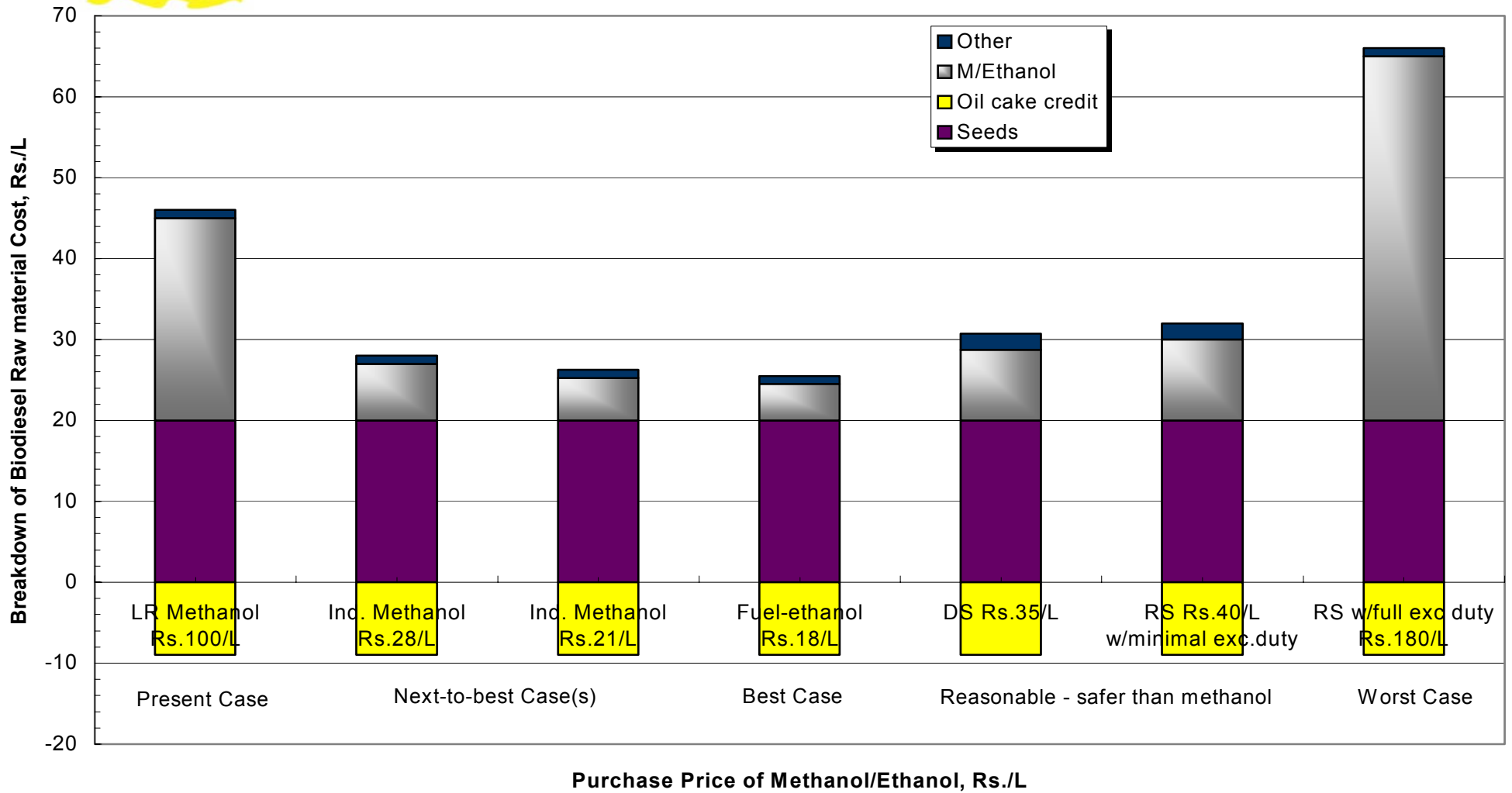
## Responses

- While soapmaking is a possibility, we are short of people resources for process development at the pilot plant (conversion of tullo & niger oils to BD is more critical). Use of glycerin as compost catalyst is to be tested at the GV Mohuda farm .
- Proposals have been prepared for testing various options for oil cake: feedstock for biogas (1 cu.m.) and compost; as fertilizer in raw, composted form or as slurry from biogas effluent. Mohuda farm proj.





### Sensitivity of Biodiesel Raw Material cost to the purchase price of Methanol/Ethanol



**Note:** Costs shown above are purely raw material costs (lye is included under “other” costs). Credits are given for oil cake only at this time, credits must be extended to glycerin (after finding suitable local uses) to further reduce unit costs of biodiesel...



# Technical, Community-level and Legal Challenges

## Technical Challenges

- Purchase of methanol from laboratory chemical stockists is not going to be cost-effective. Cash for methanol and ethanol purchases will be the single largest “cash-outflow item” and must be reduced.
- Currently, as a stop-gap arrangement until the government of Orissa issues permits to purchase alcohol (ethanol, methanol, RS and DS), we are purchasing methanol in 30L batches from laboratory chemical stockists at Rs. 80/L. Cannot be sustained.
- Long-term Policy Support needed

## Responses

- First letter regarding this permit to purchase was submitted in May 2004. The wait continues after several meetings with the authorities, including a recent meeting with the Hon. Minister of Excise and Tribal Development.
- A proposal for funding support for a legal and policy issues study was submitted to the SDC/IC-NRMPO. Study was carried by ELDF, and excerpts of the study are presented. A study dissemination workshop is planned.



# A Study sponsored by the SDC/IC – PSU ISNRMPO

Swiss Agency for Development and Cooperation/Inter Co-Operation - Programme Support Unit  
Indo-Swiss Natural Resource Management Programme Orissa



## Full Title of Study

“A study on the policy and legal issues governing tribal access and rights over natural resources (including value addition) in the context of the 73<sup>rd</sup> Constitutional Amendment and PESA with particular reference to the use of ethanol for small scale biodiesel fuelled energy systems in tribal Orissa”

### A Case Study:

*Legal Feasibility of  
the Carbon-neutral  
Biodiesel Project  
for Rural Energy  
Needs in non-grid  
Orissa villages*

### Study Conducted by

Sanjay Upadhyay



Enviro Legal Defence Firm, Noida, UP

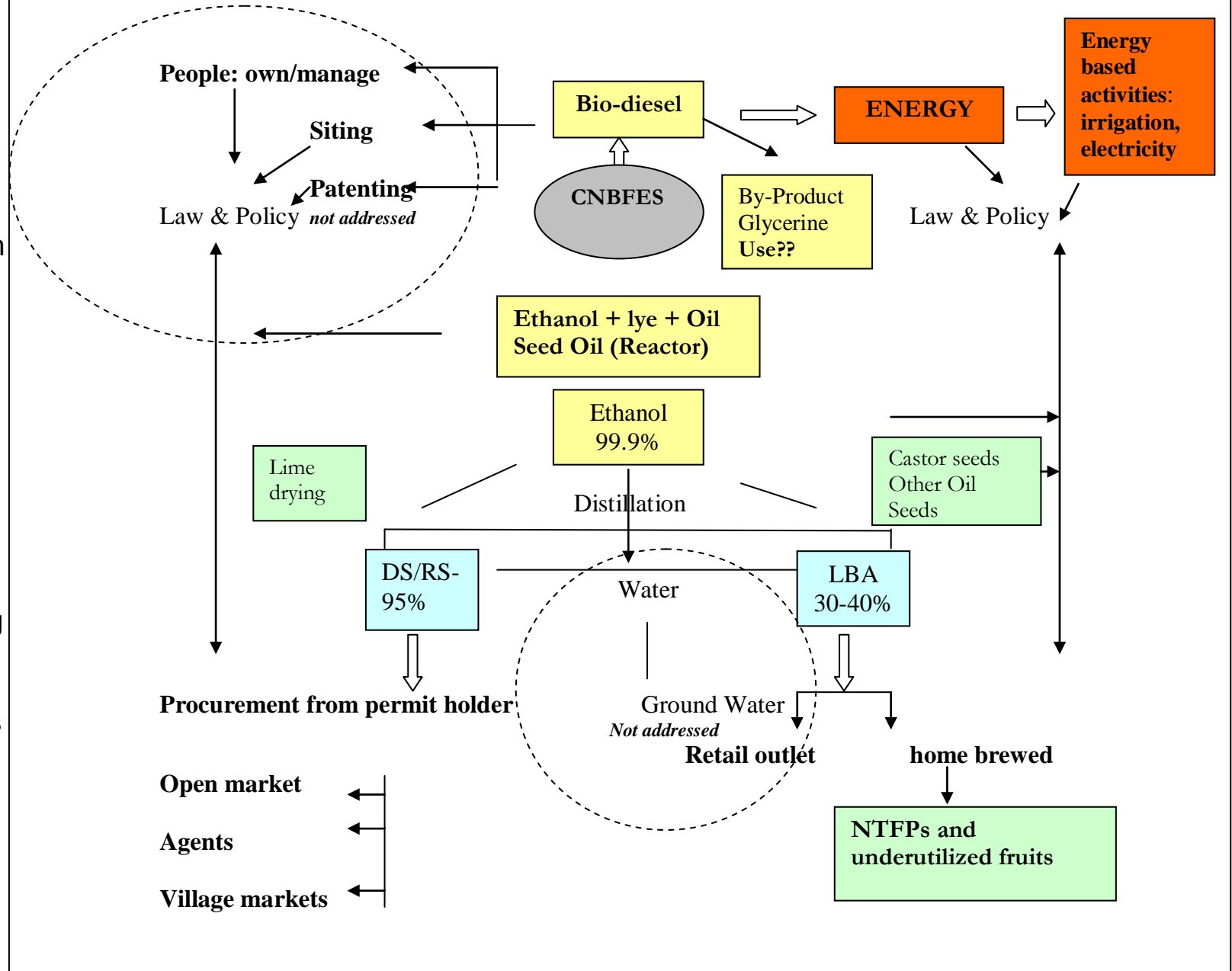
Draft Report is ready.

A dissemination workshop with key stakeholders, including different levels of governments, is planned for Jan/Feb 2006. You are invited.





### LEGAL & POLICY IMPERATIVES FOR Carbon-neutral Biodiesel PROJECT



A flow chart excerpted from the study shows connections between (a) the legal regimes governing tribal rights of access to forest produce, and to manufacture alcohol for bonafide consumptive uses, and (b) unhindered long-term replication of the product and process, while staying in conformance with the basic legal regime governing various aspects of the biodiesel project.

The flow chart also identifies aspects considered within scope and out-of-scope of the study undertaken.



## Excerpted Conclusions & Recommendations from the Legal Feasibility Study



- While a number of recent policy initiatives have been adopted by the government to encourage biofuels development for the transport sector, the “*carbon-neutral biodiesel-fuelled energy system*” seeks to ensure tribal energy self-sufficiency, particularly in regions where grid extension may be difficult, or supply is intermittent and/or unreliable.
- If bonafide rural energy programs such as biodiesel are to be supported, there may be a reason to look at Excise and Forest laws differently.
  - Excise laws do not mention the use of ethanol/methanol for biodiesel manufacture
  - National and State-level policies on biodiesel are still in the making
  - While import and transport of intoxicants (including methanol and ethanol) attract the provisions of excise laws, there may be two possibilities that can be applied to advantage to facilitate rural-biodiesel initiatives, viz., Exceptions provided under the Medicinal and Toilettries Preparations (Excise Duties) Act and the Exclusive Privilege Clause to obtain exemptions on duties.
  - Most importantly, in spite of using methanol and/or ethanol as a raw material, biodiesel as a product or commodity does not contain any alcohol.
  - Duties on rectified spirits (RS), a potential ingredient in the manufacture of biodiesel, have been exempted for Government institutions and departments as specified by the state.
  - the State has the power to exempt ‘specified’ educational institutions, firms for any scientific or industrial purposes other than preparation of commodities which when made will themselves contain alcohol -- fits the case of biodiesel
- An institutional change or a strategic partnership with government institutions or departments may be required.



## **In closing, a few open questions seeking policy directives and support**

- **Small-scale Biodiesel manufacture for rural energy applications:**
  - Does it not fall outside the purview of excise laws?
  - To qualify for special provisions, as needed, particularly in light of the benefits in tribal energy security in areas where grid extension may not be an option, what additional partnerships (or institutional changes) are needed?
- **What are the implications of waiving duties?**
  - approximately Rs.10,000 per village/year in waived excise revenue loss is not significant compared to the benefits (avoided costs of grid extension apart).
- **What are the legal and policy directives for village level manufacture of suitably denatured ethanol, from local waste fruits?**