Energizing Sustainable Livelihoods

A Study of Village Level Biodiesel Development in Orissa, India

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The present worldwide scenario is one of land-based livelihoods that are increasingly vulnerable to the impacts of climate change. While being committed to environmental goals, India's National Action Plan on Climate Change released in 2008, reaffirms that maintaining a high growth rate is essential to raising the standard of living of the people. Curbing emissions while maintaining high growth rates and achieving the Millennium Development Goals without increase in fossil fuel consumption, both appear to be paradoxes.

Community-based micro energy initiatives have the potential to support productive development without fossil fuel consumption. This study examines small scale, village level biodiesel production for local use, based on unutilized and under-utilized, existing oil seeds in remote rural locations in Orissa, India. The village level biodiesel model is a response to large agro-industrial models that promote plantation of energy crops like jatropha, and to centralized production of biofuels as an alternative to petrodiesel. Village level biodiesel adds value to the large quantity of locally unutilized forest seeds and underutilized short duration oilseed crops like niger that are exported as birdfeed, to fuel livelihoods and boost the local economy. The development of a village level biodiesel model in a participatory manner within an agroecosystem boundary, and its ability to catalyze livelihoods that are sustainable, have been analyzed. Participant observation techniques have been used to develop narrative case studies for three village communities. Methodology for the study is based on Participatory Action Research approaches (Kemmis *et al*., 2000), where the research process has contributed to community action. The Sustainable Livelihood approach forms an important foundation of this research. A conceptual framework adapted from the original Sustainable Livelihood Framework (Scoones, 1998), to include Complex Systems Thinking (Holling, *et al*., 1995, Kay, *et al*., 1999) was used to analyze case studies in two communities of Orissa, India. Informed by results in the first two case communities, the same framework was used to develop a livelihood strategy based on Village Level Biodiesel (VLB), in a third cluster of villages also in Orissa. Three additional inclusions are proposed as a result of the research, to address some gaps in the original framework. These are the concepts of (1) Entitlements (Leach, *et al*., 1997) to understand power structures, (2) Adaptation Continuum (McGray 2007) to include issues of climate impacts and (3) Rural Livelihood System (Hogger, 2004) as a complex whole relating the inner reality of the farmer to the outer reality of a swiftly globalizing world. Resilience of livelihoods was identified as a key outcome parameter. Three main considerations for assessing sustainability and resilience of livelihoods, as defined by this research are (1) potential for livelihood diversity and intensity, (2) connectedness of the institutions involved in the decision making process, and (3) adaptation – that is resilience of livelihoods in terms of their capacity to resist drivers of vulnerability and confront impacts of climate change.

The VLB in Orissa approaches livelihood diversity and intensity through a three-pronged approach consisting of biodiesel fuelled livelihoods, sustainable agriculture and local value addition. Careful attention is given to the specifics of the context in designing the VLB, thus enhancing the adaptive capacity of the technology. In the context of India, with the devolution of power to the local level, the Gram Sabha, or the village governing council, has political powers and the ability to negotiate with the State because of the authority vested in it by the 73rd amendment to the Constitution of India, and can additionally regulate the market at the local level. Leveraging the powers of this entity may provide the VLB with the needed impetus to replicate and move beyond pilot implementations. Obstacles in the implementation and strategies to overcome these have been identified. The challenge to future research and action is to span regional, national and global levels to influence policy makers to take cognizance of and promote the VLB as a viable development alternative to agro-industrial models designed to generate transport fuel.

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The project that I describe in the thesis was a journey that Ramani and I launched into, on a 'rudderless boat.' Both of us knew the general direction that we were heading in but had no specific 'personal' goals. The journey was the goal and traveling together was the purpose. To that effect this process has been very fulfilling, until the last lap, *in the writing* of the thesis. The writing became very ritualistic and for a person like me, who finds it hard to be blinkered and constrained, a very difficult process. Over the last 4 months, writing became like breathing, a constant act interrupted by a few hours of sleep. I am grateful for the support and reining-in I received during my intense four-month writing exile in Canada.

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Dedication

This work is dedicated to Rajendra Bisoyi.

He showed his spark and promise as the keeper of the technology, and then stole away, reminding us of the illusory nature of life.

He will continue to inspire us to search for such sparks in remote villages, where going to school is a privilege, to enjoy learning a divine blessing and a luxury.

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List of Abbreviations

AC	Adaptation Continuum
ALCS	Action Learning Case Studies
CBNRM	Community-based Natural Resource Management
CDC	Civic Driven Change
CFL	Compact Fluorescent Lamps
CNBFES	Carbon Neutral Biodiesel-Fuelled Energy Services
CTx GreEn	Community-based Technologies Exchange, fostering Green Energy partnerships
EEA	Environmental Entitlements Analysis
ENERGIA	International Network on Gender and Sustainable Energy
FAO	Food and Agricultural Organization
FDA	Forest Development Agency
FIAN	Food First Information and Action Network
Genset	Generator set
GV	Gram Vikas
HBF	Heinrich Boell Foundation
HYV	High Yielding Varieties
ICA	The Canadian Institute of Cultural Affairs
IDRC	International Development Research Centre, Canada
IGA	Income Generation Activity
IMR	Infant Mortality Rate
IPCC	Intergovernmental Panel on Climate Change
IOC	Indian Oil Corporation
ITDP	Integrated Tribal Development Program
JFM	Joint Forest Management
JITM	Jagannath Institute of Technology and Management
KBTT	Kandhabanta Talataila (twin villages)
kWh	kilo Watt hour
LED	Light Emitting Diodes
LISS	Linear Imaging and Self Scanning Sensor
MANTRA	Movement and Action Network for Transformation of Rural Areas
MDG	Millennium Development Goals
MSSRF	MS Swaminathan Research Foundation
NABARD	National Bank for Agricultural and Rural Development
NAPCC	National Action Plan on Climate Change
NGO	Non Governmental Organization
NPK	Nitrogen, Phosphorus, Potassium
NREGA	National Rural Employment Guarantee Act
NRM	Natural Resource Management
ODAF	Orissa Development Action Forum
OERC	Orissa Electricity Regulatory Commission
PESA	Panchayats Extension to Scheduled Areas
PISCES	Policy and Innovation System for Clean Energy Security
PLA	Participatory Learning and Action
PRI	Panchayati Raj Institutions
RGGVY	Rajeev Gandhi Grameen Vidyutkaran Yojana (Rural Electrification Program)
RHEP	Rural Health and Environment Program
RLS	Rural Livelihood System
SC	Scheduled Caste
SEA	Strategic Environmental Assessment
SHG	Self Help Group
SL	Sustainable Livelihoods
SLF	Sustainable Livelihood Framework
SLF for VLB	Sustainable Livelihood Framework for Village Level Biodiesel
ST	Scheduled Tribes
SVO	Straight Vegetable Oil
UNFCCC	United Nations Framework Convention for Climate Change
VEC	Village Executive Committee
VLB	Village Level Biodiesel
VSS	Van Suraksha Samiti (Forest Protection Committee)
WBDM	World Bank Development Marketplace
WCED	World Commission on Environment and Development
WISIONS	Initiative of the Wuppertal Institute of Climate, Energy and Environment

SECTION I

Introduction

Progress happens fastest when a new discovery or a new idea generates a new way to tackle an old problem.

Bill Gates while receiving the Indira Gandhi Peace Prize for 2007 (July 26, 2009)

1. Introduction: Village Level Biodiesel model

When production and consumption both become localized, the temptation to speed up production, indefinitely and at any price, disappears.

Mahatma Gandhi on village development and economics

Chapter Summary: "Can the development of a grassroots biofuel-based strategy catalyze livelihoods that are sustainable?" If so, "what are the challenges to such a strategy and how do we address them?" These are questions that this research addresses by studying the development of the Village Level Biodiesel (VLB) in three communities of Orissa, India. The project, Carbon Neutral Biodiesel-Fuelled Energy Services (CNBFES) is being implemented by the Canadian NGO, CTxGreEn with its Indian NGO partner, Gram Vikas. CNBFES attempts to strengthen linkages between the community with the State and the Market, through the medium of VLB. VLB has the potential to bridge the macro and micro by being a means to fuel livelihoods at the micro level while limiting CO_2 emissions at the macro level. The current research traces the development of VLB in two communities and assists the development of a participatory livelihood strategy in the third community, all in Orissa, India. The research has provided inputs to the CNBFES project, which is focused on ground realities of implementation through action research.

1.1. Background

On the 12th of June 2009, 9300 tonnes of biodiesel was flagged off from the Indian port of Vishakapatnam, in the state of Andhra Pradesh. The consignment was bound for Spain. Cleancities Biodiesel India Ltd. has a capacity to produce 273,000 tonnes of biodiesel per annum and is capable of producing biodiesel conforming to European and American standards. Palm and soya, both edible oils, are the feedstock[1] in addition to jatropha, which is non-edible oil. The unit is located in Vishakapatnam's Special Economic Zone (Hindu Bureau, 2009), and benefits from liberal economic laws.

Just about 200 kms north of Vishakapatnam, in the neighboring province of Orissa, Kinchlingi is a 15-household village that has been producing and using biodiesel since 2004. The micro energy initiative was initially used to pump water for drinking and sanitation and subsequently for providing home lighting. In Kinchlingi, over 2 million litres of water was pumped over three years using 450 litres of biodiesel in a regular diesel pump set. The biodiesel conformed to European and American standards, but more importantly to the specifications of the diesel pump set manufacturer, ensuring that there is little wear on the machine. Niger, an indigenous oilseed with a 120-day growing cycle, is more typically exported to North America as bird feed. In this case it is grown by the community and used to make biodiesel. The oilseeds are locally pressed and the oil converted to biodiesel. The remnant oil cake is used as an organic manure and as livestock feed. The nutrient is thus retained in the local carbon cycle. Biodiesel is produced in a 5 litre pedal-driven machine, (capable of producing 10 litres per day and a minimum of 3000 liters per annum), with a total capital investment of less than USD 1000. (Vaidyanathan & Sankaranarayanan, 2007; 2008)

Comparison between these two biodiesel scenarios suggests a discussion on economies of scale (Sawyer, 2007; Mazza, 2008), or food-fuel conflicts (FAO, 2008; 2009; Bailey, 2007) but there is another relevant discussion which is the focus of this research. Current national policies in India and elsewhere are focused on centralized large scale efforts, most of which ignore poor farmers, their livelihoods and the agro-forest ecosystem which produces the feedstock. Initiatives that could create local self-reliance and catalyze livelihoods that are sustainable are barely identified in policy making (Korten, 2009; Henderson, 2009).

1.1.1. The global impact of Village Level Biodiesel- the link to climate change

The present worldwide scenario is one in which land-based livelihoods are vulnerable to impacts from climate change (Sathaye, Shukla & Ravindranath, 2006; UNFCCC, 2007; MOEF, 2004) and where development has to be pursued and emissions capped (IPCC, 2007; PMCCC, 2008; Sathaye *et al.,* 2006). Community-based micro energy initiatives that nurture the local resource base while fuelling livelihoods have the potential to support productive development without fossil fuel consumption (Hazell & Pachauri, 2006). Renewable energy options are considered to be a promising solution. Recognizing this, India has been implementing one of the world's largest renewable energy programs that include bioenergy (Ravindranath & Balachandra, 2009).

Bioenergy consists of a large portfolio ranging from biomass stoves and biogas, to bioethanol and biodiesel. Biofuels include biodiesel and bioethanol, both of which can be produced from feedstock that is harvested from trees or agricultural crops. The promotion of large scale plantations for energy crops has in many countries displaced food crops and threatened food security (Oxfam, 2007). However, small scale biodiesel options may serve better in protecting traditional knowledge and agricultural practices avoiding long duration energy crops that displace food production, augmenting incomes of smallholder farmers (Rossi & Lambrou, 2008; FAO, 2008), and contributing to local livelihood opportunities. Food-fuel conflicts can be also avoided when villages produce the biofuel and use it locally to fuel livelihoods, instead of exporting the feedstock to large-scale central biofuel production facilities that generally produce the fuel for transportation (Sankaranarayanan, 2009; Vaidyanathan, 2009).

Community-based biofuel initiatives that are tied to local livelihoods and agricultural practice are no doubt complex in nature and require intense efforts over longer time horizons (Dubois, 2008). However, in the long run, such approaches have the potential to enhance the capacity of the communities to adapt to change, making them more resilient (Folke, Carpenter, Elmqvist, Gunderson & Holling, 2002).

This research examines that potential in villages of Orissa, India where a community-based micro energy initiative, the "Village Level Biodiesel, VLB", has been implemented. The development of the village-level biodiesel in a participatory manner within an agroecosystem boundary, and its ability to catalyze livelihoods that are sustainable, has been analyzed.

1.1.2. Local impacts of village level biodiesel- the link to livelihoods

"We should not only work for the consumer but also for the producer," says Dr Swaminathan (2001), the father of the green revolution in India. He makes a case for working with and for the farmer. In India only a little over 40% of the total land under cultivation is irrigated, and in Orissa it is only about 37.5% (Prasad & Sindhi, 2009). Most farmers continue to depend on the monsoons and practice rain-fed agriculture. Raising the productivity of crops to achieve another green revolution, an evergreen revolution (Swaminathan, 2001) this time, will depend on a number of factors, timely inputs (water, nutrients, implements) being a major one.

Village Level Biodiesel can be a means to fuel this evergreen revolution (Sankaranarayanan & Vaidyanathan, 2009). By locally pressing available oilseeds, the community could sell oil instead of the seeds and the remnant oil cake can be used either as an organic manure or livestock feed (CTxGreEn, 2009; Mishra, Mahapatra, & Patil, 2008; CTxGreEn, 2004b). Such oil milling units could cater to local demand for edible oil and also provide oil from non-edible sources to make biodiesel (ENERGIA, 2009; Practical Action Consulting, 2009). Currently India is the second largest importer of edible oil, accounting for 15% of the global imports and 55% of the total edible oil consumption in the country (Pan, Mohanty, & Welch 2008). According to Pan *et al.*, (2008) this is half the value of India's total agricultural imports. It is a paradox therefore that edible oil is currently being imported[2] for local consumption even as edible oilseeds like niger are exported for use as bird-feed[3] instead of being locally milled and consumed.

VLB as proposed by CTxGreEn uses locally produced biodiesel to fuel small equipment, including oil expellers, tillers and irrigation pump sets. This could catalyze several local livelihoods, and edible oil and oil cake can be locally produced for local consumption (ENERGIA, 2009). CTx GreEn visualizes that with secure livelihoods based on their existing resource base, the community can be facilitated to negotiate for their rights directly with the State[4] (the political system) through the existing village council, the Gram Sabha, and with the Market[5] (economic system), which presently consists of traders and middle-men, through Federations of Self Help Groups (CTxGreEn, 2009). This is already in evidence in the case of community forestry projects in Orissa (Agarwal, 2000; Singh, 2000; Rath, 2002; P. Sathpathy, personal communication, July 1, 2008). Many forest products, originally regulated by the government and a State monopoly, have been deregulated, and are now being traded in the open market through federated groups. *This is the rationale for CTxGreEn's promotion of biodiesel as an agro-booster fuelling an evergreen revolution at the grassroots, instead of being just another renewable energy alternative for transport fuel.* This research explores the feasibility of such a proposal, first by studying the implementation of VLB in two set of villages (Kinchlingi and the twin villages of Kandhabanta-Talataila) and then by incorporating necessary parameters for a livelihood strategy in a new cluster of villages (in Tumba).

1.2. Thesis question, methodology

To summarise the discussion in Section 1.1, the central question that this research explores is, "Can the development of a grassroots biofuel-based strategy catalyze livelihoods that are sustainable?" In addition, to understand how to enable replication, the research also explores "What are the challenges that such a strategy will need to overcome and how can these be addressed?"

While there is no dearth of literature on biofuels and biodiesel *per se*, there is only a limited amount of literature on small scale applications. The Food and Agriculture Organization (FAO), concerned about the food-fuel crisis, has commissioned studies on small scale biofuel projects (Practical Action Consulting, 2009). Similarly the International Network on Gender and Sustainable Energy, ENERGIA (2009), with a focus on mainstreaming gender in energy projects, has published select case studies of biofuel applications. WISIONS (2006), an initiative of the Wuppertal Institute of Climate Energy and Environment, and premised on the Factor Four concept of de-materialization (Weizsacker, Lovins & Lovins, 1997), has prepared case studies on biofuels with a focus on resource efficiency. All the three organizations have included the

CNBFES in their case studies. An overview of these is presented in Chapter 4 with the intent of locating VLB *vis-à-vis* other similar models.

An attempt has been made to combine theoretical constructs and academic literature with voices from the community to understand if meaningful livelihoods can be facilitated using community-based micro energy systems like the Village Level Biodiesel (VLB), a ‘local-production-for-local-use’ model.

Many of the lessons and inferences in this research have been developed reflexively (Ellis, & Bochner, 2000; Kincheloe & Mc Laren, 2000). As a researcher closely involved in the project, I have been a participant observer, affecting and being affected by the research. Narratives and stories are perhaps the best way to capture this part of the research. Case studies in a storytelling mode show how the project responded to changing needs of the community. Each of the case studies includes a reflection of the narrative and my own observations, which are significant to the analysis as they allow an insider view of the issue. The methods used have been further elaborated in Chapter 2.

1.3. The CNBFES project and the Research

The village level biodiesel has been implemented in the villages of Orissa, India by CT_x GreEn in partnership with Gram Vikas through the World Bank Development Marketplace (WBDM) 2003 award targeted at “Making services work for poor people.” The project was originally the “Carbon-Neutral Biodiesel-Fuelled Energy System” (CNBFES) for rural water supply and sanitation.

The CNBFES project is being implemented in three village communities in the state of Orissa, India and has over five years, adapted to the changing needs of the community and grown into a project for fuelling livelihoods (Vaidyanathan & Sankaranarayanan, 2007; 2008; 2009). What has remained unchanged is the village scale of production and the use of local unutilized or underutilised oilseeds, both of which are features that were developed with the community through knowledge exchanges. A detailed description of the development of the village level biodiesel in two communities of Orissa is in Chapters 5, 6 and 7.

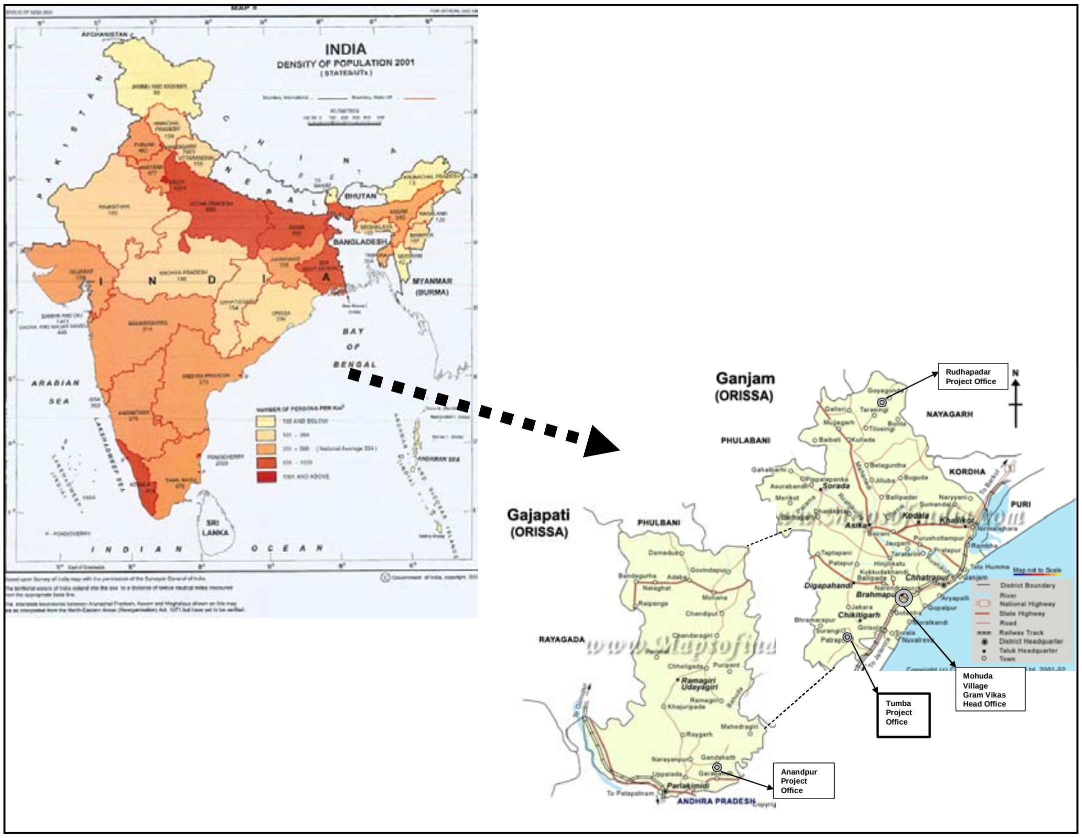

Figure 1-1: Map of India showing state of Orissa, Ganjam and Gajapati districts

The CNBFES was launched in Orissa, India in February 2004 as the Gram Vikas-CT$_x$GreEn Biodiesel project. GramVikas is a voluntary sector non-governmental organization that has been working in Orissa for over 30 years through its integrated tribal development program and the rural health and environment program. Construction of washrooms is the focus of their current integrated habitat development program, also known as Movement and Action Network for the Transformation of Rural Areas (MANTRA) (www.gramvikas.org). Gram Vikas has fast-tracked its original target of building washrooms in 100,000 households in the state by 2020 to 2010, and is pursuing the target on a war footing. To date about 45,000 washrooms have been built and 22,000 families have continuous running water (Gram Vikas, 2009).

CT$_x$GreEn, a Canadian not-for-profit organization fostering green energy partnerships, believes that local food and fuel security are important for global environmental security (CTxGreEn 2009). Focusing on micro energy initiatives, CTxGreEn believes that technology is only one of five components necessary to guarantee successful implementation, the other four being social, environmental, political and economic, components (http://www.theworkingcentre.org/wscd/ctx/ctx.html). CT_xGreEn is implementing the biodiesel project at a village scale in three communities in Orissa in close partnership with Gram Vikas (www.gramvikas.org). While the application has been functioning in the village for over four years, the adaptability and its ability to catalyze livelihoods in the local economy is under review.

1.3.1. Focus of the Research

For this research, two pilot cases in the villages of Kinchlingi and the twin villages of Kandhabanta-Talataila where the biodiesel technology had already been implemented were initially studied. The analysis of the process in these two villages laid the foundation for a proposal in a new cluster of villages, Tumba. An adapted sustainable livelihood framework (see Chapter 2) was used through action research methods (see Chapter 3) to examine the process of participatory implementation of VLB in the first two set of villages. This was followed up with an involved process of engagement with the community in Tumba to develop a context-specific livelihood strategy. The proposal was based on the adapted sustainable livelihood framework (see Chapter 2) and included lessons from the earlier experience.

Much of the research process overlapped with the implementation of the project by CTxGreEn. However, the CNBFES project was focused on training, demonstration and collaborative knowledge exchange while the research discussed here focused on documentation of the process and discussions with the community for the development of a replicable livelihood strategy based on village level biodiesel (Table 1-1).

Table 1-1: Summary of the different focus of the CNBFES project and the research

Focus of the CNBFES project	Focus of the research
In first 2 villages: Kinchlingi and KBTT Discussions on biodiesel beyond water pumping for uses such as biodiesel-fuelled multipurpose tiller (for ploughing, water pumping, threshing), biodiesel-fuelled oil expellers Strengthening of local level institutions Bringing in new stakeholders	**In first 2 villages: Kinchlingi and KBTT** Recording the history of the implementation process Participating in ongoing discussions, demonstrations, workshops and recording the process Incorporating lessons into the livelihood strategy for Tumba
In Tumba, the third community Primary data collection and feasibility study for village level biodiesel Demonstrations, training to develop green energy enterprises.	**In Tumba, the third community** Engaging with the community to discuss livelihood possibilities Develop with the community a proposal for VLB integrated with local livelihoods

Because of the exploratory nature of the research and relatively early experiences of the CNBFES, outcome measures are the least relevant set of parameters for this study. However it is an underlying assumption of the study based on literature review (See Chapter 2) and evidence from earlier implementation experience (Vaidyanathan, 2002) *that collaborative knowledge exchange, strong micro-macro linkages and the ability of the community to respond to the changing context will enhance their adaptive capacity, safeguard their livelihoods and reduce their vulnerability.*

1.4. Outline of the chapters

This thesis has nine chapters under three main sections. The first section contains Chapters 1-4, including this introductory chapter, and covers a review of the literature, the methodology and an introduction to the study site where an early pilot resulted in the proposal for this research. Section 2 with Chapters 5-7 includes the discussion of the two pilot VLB sites (Chapter 5 and 6) and the presentation of the livelihood planning process in the research site (Tumba) in Chapter 7. The third and concluding section containing Chapters 8 and 9 presents the analysis, results and some conclusions.

The literature review in Chapter 2, examines the sustainable livelihood approach and draws on grassroot experiences in natural resource management and on the work of Conway (1985; 1987), Chambers (1992; 1993) and Scoones (1998). An adapted framework has been developed and is used to discuss the case studies. Chapter 3 discusses the methods used and the research plan. Some tools used for analysis are also described here. The fourth Chapter gives an overview of the communities being studied and their relationship to the village level biodiesel model. Case studies of the first two villages are presented in Chapters 5 and 6. Chapter 5 is about Kinchlingi while Chapter 6 covers the twin villages of Kandhabanta Talataila (KBTT). Chapter 7 summarizes the lessons from the first two case studies, and lays the basis for the livelihood planning in Tumba. This chapter describes the livelihood planning process facilitated in Tumba. Chapter 8 summarizes the key lessons and conclusions of the research and Chapter 9 discusses the challenges to VLB and contribution to literature and recommendations for future research.

2. Literature Review: Village Level Biodiesel and links with sustainable livelihoods

It is in the light of both immediate experience and long term prospects that the study of Buddhist economics could be recommended even to those who believe that economic growth is more important than any spiritual or religious values. For it is not a question of choosing between "modern growth" and "traditional stagnation." It is a question of finding the right path of development, the Middle Way between materialist heedlessness and traditionalist immobility, in short, of finding "Right Livelihood."

Schumacher in Buddhist Economics (P.7)

Chapter Summary: The literature review identifies the VLB as a community-based approach and draws on the lessons from natural resource management and agroecosystem analysis as promoted by Conway (1987). This provides the necessary linkage to the sustainable livelihood work, which had its genesis in the work of Chambers and Conway (1992). The Sustainable Livelihood literature provides the theoretical foundation for this research, adapted to include concepts of appropriate technology, agroecosystem analysis and entitlements analysis. The legal and policy regime is an important factor for the replication of VLB model. However, since most of the policies and acts are very specific to the case studies, details have been left out of this chapter and discussed in Chapter 4: Context for VLB. Complex system thinking has helped in understanding the interconnected web of themes that sustainable livelihood presents.

2.1. Key influences

A large part of the learning for this research has been in the field, from oral history and practical trial and errors. Knowledge has emerged from responding to the socio-cultural milieu and the ecological base, both of which have provided the context for the research. There are additionally three key influences common to both the CNBFES and this research. These influences are Gandhi's principle of *Gram Swaraj* or village self-reliance (Sharma, 2005), Illich's philosophy of *Community Tools* (Illich, 1973), and Schumacher's answer to questions on economies of scale, *Buddhist Economics* and *Small is Beautiful* (Schumacher, 1966; 1999).

Mahatma Gandhi laid stress on development at the village level and the devolution of power to Panchayati Raj Institutions (local self-governing institutions). He believed in the participation of the people in development, and in the village as a unit of administration. This led to the inclusion of Panchayati Raj as a Directive Principle (Art.40) in the Constitution of India (Sharma, 2005). Illich and Schumacher extend Gandhi's concept of dignified living to industrialized society. Illich proposes convivial modes of production in place of industrial modes, where people use simple tools to pursue their goals in their own unique way (Illich, 1973). Schumacher's ideas of an alternative economic model, where small-scale local production from local resources is used for satisfying local needs (Schumacher, 1999), resonates with the ideas of Illich and Gandhi and is the foundation of the Village Level Biodiesel model, as promoted by CTxGreEn.

In locating VLB within an existing body of literature it is useful to refer to CTxGreEn's original approach to the CNBFES project. Five parameters were identified as the building blocks for their strategy (http://www.theworkingcentre.org/wscd/ctx/ctx.html). These five building blocks are: (1) natural resource assessment and monitoring (2) rural energy planning (3) community and institutional structures (4) appropriate technology and (5) legal and policy regimes (see figure in APPENDIX I). In tracing the evolution of the CNBFES, it is easy to see that although the project had tagged onto the Gram Vikas rural infrastructure project to provide an alternative energy source for water pumping, it was holistic in approach and more inclined to being a livelihood enabling process. CTxGreEn believes that the VLB approach promotes self-help and a means to create livelihoods (R. Sankaranarayanan, personal communication, February 1, 2009).

Following the logic of Right Livelihood, it may be argued that this research is based on principles of Buddhist Economics, which may or may not be recognized as a valid discipline. There is, however, simplicity and honesty in Schumacher's argument that since Right Livelihood is one of the eight Noble Truths preached by the Buddha, there must be such a thing as Buddhist Economics. He suggests that unlike the materialist, who is always interested in goods, the Buddhist is interested in liberation. Simplicity and non-violence are the keynote of Buddhist economics. Schumacher says that the marvel about this way of life is how small means lead to extraordinarily satisfactory results (Schumacher, 1973; 1999). This description fits the essence of VLB as a means to Right Livelihood.

There is a large body of literature on Sustainable Livelihoods which offers a good foundation for this research (Uphoff, 2006; Perrin *et al*., 2006; Almas *et al.*, 2003; Dalal-Clayton, 2003; Hussein, 2002; Bebbington, 2000; 1999; Carney *et al*., 2000; DFID, 1999; Scoones, 1998). The literature can be largely divided into two parts. The first includes the work of Chambers & Conway (1992) and Scoones (1998), which are seminal works in this field and propose a framework that promotes pro-poor, bottom-up development. Most of the other work on sustainable livelihoods uses the proposed framework with or without modifications and applies it to program planning and guiding implementation strategies (DFID, 1999; Carney, *et al*., 2000; Hussein, 2002; Dalal-Clayton, 2003; SLSA, 2004; Uphoff, 2006; Tao, *et al.*, 2009).

The genesis of sustainable livelihood as a concept can be traced back to the work of Chambers and Conway in the late 1980s. Sustainable Livelihood Thinking, as it was then called, was a combination of three approaches: Developmental Thinking, based on the economic school of thought; Environmental Thinking, based on the environmental school of thought; and Livelihood Thinking, based on survival strategies adopted by the poor to meet their basic needs (Chambers, 1987). Chambers (1987) noted that such a synthesis is implicit in the four properties of agroecosystem proposed by Conway (1987): productivity; sustainability; stability; and equitability. Chambers introduced the idea of multiple livelihood strategies in place of a single source of income, and the concept of assets and buffers to handle contingencies.

2.2. Grassroot strategies

Chambers introduced sustainable livelihood thinking as a response to the Brundtland report commissioned by the World Commission on Environment and Development (WCED, 1987). The Brundtland report drew attention for the first time to the interlinked nature of problems associated with population, environment and development. Chambers (1987) argued that the strategies were, however, top down and he called for a reversal of roles, putting the priorities of the poor first. The Sustainable Livelihood approach promotes a bottom-up pro-poor approach, which makes it a useful framework in the context of this research.

There is currently an increasing realization, especially in relation to livelihood strategies for adaptation to climate change, that grassroot action should inform national and international policy making (Huq, *et al.*, 2004; SDC, 2005; Vaidyanathan *et al.*, 2009). The gap between the rhetoric and practice, however, continues (Tyler, 2006). One approach to addressing this gap is 'Civic Driven Change', CDC that moves away from the State and the Market as agents of change, placing civil society in the centre of the action (Context, 2009). CDC offers an alternative to the controversial development paradigm based on aid (Easterly, 2006) and views development as a complex self-organizing open system that is accompanied by tiers of institutions with associated power structures (Fowler, 2007). Civic Driven processes have been successful with respect to forestry in India. There are several successful community forestry projects in the state of Orissa, India (Agarwal, 2000; Singh, 2000; Rath, 2002; Sathpathy, personal communication, July 1, 2008), where the current research is based. These community forestry projects are an alternative to the Joint Forest Management (JFM) program (Agarwal, 2000; Sarangi, 2002; Vira, 2005) being promoted by the State Forest Development Agency, and fall into the realm of community-based natural resource management (CBNRM). Armitage

(2005) defines CBNRM as an approach that promotes complete participation of a community of informed resource users, and incorporates formal as well as informal institutional structures in every aspect of management and control (Pomeroy, 1996; Borrini-Feyerband, 1996; Barret and others 2001, Berkes and Folke 1998). In spite of several shortcomings in the approach (Armitage, 2005; Singh, 2002), Community-based Natural Resource Management projects offer a good example of attempts to close the theory-practice gap.

For example, the CBNRM program of International Development Research Centre, IDRC Canada, offers a compendium of experiences from a range of contexts. CBNRM like the CNBFES project on VLB was an action research focusing on natural resources, institutions and governance structures. The program was formulated to fill the gap that existed in translating global and national agendas (including the Millennium Development Goals, MDG) to the village level, so that the marginalized could share benefits (Tyler, 2006). This is one of the primary concerns of VLB: most national and global policies on biodiesel continue to ignore small scale, local production for local use models.

IDRC's concept of CBNRM is about governance and livelihoods in addition to technical improvements for enhancing productivity of resources. This is another important similarity between the IDRC-CBNRM approach and the VLB that is the focus of this research. CBNRM, like VLB, is aimed at strengthening the livelihoods of the poor. CBNRM is a response to the dominant techno-centric paradigm of centralized bureaucracies (Anderies, Janssen, & Ostrom, 2004; Berkes *et al*., 1998) that resulted in agricultural innovations such as high yielding varieties of crops, developed in isolation from farmers (Tyler, 2006; Douthwaite, 2002). CBNRM evolved through integrated approaches such as Farming System research, Agroforestry and Watershed management to its present form, as a response to research on production technology and on plant breeding and genetics (Tyler, 2006).

Similarly, VLB is a response to (a) agro-component of industrial biofuel models that promote monoculture of plantation-based, nonindigenous energy crops, displacing food production (FIAN & HBF, 2008; Oxfam, 2007) and (b) centralized modes of production of biofuels for petrodiesel that promote transportation at the cost of productive livelihoods. The industrial models are aimed at reducing import of fossil fuels, but at the cost of local development (Sankaranarayanan, 2009).

Figure 2-1 depicts the road map of the VLB during implementation of the CNBFES project in Orissa, by CTxGreEn (2004-2009). The CNBFES followed an integrated approach attempting to include (1) natural resource assessment (2) rural energy planning (3) leveraging community level institutions and organizations (4) understanding legal and policy regime and (5) developing technology and providing training. The response of CNBFES to industrial and agro-industrial models of biofuel production is similar to that of CBNRM to topdown approaches to agriculture (Tyler, 2006). It is therefore worth looking at VLB in the CNBFES, through the CBNRM lens.

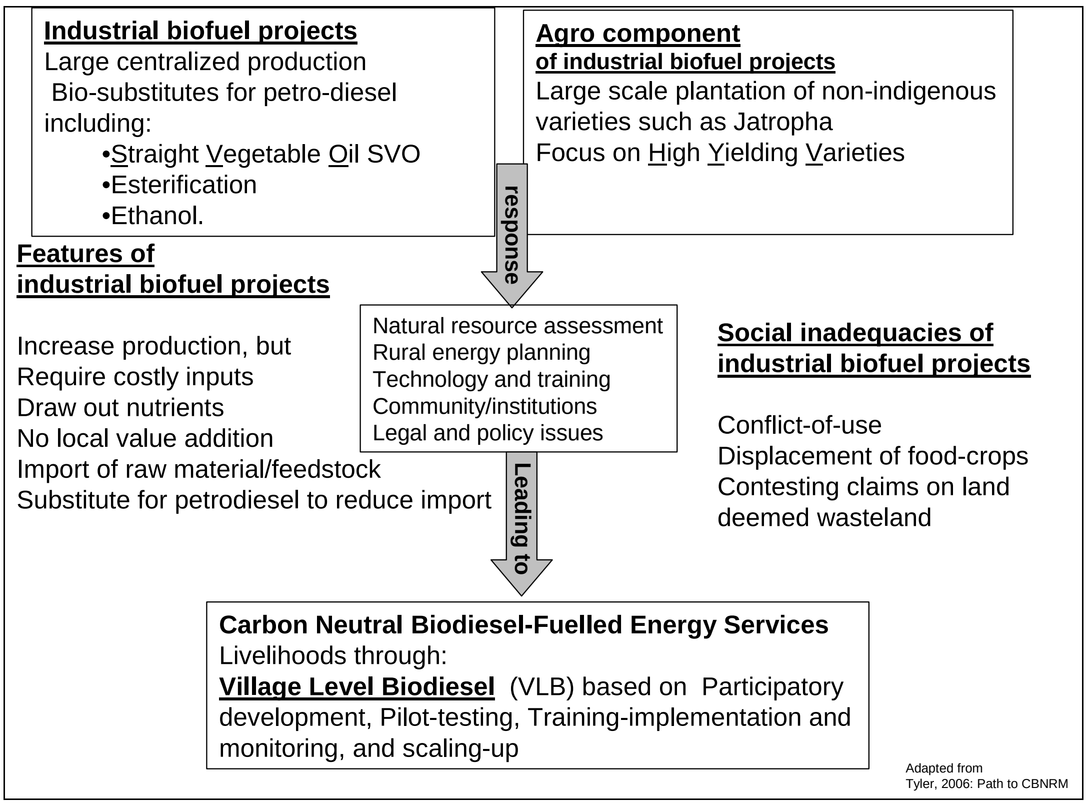

Figure 2-1: Road map of the Village Level Biodiesel (in the CNBFES project)

Tyler (2006) depicts the building blocks of CBNRM in the form of a pyramid with its first tier being foundation in agro-ecological research; indigenous knowledge; meaningful participation; and resource tenure. This is achieved through interdisciplinary learning, social analysis and learning by doing, which are represented in the second tier (Figure 2-2). Livelihoods and collective action are in the third tier and contribute to poverty reduction and to empowerment through processes and institutions. This is achieved through action research based on shared learning which occupies the top of the pyramid.

The CNBFES shares a similar outlook for action research (see Figure 2-2), with the difference that it has its foundation in an interdisciplinary approach that includes forest agroecosystems, appropriate technology, rural energy planning, institutional structures and legal and policy issues (APPENDIX I). VLB extends the concept of resource tenure as proposed by the CBNRM approach to include institutional structures (formal and informal) in addition to legal and policy issues (CTxGreEn, 2005).

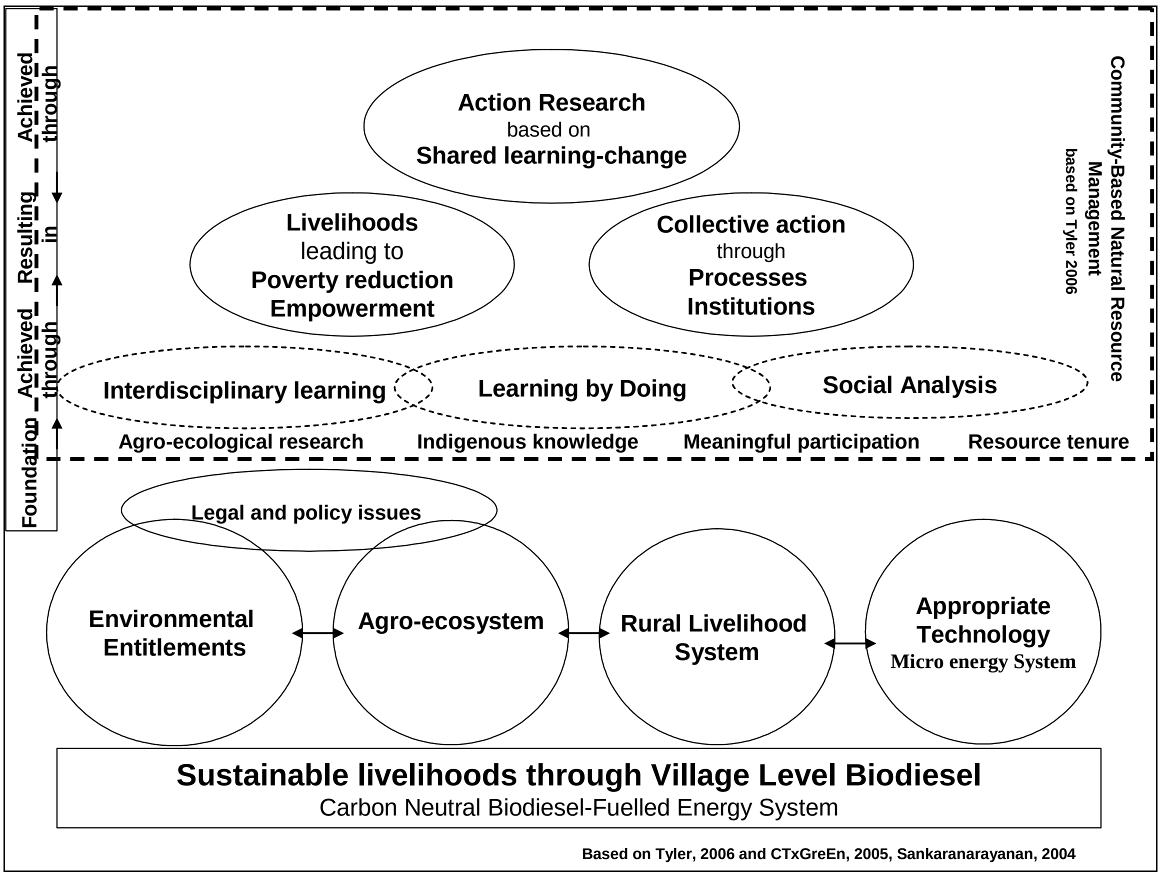

Figure 2-2: Building blocks of the Village Level Biodiesel

A valid criticism for CBNRM approaches is that they do not sufficiently consider adaptive capacities and the inherent resilience of socio-ecological systems (Armitage, 2005). It has also been pointed out that the robustness of socio-ecological systems is affected by the linkage between the community of resource users and the public infrastructure providers (Anderies, *et al.*, 2004), which is also not adequately considered in traditional approaches to CBNRM.

The four properties of the agroecosystem proposed by Conway (1987) to define sustainable livelihood thinking include productivity, sustainability, stability and equitability. Chambers and

Conway (1992) developed sustainable livelihoods into an approach for bottom-up development. Several of the shortcomings of the CBNRM approach are addressed by the sustainable livelihood approach. The path to VLB is similar to the CBNRM path as suggested by IDRC (Tyler, 2006), and so is the nature of the implementation under the CNBFES (see (Figure 2-1, p.13 and Figure 2-2, p.14). Both CBNRM and CNBFES lay emphasis on the community and follow an action research approach with the aim of establishing the micro-macro link. Beyond this, the Sustainable Livelihood Approach appears to be better suited to understand the development of VLB in the two villages of Orissa. SLA includes the concepts of resilience and adaptive capacity in the properties of sustainability and capabilities. The SLA concept of equity, interpreted as less unequal distribution of assets, capabilities and opportunities, is achieved through institutional linkages (Chambers, 1992).

2.3. Sustainable livelihoods in agroecosystems

Moving beyond the four properties of agroecosystems, Chambers and Conway (1992) developed the concept of sustainable livelihood security and presented it as an integrating concept to the World Commission on Environment and Development (WCED, 1987, pp. 2-5). A modified version of the WCED definition was further developed by Chambers and Conway (1992) into a working definition of sustainable livelihood. It is:

> *A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shock, maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation: and which contributes net benefits to other livelihoods at the local and global levels in the short and long term (Chambers 1992, pp. 7-8).*

This precise definition of the sustainable livelihood includes three concepts of (1) capabilities (2) equity (3) sustainability (Chambers, *et al*., 1992). The definition is extremely rich and needs to be unpacked to reveal its complexity and its depiction of the real world.

Chambers believed that diversity of livelihood approaches are necessary to safeguard against vulnerability. Livelihood diversity and intensity are outcomes that contribute to opportunities for sustainable livelihoods, and depend on the community’s access to resources (Chambers, *et al*., 1992). The two outcomes may be defined as follows:

(a) **Livelihood diversity**, where a single source of income is replaced with multiple livelihood strategies and

(b) **Enhanced livelihood intensity** that enables communities in varying contexts (in different agroecosystems and socio-cultural milieu, with differing degrees of access to resources) to generate (i) their own mix of solutions: for example, mixed farming, change of land use, and (ii) small scale economic synergy: for example, farm labor and other jobs that allow local recirculation of income (Chambers, *et al*., 1992).

The Sustainable Livelihood Framework (SLF) was developed by Scoones (1998), based on these concepts (Chambers and Conway, 1992; Scoones, 1998), and is an attempt to guide development practice. Although the framework as proposed by Scoones (1998) acknowledges that sustainable livelihood approaches do not follow a linear cause and effect relationship, the iterative nature of livelihood strategies is not reflected in the framework. The combination of resources through livelihood strategies leads to livelihood outcomes, but these strategies affect the stocks of resources, the tangible and intangible assets, and alter the livelihood capabilities of people. The context is dynamic and affected by feedback loops (Figure 2-4, p.25). The complex nature of sustainable livelihoods will require attention to multiple perspectives, hierarchical and cross scale interactions. Self-organization caused by feedback loops implies that there is uncertainty and unpredictability of outcomes (Checkland, 2000; Waltner Toews, 2004). In keeping with the nature of complex systems (Kay *et al.*, 1999; Fowler 2007), therefore, for the practical application of the sustainable livelihood approach, it would be useful to separate the framework into two parts: one that depicts the structure (see Section 2.4) and a second that explains the function (see Section 2.5, page24).

2.4. The structure of the SLF for VLB

The building blocks of VLB proposed by CTx GreEn (2005) in Section 2.1, page 9 (and in APPENDIX I) are similar to the elements of the SLF suggested by Scoones (1998, APPENDIX II). The five building blocks of VLB have been compared to the SLF in Table 2-1. The comparison helped to sharpen the focus of the VLB approach, resulting in a slight change in the nomenclature of the original blocks. For example, we include agroecosystem resources as a whole rather than limiting it to natural resource assessment and monitoring. Similarly the focus was shifted to rural livelihoods and rural energy from ‘rural energy planning.’ There is also emphasis on entitlements instead of community organizations and institutions. The other two building blocks, legal and policy regime and appropriate technology remain the same. The restated five building blocks are: (A) Rural Livelihood System (B) Legal and Policy regime (C) Agroecosystem (D) Appropriate Technology and (E) Environmental Entitlements. The modified building blocks of Village Level Biodiesel are compared with the elements of the SLF in Table 2-1 and presented in Figure 2-3.

Table 2-1: Parameters defining the SLF and VLB

Sustainable Livelihood Framework (Scoones, 1998)	**Village Level Biodiesel model (CTxGreEn, 2005)**
Context: agro ecology and socio cultural aspects	**Rural livelihoods** including rural energy, energy usage and socio-cultural patterns
Context: history and political economy	**Legal and policy regime**
Livelihood resources/Assets: human, physical, financial, natural and social	**Agroecosystem** consisting of people, nature and exchange system including natural resource assessment
Livelihood Strategies: agriculture intensification, extensification, migration	**Appropriate technology** including micro energy system
Institutional processes, organizational structure referred to in the research as: **Institutions & organizations**	**Environmental entitlements** including community and institutional structures

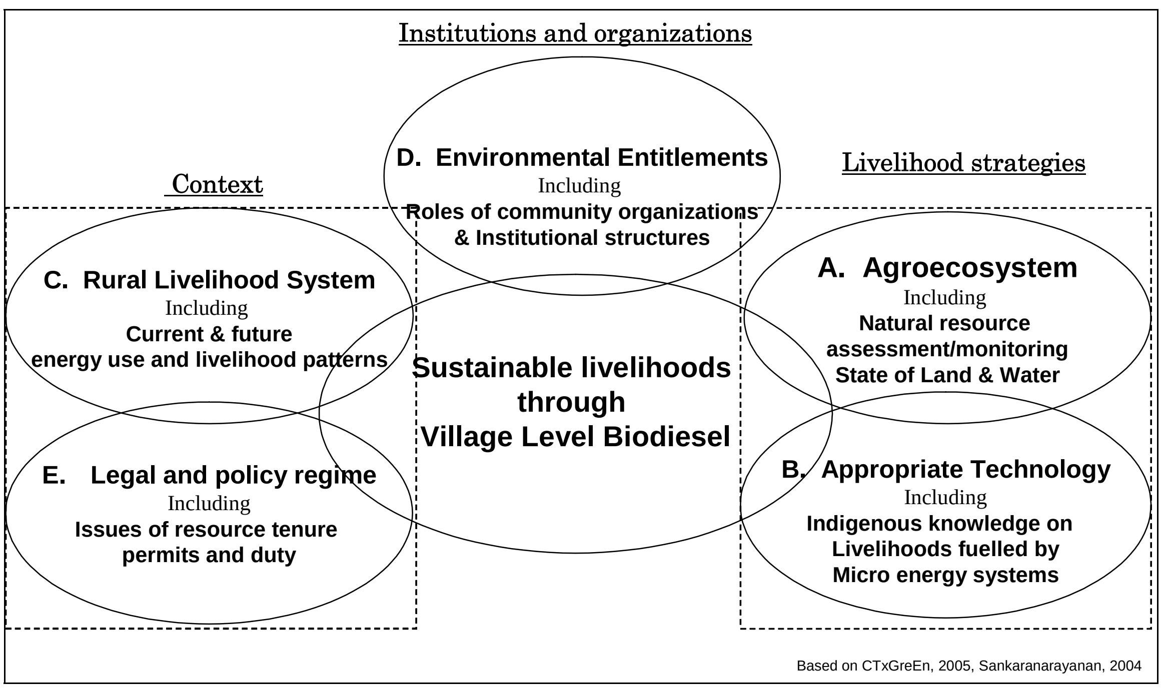

Figure 2-3: Building blocks of VLB adapted for the Sustainable Livelihood Framework

Having focused the VLB building blocks to the elements of the Sustainable Livelihood Framework, SLF (Scoones, 1998), the next step is to substitute them within the SLF developed by Scoones. SLF elements adapted for VLB therefore include:

I. **Vulnerability** in the **context** of people and ecosystems, which is the inability to adjust to shocks and stresses. Adaptive responses would be to adjust *externally through an enabling* ***legal and policy regime*** *and/or internally through a resilient* ***rural livelihood system.***

II. **Livelihood strategies**, which are a result of combining **agroecosystem** characteristics (which include livelihood assets *viz.*, human, physical, financial, natural and social) *with different* ***appropriate technological innovations,*** resulting in livelihood outcomes

III. **Institutions and organizations** that influence the ability of the community to gain access to and control over resources and convert them into capabilities through e***nvironmental entitlements.***

Based on concepts from the literature, the five building blocks are included in the above three elements of the SLF, and described in brief below. Each of the building blocks is further elaborated in Table 2-2, page 23.

2.4.1. Vulnerability context

Chambers (1992) defines vulnerability as consisting of two parts, the first being the shocks and stresses that the community is subject to, and the second, the ability of the community to cope (IDS, 1989). This ability to cope is a reflection of resilience, the capacity of the system to experience disturbance and still maintain ongoing function and controls (Holling, *et al*., 2002). Resilience can be maintained internally through a robust **livelihood system** (Anderies, Jannsen & Ostrom, 2004) and externally through a favourable **legal and policy regime**.

Rural Livelihood System

The resilience of traditional livelihoods appears to be rooted not in the outer reality of resources and their flows alone but in the inner reality of the community's way of life (Hogger, 2004). Information on physical, occupational and emotional aspects of the livelihood system, from the perspective of the individual, family and the collective, helps to gain multiple perspectives of the plural way of life of the community. This helps in understanding the magnitude of disturbance that the community can absorb without becoming de-stabilized, and is a measure of the resilience of the system (Holling, 2002). Access to energy can contribute to the goals of democratization within the village structure (Thompson, 1996) and influence adaptive capacities of the community (Westley, Carpenter, *et al.,* 2002). Renewable energy technologies can be scaled to the requirement of the community (Thompson, 1996; Vaidyanathan, 2009). But to understand what motivates acceptance of innovations, one has to explore the inner reality of the villager's livelihood system (Hogger, 2004). Design of technologies optimised to the need of the community requires incorporation of the user's concerns (Neudeoerffer, Malhotra, & Ramana, 2001) and an understanding of current energy use patterns and future aspirations, especially of women. Women are usually the ones most affected by lack of clean energy sources and efficient end-use devices (Agarwal, B., 1986).

Legal and policy regime

Enhancing the robustness of a livelihood system which is socio-ecological in nature is difficult due to inherent uncertainty of social and ecosystems (Anderies, *et al.*, 2004). Similarly, renewable energy technologies cannot be viewed only through the techno-economic lens but are also political in nature (Thompson, 1996). Technical feasibility does not guarantee the adoption of a technology, and often government intervention is needed to overcome obstacles (Goldemberg, 1996; CTxGreEn, 2006). For example, promotion of the ethanol program by the government in Brazil (Goldemberg, 1996; 1999; 2004) led to a reduction in fossil fuel consumption and reduced CO_2 emissions, and at the same time also led to technological developments in agriculture production and in sugarcane processing. This automatically resulted in enhanced ethanol production and an associated increase in displacement of fossil fuels (Goldemberg, 1996).

When the community is reinforced for productive action, the larger social system is also automatically strengthened (Korten, 1987). This is the principle of mutuality, and is applicable to livelihood systems. Several policy amendments and additions in India facilitate mutuality, but these policies have not yet been implemented. The 73rd Amendment to the Constitution of India, the Scheduled Tribes and other Traditional Dwellers (recognition of Forest Right) Act 2006, and the Government of India's Common Minimum Program (NAC, 2004), committed to providing basic infrastructure facilities to all by 2009, are mechanisms that exist for the devolution of power to the grassroots. The National Action Plan (2008) addresses climate change through eight core missions. Legislation is needed for the further development of policy (Upadhyay, 2005), to facilitate grassroot action. Livelihood based programs can, with the backing of the government, proactively confront the impacts of climate change. They can drive development processes towards adaptation to climate change (UNFCCC, 2002; UNFCCC, 2007; IPCC, 2007; Mc Gray, 2007) at the community level where they have the most impacts, instead of the current top-down fashion (Huq and Reid 2004).

2.4.2. Livelihood strategies

Using the definition of sustainable livelihoods as the basis, Scoones (1998) recognizes five set of indicators that can assess outcomes. These are (1) creation of working days, (2) poverty reduction, (3) well being and capabilities, (4) livelihood adaptation, vulnerability and resilience and (5) natural resource base sustainability. These are suggestive indicators that assess the impact of the livelihood activity on tangible and intangible assets and on the capabilities of the community. The value of these indicators is in understanding the trends, in order to inform decision making (Chambers, *et al*., 1992). It is considered premature to assess the CNBFES using the above indicators, as the project is less than five years old and is still at the initial stage in some of the villages. Therefore, for the purposes of this research, we have focused only on the fourth indicator, (livelihood adaptation, vulnerability and resilience), and selected adaptive capacity and hence resilience as a key characteristic of livelihoods that are sustainable (based on the work of Holling, *et al*., 1995; 2002). Resilience is therefore used in this research to assess sustainability of livelihoods.

With resilience (the opposite of vulnerability) defining the livelihood outcome, we need to understand how **agroecosystem** resources are combined with **appropriate technological innovations** to enhance adaptive capacity. Possible livelihood strategies, according to Chambers and Conway (1992) are (a) livelihood diversity defined as scope for multiple livelihood strategies in place of a single source of income and (b) enhanced livelihood intensity including mix of solutions and small-scale economic synergy.

Agroecosystem

Agroecosystems are semi-domesticated ecosystems derived from human inflicted changes to natural ecosystems (Clements, *et al.,* 2004). These fall between natural ecosystems and those under maximum human control like cities (Altieri, 1995). According to Conway (1987), because of this transformation, the system boundary acquires a socio-economic dimension that makes it amenable to classical hierarchy, with the individual plant at the bottom, followed by the crop, field, cropping system, farming system …extending all the way up to the nation, the economic community and the World. Agroecosystems are complex because of interactions between economic and ecological processes (Conway, 1987) and contain livelihood resources that can be combined through diverse strategies to yield livelihood outcomes. Social and ecological systems co-exist as open systems that are self-organizing in nature, containing (1) patterns of space, time and flow defining the ecological system and (2) decision and information flows reflecting human management systems. Social systems, unlike ecological systems, are structured by power relationships, rules and norms (Westley, *et al.,* 2002) and exhibit human innovation. These innovations for the purposes of this research are limited to convivial tools (Illich, 1978) and renewable energy technologies that are able to incorporate the 'exigencies' of the community (Thompson, 1996) without overly compromising the ecosystem.

Appropriate technology

Collaborative exchange between traditional and scientific knowledge can lead to relevant technologies that are context specific and scaled to the needs of the community and ecosystem on which they are based. Technology for the masses, in contrast to mass-production-technologies, is conducive to decentralization, compatible with laws of ecology, gentle in use of scarce resources, and designed to serve people instead of making them servants of the machine (Schumacher rev., 1999). Closely coupled to the agroecosystems, these technologies use benign forms of energy, low entropy energy and depend on solar energy flows, including attendant carbon and water cycles, without depleting accumulated terrestrial stocks of natural resources (Daly *et al.,* 1994; Georgescu-Roegen, 1971). The efficiency of conversion is implicitly tied to land requirements: the lower the efficiency, the higher the land requirement and potentially the greater the conflict of use with food production (Dewulf, 2005). In the case of biodiesel, it is implicit that un-utilized and under-utilized oilseeds are used for productive purposes to avoid any conflicts (CTxGreEn, 2009). The design criteria aims to maximize the efficiency of human effort while optimizing the mechanization needed, ensuring that the machinery can be operated with ease and manufactured locally (Vaidyanathan *et al.*, 2009). Such criteria ensure that the technologies are designed and operated at the human scale, remain simple and flexible, rather than making people slaves to the machine (Hogger, 2004; Plumwood, 2002; Schumacher, 1999; Thompson, 1996; Haraway, 1991; Dickson, 1974; Lovins, 1977). It is important to stress that the primary niche for these technologies is to meet subsistence activities (Hiremath *et al.*, 2009) at peak efficiency for the lowest load required, extending seamlessly to meet the larger load requirements of economic activities (Gupta, 2003; Vaidyanathan, 2005; CTxGreEn 2009).

2.4.3. Institutions and organizations mediating Environmental entitlements

Based on co-evolutionary principles (Altieri, 1995; La Ravore *et al.,* 2005), livelihoods in agroecosystems are multidimensional, dealing not only with ecological dimension of natural ecosystems alongside subsistence agriculture, but also including technological as well as social and cultural dimensions (Altieri, 2002; Vandermeer, 1997). Esmail argues that even the World Bank has realized that there is a better chance of success in multidimensional projects instead of single sector activities like forestry, biodiversity *etc*. (as cited in World Bank, 1997a). Decentralized decision making through institutions for collective action is seen to be more viable, including the 'resource-appropriators' at the micro-level (Esmail, 1997). The result has been to include the community in natural resource management. This process, when framed as a program for implementation and called Community-based Natural Resource Management Program, ignored the dynamic nature of communities and the ecosystem, assuming a linear cause and effect relationship between the two (Armitage, 2005; Leach, *et al.*, 1997).

According to Leach (1997), diverse institutions mediate between people and the ecosystem. These institutions operate at different levels, ranging from the micro to the macro, and are not restricted to community level organizations (Leach *et al.,* 1997). Leach (1997) draws on the work of Amartya Sen on entitlements (Sen, 1981), who argued that scarcity was not about lack of resources but often about issues governing access to and control over resources. Leach (1997) suggests that environmental entitlements are utilities derived from environmental goods and services over which people have effective and legitimate command. How people convert their rights and resources (endowments) to entitlements and enhance their capabilities is therefore important in understanding how livelihoods dependent on the resource base are sustained (Leach *et al*., 1997). Extending Sen's argument to the environment, Leach includes customary laws in addition to formal institutional arrangements.

The three SLF elements (which include the five building blocks) are summarized with key descriptors derived from literature in Table 2-2: Key elements of proposed framework.

Table 2-2: Key elements of proposed framework
to analyze and design livelihood strategies in agro-forest ecosystems

Concepts	**Key components used in design of building block**
Sustainable Livelihoods (Chambers and Conway, 1992; Scoones, 1998; Dalal-Clayton, 2003) Livelihood system use resources and transform them into livelihood outcomes through diverse strategies	**R**esilient livelihoods and **N**atural resource base sustainability
I. CONTEXT: E. Legal and policy framework and to facilitate on-the ground-action (micro-macro links)	
Alternative economies (Korten, 2009) Adaptation continuum (Gray, 2007) Biodiesel/Biofuel policy (Global, national, state) National Action Plan (PMCCC, 2008), India's initial communication to UNFCCC (MOEF, 2004). Orissa excise law Panchayats Extension to Scheduled Areas Act (MPR, 1996) National Rural Employment Guarantee program (MRD, 2005) Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Forest Acts	**A**ddress drivers of vulnerability **C**onfront impacts of climate change **L**egal regimes linking the micro to the macro considered so that the result is meaningful policy that actually make a difference at the grassroots. **S**trategic Environmental Assessment (IC& NCEA, 2008) are other methodologies for engaging in **C**ivic Driven Change (Fowler 2007) **P**articipatory Action Research
CONTEXT: C.Rural Livelihood System reflecting socio-cultural patterns of traditional livelihoods, energy planning	
Rural Livelihood Framework (Hogger 2004)	**U**nderstanding inner and outer realities of a livelihood system. Individual, family and community perspectives are considered.
Gender sensitive design (Agarwal, B., 1986; Haraway, 1991; Milroy, *et al.*, 1994; Jackson *et al.*,1995; Franklin ,1999; Plumwood, 2002)	**P**rocess oriented design **C**are models **H**uman scaled systems
Rural Energy Planning (Sinha, *et al.*, 1994 ; Neudoerffer, *et al.*, 2001; Malhotra, *et al.*, 2004)	**G**ender-sensitive participatory planning, inclusive of user requirements (present and future)
II. LIVELIHOOD STRATEGIES :A. Resource base characterization of agroecosystem	
Agro ecosystems (Conway, 1987; Altieri, 2002) Self Organizing Holarchic Open System (Kay, *et al*.,1999; Holling, *et al*., 2002; Waltner-Toews, 2004); Hierarchy (Giampietro, 1994; Tognetti, 1999) Open Systems (Von Bertalanffy, 1972; Brodt, 2001) Community tools, local agriculture (Illich, 1973; Berry, 1993) Sustainability (Gibson, *et al*., 2005; Hunsberger, *et al*., 2005)	**S**ocial system and Ecological systems co-exist as open nested structures and processes. Feedbacks are included resulting in constant self organization, characterized by unpredictability and uncertainty **P**atterns of space, time and flow define ecological systems, decision flows reflect human management processes. Multiple perspectives required to understand complex systems **N**atural resource sustainability, human well-being
II.. LIVELIHOOD STRATEGIES: B**:** Appropriate technological innovation	
Intermediate Technology (Schumacher, 1979; 1999) Ecological Economics (Georgescu-Roegen, N. 1971) Industrial Ecology (Ayres, 1996; Allenby, 1999) Participatory technology development (Reijntjes, *et al.*, Shove, 2003; Ornetzeder, 2006; St.Denis, *et al.*, 2008.)	**S**mall is beautiful **S**oft energy paths **C**losed loop system, Green process design **R**egenerative technology design **I**ndigenous knowledge
III. ORGANIZATIONS AND INSTITUTIONS MEDIATING : D. Environmental entitlements	
Environmental Entitlements[6] (Leach, *et al.*, 1997 ; Agarwal, B., 2000) ; Environmentality (Agarwal, 2005); Institutional Structures/processes (Farrington *et al.*,1997; Hobley *et al.*,2000; Almas *et al.*, 2003) Participatory processes (Johnson *et al.*, 2003; Classen, *et al*., 2008); Civic-Driven-Change (Fowler, 2008; Context International, 2008)	**R**esources are converted to endowments when people acquire rights over them. Endowments are converted to entitlements 'through legitimate and effective command over resources,' resulting in enhanced capabilities and well-being. **L**ink Meso, micro and macro level institutions moderate access to and control over resources **R**ole of women and other marginalized groups enhanced

2.5. The functions of SLF

Sustainable livelihood processes consist of social and ecological systems. This combination can be described as a socio-ecological system including:

- Social systems defined as a group of people bound by a shared understanding and code of conduct (Westley, *et al.*, 2002) or as an interdependent system of organisms (Anderies, *et al*., 2004) and
- Ecological systems or ecosystems consisting of biotic, abiotic and physical components located on the earth (Westley, *et al*., 2002) or also as an interdependent system of organisms and biological units (Anderies, *et al*., 2004).

This interlinking of two complex systems is also complex and does not follow linear cause and effect relationships. The depiction of the process in the framework suggested by Scoones (1998, p.4) can therefore be misleading.

The combination of (a) agroecosystem resources with (b) appropriate technologies (c) mediated by organizations that convert them into entitlements for the communities, takes place within (d) the rural livelihood system which exists in (e) a legal and political context.

This research argues that when the outcomes of such a combination lead to livelihood diversity (multiple strategies including small-scale synergies), and livelihood intensity (characterized by byproduct synergies), they are more likely to be able to adapt to external and internal shocks and stresses. Such livelihood outcomes are by definition more resilient.

Additionally, resilience is improved through better connectedness between micro, meso and macro-level organizations.

A further argument of this research is that sustainability of the livelihood system is characterized by resilience, **<u>and</u>** additionally dependent on the sustainability of each of the building blocks in Figure 2-3.

The outcomes are a moving target, shaped by the actors, resources and their relationships. Outcomes also affect and change the context (Figure 2-4). Feedback loops make the entire process iterative, and an open system (Bertalanffy, 1968).

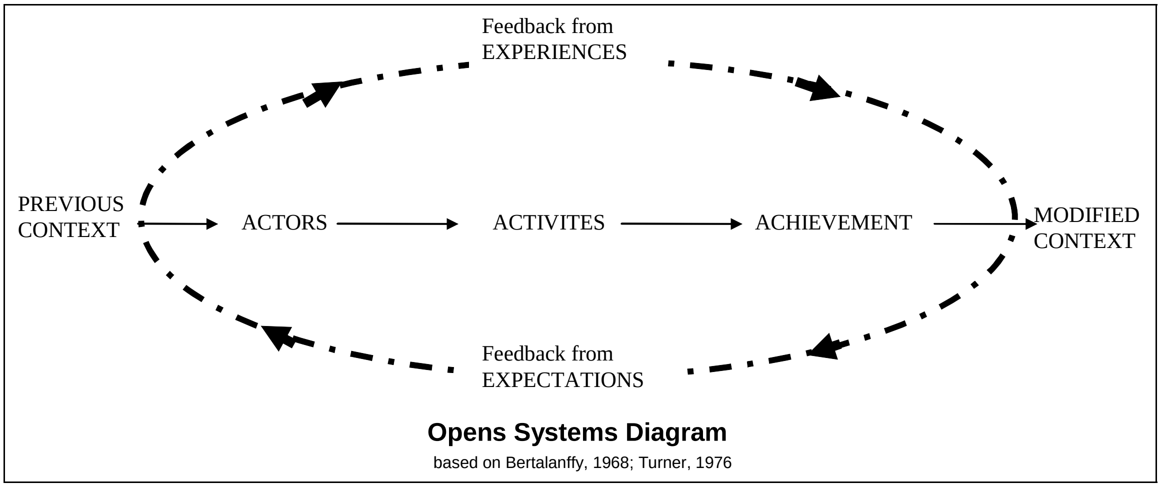

Figure 2-4: Functions of Sustainable Livelihood Framework defined using Open Systems diagram

2.6. Framing VLB as a catalyst for sustainable livelihoods: A Conceptual framework

'Sustainable Livelihoods' has its roots in agoecosystem research (Conway, 1987) and is a rich concept that establishes the link of people to land. This is why the Sustainable Livelihood Approach as proposed by Conway and Chambers and further developed by Scoones is a very valuable lens to assess development. The interest in the concept has dwindled over the past decade resulting in a call by Scoones (2009) and Chambers (2009) to re-engage in the concept.

Two points have been made by Chambers and Scoones, both of which are central to the current research. The first point is that the concepts of sustainable livelihoods are applicable both to southern and northern communities, subsistence and industrialized economies, and the second is that the livelihood perspective does not adequately address micro-macro linkages and power relationships.

Chambers (2009) points out the relevance of sustainable livelihoods thinking not only to the poor but also to the over-consuming rich economies of the North. Scoones (2009) acknowledges that the livelihood concept is an important lens for looking at complex rural development issues. He points out that the focus of research and policy has shifted away from insights of a livelihood perspective, back to macro-economic analyses, and suggests inclusion of new themes to re-energize the concept (See Chapter 9, for the new themes that have been included).

The Sustainable Livelihood Approach was used extensively in the 1990s by bilateral agencies and NGOs, mostly in program planning and evaluation and assessment (Hussein, 2002). The challenge is to use it to design strategies that integrate technological innovation within the established livelihood of people in a manner that people's needs and changing aspirations are addressed. Concepts about technology such as 'small is beautiful' (Schumacher, 1999) and convivial tools (Illich, 1973) are as valid today as they were three decades ago. What we need is a practical guide for collaborative technology development, and its integration into the local livelihood system as a means to fuel livelihoods that are sustainable. Some parallels can be found in the concept of participatory technology development in agroecology (Altieri, 2002) but they are limited purely to agricultural practices and do not include small-scale renewable energy technologies.

Douthwaite (2002) proposes a learning selection model for fostering technological change. He says that collaborative design is important for fostering acceptance of technology. It was pointed out to him that many engineers, scientists, policy makers and extension workers who know how to develop a prototype that doesn't inconvenience the manufacturers and the users, are assuming a consultancy model that is good for improving an existing product, but is not suitable for developing new technologies (Douthwaite, 2002). Douthwaite, an engineer and a technology developer himself, developed his learning-selection model when he realized both from practice and literature review that top-down approaches do not promote technological innovation. His research led him to believe that what was needed was a co-development model in which the key stakeholders and researchers construct the technology together, during the early adoption phase. While his model addresses the technology development phase, and the link between adoption and adaptation of technological innovation, integration within the local livelihood system is not addressed. In case of Douthwaite, the technology itself was the end rather than a means.

Relating back to my own practical experience in architecture, which was influenced by Habraken (1972), Turner (1991, 1976) and Hamdi (1991, 1997), building and housing were verbs and not nouns, especially when mass production was not intended (Vaidyanathan, 2000). Based on literature and experience, it is therefore an important consideration of this research to focus *VLB not as an energy technology but as a means to catalyze livelihoods*.

The collaborative process of technology development as a means to facilitate livelihoods is considered especially important in order to avoid the trap of a "faulty technology" (as defined by Commoner cited in Illich, 1973, p. 34). Faulty technologies according to Illich (1973) are a result of transformation of means into an end. Schumacher (1999) advocates for simple and nonviolent technologies based on Buddhist Economics, where the worker for whom it is meant is more important than the product of the work. Democratization of the technology (Wakeford, 2004) as a means to create community and grassroot action for local self-reliance (in the model of Gandhi's Gram Swaraj or Village republic), is the essence of the argument of this thesis in exploring 'whether VLB can catalyze livelihoods that are sustainable'

An integrated framework based on the sustainable livelihood approach was used (See Figure 2-5, Figure 2-6) to understand and analyze the development of Village-Level Biodiesel (VLB), in two villages where the technology had already been implemented. It was later used to design the implementation of VLB for facilitating livelihoods in another village cluster.

2.7. Sustainable Livelihood Framework to analyze Village Level Biodiesel: A summary

The sustainable livelihood framework used to analyze the case studies consists of two parts, one describing the structure (the building blocks in Figure 2-5) and the second discussing the process (dynamic nature in Figure 2-6). Based on concepts from literature the five building blocks of the adapted SLF are included within three main elements of the original SLF (Scoones 1998). The structure of the SLF (see Figure 2-3, page 17) for VLB presently includes:

(I) Vulnerability context consisting of (1) rural livelihood system (2) legal and policy regime

(II) Livelihood strategies consisting of (3) agroecosystem resources and (4) appropriate technological innovations

(III) Institutions and organizations mediating (5) environmental entitlements.

The VLB building blocks exist in a system where agroecosystem resources and appropriate technological innovations represent actors and their relationships, mediated through institutions and organizations representing decision making processes, existing in a context defined by rural livelihoods and the legal and policy regime. This is represented in Figure 2-6: Functions of the SLF for VLB. The figure also indicates that the combination is a dynamic process and consists of feedback loops, from expectations (during the design process) and from experience (as a result of outcomes).

Based on a review of the literature (see earlier sections of this Chapter) and in the context of VLB, livelihoods that are sustainable imply a local means of production and use that (a) respects the culture of local livelihoods (b) enables local access, control, women-headed enterprises (c) promotes local utilization and value addition of natural resources (d) enhances food and energy security and (e) regenerates the natural resource base. Opportunities for sustainable livelihoods that incorporate these considerations enhance the adaptive capacity of communities, without overly compromising the environment. In the process they reduce vulnerability of the livelihood system. Given that the CNBFES project itself is less than five years old, most of the implications of the work (as suggested above) are only indicative.

One criterion suggested above, resilience of the livelihood system, has been identified in the literature as an important parameter for ensuring sustainable livelihood opportunities. As previously stated (Chambers, *et al*., 1992), vulnerability can be reduced through (a) livelihood diversity and (b) livelihood intensity. For the purposes of this research, and in order to understand the ability of VLB to fuel sustainable livelihood opportunities, the potential contribution of the energy system (VLB) to the resilience of the existing livelihood base (in terms of livelihood diversity and livelihood intensity), will be examined. The goal is sustainable livelihoods, characterized by resilient livelihoods and natural resource sustainability. It is assumed that the enhanced capabilities of the community are closely linked to the capacity of the agroecosystem. Thus the sustainability of the social system is dependent on the integrity of the ecological system.

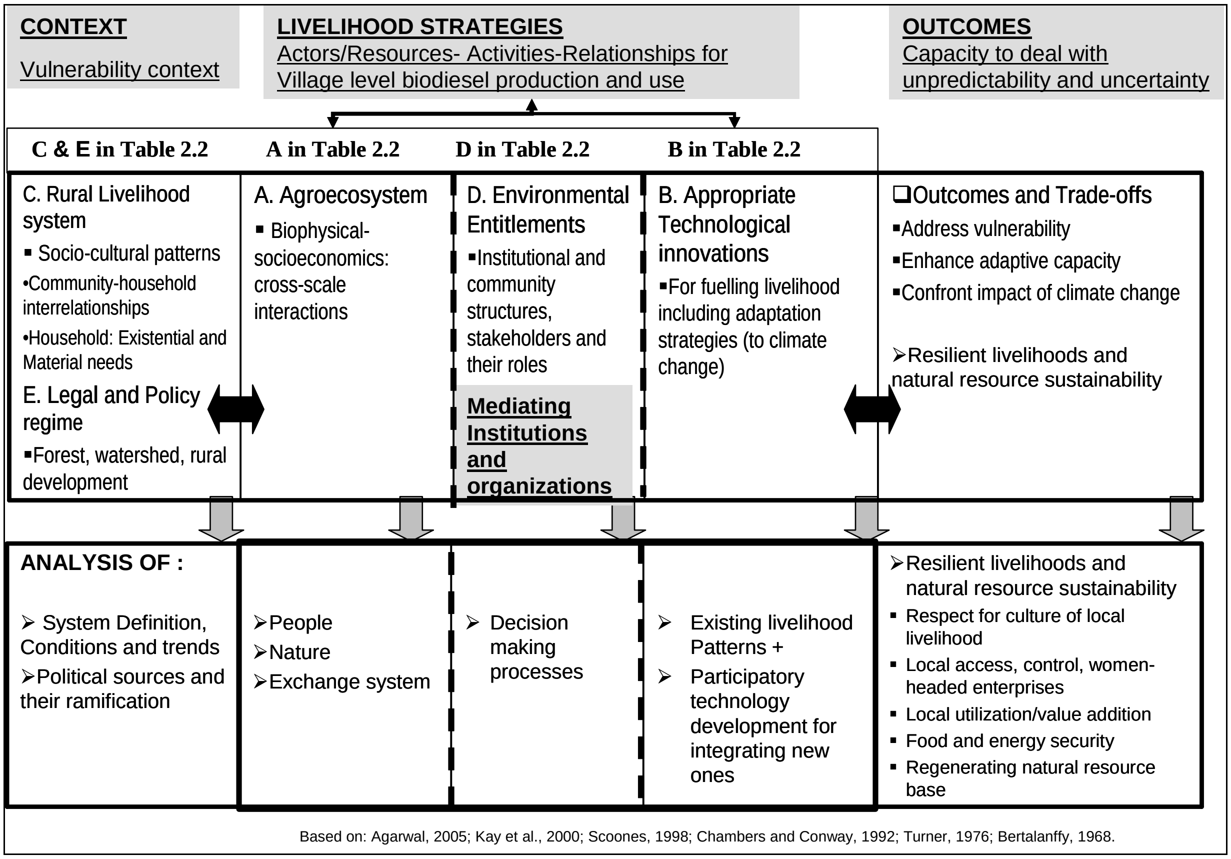

Figure 2-5: Structure of the SLF for VLB

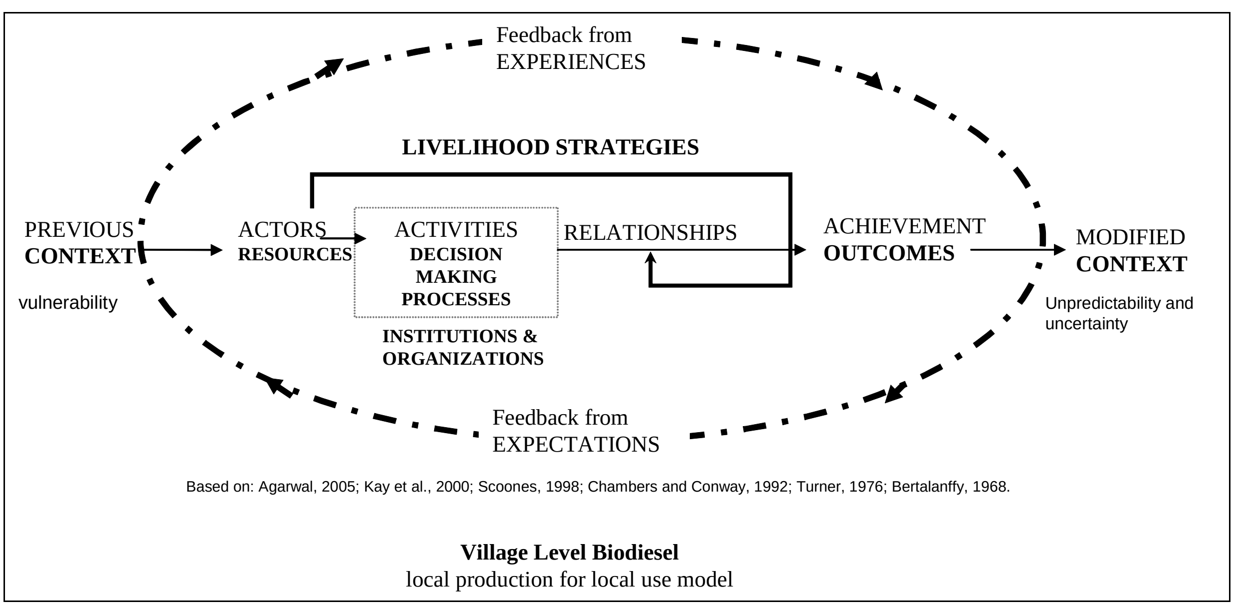

Figure 2-6: Functions of the SLF for VLB

2.7.1. A short note on how the framework (SLF for VLB) is used in this research

The Sustainable Livelihood Framework for analyzing the Village Level Biodiesel model (SLF for VLB) has multiple applications. In the case of the current research, the SLF for VLB has been used to design the research plan and to collect and analyze information (See APPENDIX IV: Detailed description of Project). The process of development of the research plan using the framework is linear but allows a mutli-optic lens and therefore results in a more holistic approach. The framework can be used in a similar manner to guide the design of a VLB-based livelihood strategy in a new geographical area.

The framework was used to assess the ability of VLB to catalyze sustainable livelihood opportunities. This was done by (1) analyzing the case study to assess how many of the building blocks were incorporated into the livelihood strategy and (2) assessing the adaptive capacity of the strategy by studying the response to feedbacks. Although it is premature to assess the outcomes of VLB, the framework was used to identify some trends with respect to the five outcomes (see Figure 2-5, right hand column) listed in the framework. As we discuss further in the case studies, the key considerations in assessing sustainability and resilience of outcomes are (1) livelihood diversity and intensity catalyzed by VLB and (2) connectedness of the institutions involved in decision making processes.

Livelihood diversity and intensity *with respect to* VLB has been addressed (as is illustrated in Chapters 5-7) through a three-pronged approach consisting of sustainable agriculture and biodiesel-fuelled livelihoods, balanced with local value addition. Connectedness of institutions is assessed using Leach's *methodology for analysis of environmental entitlements* (Leach *et al*., 1997) discussed in more detail in Chapter 3 and Chapter 8. Environmental Entitlements is one of the five building blocks of the SLF for VLB. The methodology for analysis of environmental entitlements developed by IDS, Sussex (Leach *et al*., 1997) has additionally been used by this research to guide analysis (see Chapter 2, Section 3.7.3, Use of Environmental Entitlements in Data Analysis p.43). Adaptation to climate change was incorporated as an additional measure of resilience during the analysis stage of the research process. Narratives indicated that agricultural productivity, and therefore feedstock production was affected by changing weather patterns. Vulnerability to the impacts of Climate Change thus emerged as an important consideration and was accordingly incorporated into definition of resilience (see APPENDIX VI: Description of the ethnographic method used in the research, for details). Managing climate risk and confronting impacts of climate change are important considerations for the resilience of livelihoods closely coupled to the agroecosystem. The adaptation continuum (McGray, 2007) was used to assess the responsiveness of VLB to impacts of climate change (See Chapter 3 for details of method and Chapter 8 for the analysis). Resilient livelihoods and natural resource sustainability together define the desired outcome of livelihoods that are sustainable. The VLB approach is premised on natural resource sustainability as is demonstrated in the casestudies. This research however, focuses on establishing how the VLB catalyzes resilient livelihoods.

We can summarize the three main considerations used by this research in assessing resilience of livelihood outcomes as: (1) livelihood diversity and intensity as characterized by VLB's three-pronged approach (CTxGreEn, 2009) (2) connectedness among institutions assessed using Leach's *methodology for analysis of environmental entitlements* (Leach, *et al*, 1997) and (3) capacity for adaptation to climate change assessed using McGray's adaptation continuum (McGray, 2007). The above discussion is pictorially represented in Figure 2-7. Elements of the SLF for VLB are presented, along with outcomes, and measures for assessing the sustainability of livelihood outcomes.

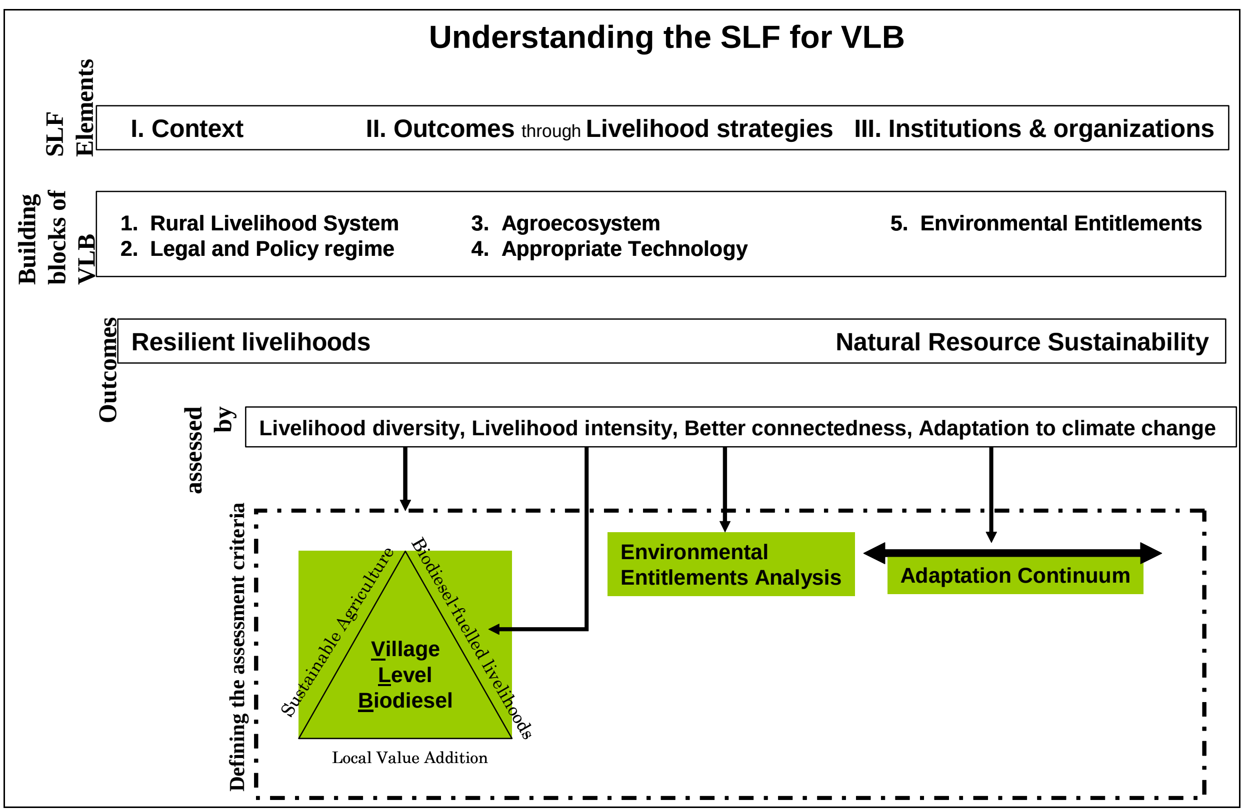

Figure 2-7: Steps in unpacking the SLF for VLB

2.8. Conclusion

The position of this research is that the VLB model is a community tool, a means to promote local self-reliance and Right Livelihood, one of the eight noble truths in Buddhism. Grassroot processes and participatory technology development are fundamental to VLB. The belief is that such processes will lead to enhanced adaptive capacities of the community and to a resilient agroecosystem that can generate sustainable livelihoods. Literature on community-based natural resource management provides a way to understand how theory and practice can be combined for grassroot initiatives, especially as an alternative to industrial, centralized top-down solutions.

The seminal work of Chambers and Conway (1992) on Sustainable Livelihoods (SL) provide links to agroecosystems (a unified socio-ecological system) and offer a framework on which to base the analysis of VLB. Components of VLB as designed by CTxGreEn are combined with the SL approach of Conway & Chambers (1992) and Scoones (1998) to arrive at an integrated framework. The framework includes a structure (Figure 2-5) made up of five building blocks (rural livelihoods system, legal and policy regime, agroecosystem, appropriate technological innovations, environmental entitlements), existing in an open system (Figure 2-6), where actors and resource relationships define livelihood strategies through decision making processes.

Parameters to define each of these building blocks have been developed from the literature in Table 2-2. The SLF for VLB is a tool that promotes a holistic approach and is useful for designing livelihood strategies for sustainable livelihood opportunities, especially for those that involve appropriate technological innovations. SLF for VLB integrates concepts from community-based natural resource management, adaptive management, environmental entitlements and sustainable livelihoods.

Livelihood diversity, livelihood intensity (achieved in the case of the VLB through a three-pronged approach including sustainable agriculture, local value addition and biodiesel-fuelled livelihoods, see case studies and Chapter 9 for details), and enhanced capabilities (through environmental entitlements, mediated through increased connectedness between micro, meso and macro organizations and community arrangements, see Chapter 9 for details), could result in a community being more resilient and therefore less vulnerable. In addition, the ability of the livelihood to adapt to climate change makes it even more resilient. Patterns of resilience of the livelihood system, catalyzed by VLB, are the primary outcome indicator suggested by the framework.

The framework, SLF for VLB, is used by this research in analyzing the potential of VLB to catalyze sustainable livelihoods in two villages (Kinchlingi and KBTT) and to design a livelihood strategy based on the VLB, for a cluster of villages (Tumba). SLF for VLB is also used as a tool to develop a holistic research plan.

In the next chapter we discuss some of the methods that were used in the research process.

3. Study design and methods: Road map for research

Chapter Summary: The focus of this research was to develop a grassroot livelihood strategy for village level biodiesel and to share it with a larger group of stakeholders. This was facilitated by the researcher in close collaboration with CTxGreEn. Participant observation and Participatory Action Research have been the primary methods for gathering data. Secondary sources of information such as reports, memos and workshop proceedings have been used as sources of information. Ethnographic analysis and Action Learning Case Studies were used for analyzing information in combination with other frameworks, like the Rural Livelihood System, Environmental Entitlements Framework and the Adaptation Continuum. The first two sets of villages, Kinchlingi and KBTT, were assessed for the ability of VLB to catalyze sustainable livelihoods, while a livelihood strategy was developed with the community in the third area, Tumba. The conceptual framework, 'SLF for VLB' was used to assess the potential of VLB to fuel sustainable livelihood opportunities. Stakeholder workshops were held to get feedback on the VLB-based livelihood strategy and to identify the legal and policy challenges that it faced.

3.1. Introduction

The research for this study took place over a 4-year period (2005-2009) and included two phases of field study in India. Field research was carried out in close collaboration with CTxGreEn, a Canadian NGO, and its Indian NGO partner Gram Vikas. CTxGreEn has been working on the biodiesel project in Orissa since early 2004 while Gram Vikas has been working in remote villages in the State of Orissa, India for the last 30 years. Their collaborative project is referred to in the discussions that follow as the Carbon-Neutral-Biodiesel-Fuelled-Energy-System (CNBFES), to distinguish it from the research. CNBFES is the name under which it was initiated in the villages of Orissa, through a World Bank Development Market Place award (WBDM 2003). An overview of the NGOs and the CNBFES project is presented in Chapter 4.

3.2. Geographical focus of the study

The focus of this research is the indigenous tribal community Sauras, in the Ganjam-Gajapati districts of Orissa. The bulk of the research on developing a biodiesel-based livelihood strategy is centred on micro-watersheds in the Tumba region of Ganjam district. Villages in two other project areas of Gram Vikas, Kinchlingi in the Anandpur project and Kandhabanta-Talataila (KBTT) in the Rudhapadar project are sites of the first and second biodiesel production facilities respectively, and provide material for the case studies in this research. (See Figure 3-1 and Figure 1-1 for location of CNBFES project villages). **The case studies are important, as they inform the development of the livelihood strategy in Tumba.**

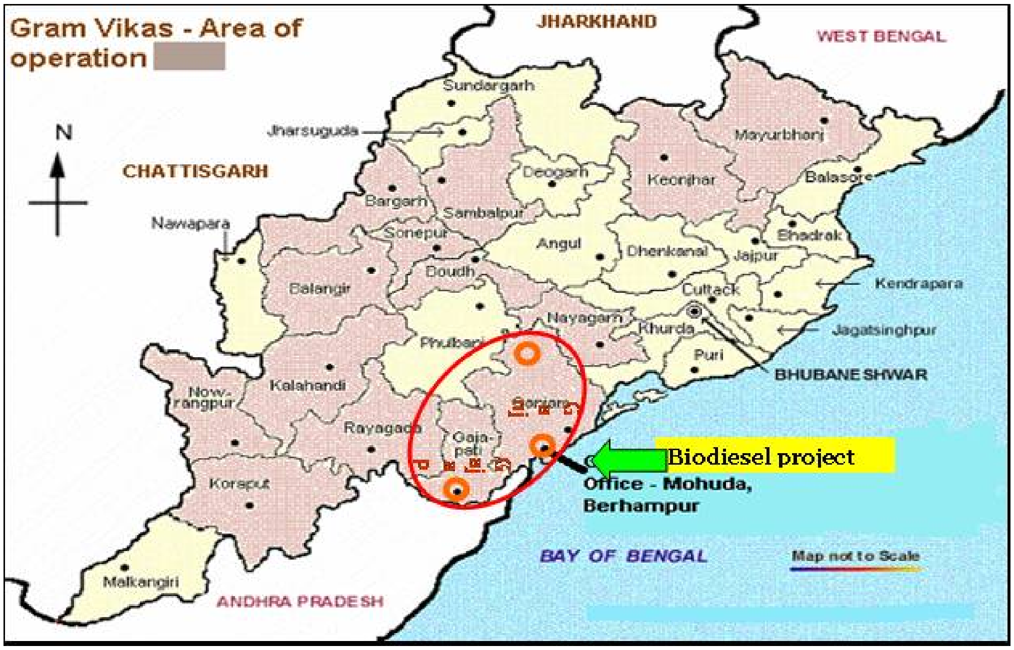

Figure 3-1: Map of Orissa showing location of the CNBFES project villages

The current study in Tumba is limited to the core village(s) where the biodiesel program is already located. However, other villages in the cluster, defined by interlinkages existing between core village, and in geographical terms by the watershed,[7] are also included. Details of the levels at which information was collected are included in Table 3-2: and in Figure 3-2.

3.3. Activities and time line

The idea for the research was seeded during early involvement with the CNBFES, between February 2004 and December 2005, when the biodiesel technology was being installed in the first two sets of villages.

The research proposal was developed through pre-feasibility studies conducted over a 6-month period between January and August 2005. The main field work was carried out in two phases: the first phase lasting 14 months between March 2006 to May 2007 and the next phase lasting 20 months from September/October 2007 until June 2009. The intermediate period of four months (June 2007 to September 2007), was used to develop preliminary case studies and re-visit the proposal. In September 2007, a preliminary report was sent to the International Development Research Centre, Canada (IDRC) that had funded the first field visit and provided input to the research design.

Research was ongoing even as the CNBFES project was being implemented. A detailed time line of the research activities is presented in APPENDIX III, along with the activities carried out under the CNBFES. Three tables for each of the research phases (Phase 1: Prefeasibility, Phases 2 and 3: Field work), clearly identify the separate focus of the two streams of activities, but demonstrate the synergies between the two (See excerpt in Table 1-1: Summary of the different focus of the CNBFES project and the research). Intermediate outputs from the research, such as workshop proceedings and livelihood proposals developed with the community, have been used by CTxGreEn in the implementation of the CNBFES.

3.4. Research proposal and overview of the research process

It is the hypothesis of this research that local-production-for-local-use biodiesel at the scale of the village can facilitate sustainable livelihoods. In order to answer the questions raised by the research a two stage proposal was suggested:

1. The two communities, Kinchlingi and twin villages of KandhaBanta-Talataila (KBTT) where the village level biodiesel had already been implemented, would be studied to assess the effectiveness of VLB.
2. In addition, lessons from the first two implementations would be used to inform a livelihood strategy based on VLB in a third community of Tumba.

A conceptual framework was developed anchored in the literature on sustainable livelihoods. This is discussed in detail in Chapter 2. The potential for VLB to catalyze sustainable livelihoods was examined in the first two villages using the conceptual frameworks (1) Figure 2-5: Structure of the SLF for VLB and (2) Figure 2-6: Functions of the SLF for VLB. In the third community of Tumba, the same framework was used to assist the development of a grassroots biofuel strategy for a cluster of villages. The goal of the village level biodiesel model is to catalyze livelihoods that are sustainable. It was therefore important to identify outcome measures to assess whether the goal was being achieved. Chapter 2 discusses the development of the conceptual framework and identifies outcome measures, which we revisit in Chapter 8.

A research proposal (Table 3-1) was accordingly prepared, based on the research question and guided by the conceptual framework, which had the following objectives, aims and key activities:

Table 3-1: Research proposal

Research question: Can the development of a grassroots biofuel (biodiesel)-based strategy catalyze livelihoods that are sustainable? What are the challenges that will need to be overcome by the VLB and how can these be addressed?'

Primary objective: To facilitate preparation of a VLB-based livelihood strategy
Part 1: To develop a cluster-level livelihood plan integrating old and new livelihood options **Activities**
• **Characterise the resource base and define an optimum livelihood cluster**
Demarcate geographical cluster on the basis of micro-watersheds, forests, interlinkages between the communities *etc*., within resource clusters of the Gram Vikas' Integrated Tribal Development Program, in the Tumba region.
o Participatory mapping of the geographical area on topographic maps and remote sensed maps: Preparing base maps of local assets and networks. (A remote sensed image of the area studied has been obtained by CT_xGreEn under the WBDM 2003 project and analyzed using National Remote Sensing Agency's level 2 land-use classification. This is the baseline resource map of the region. The map formed the base document for the participatory micro energy planning with the community.)
o Prepare an inventory of potential seeds and fruits from the forest, agricultural fields and homestead that could be tapped for the preparation of biodiesel. Map their habitat, seasonality and usage pattern.
• **Conduct a livelihood analysis focusing on existing patterns of agriculture**
o Identify the Strengths, Weakness, Opportunities and Threats of the existing system.
o Identify traditional oilseeds and other native species that can be included into the package of existing practices to promote more sustainable agricultural practices. Select underutilised seeds for use within the context of the biodiesel programme, and identify those that are vulnerable among them. Identify current uses of the seeds and potential conflict of uses with regard to food, fodder, habitat and fuel.
o Identify oilseed crops that can be included in land conservation measures for watershed development and also as homestead crops that serve multiple functions-nutrition/fencing/insect-traps. (*A participatory documentation workshop using the rural livelihood framework was conducted in August 2004 under the CNBFES project. Key findings of the workshop have been analyzed and findings incorporated into the livelihood plan for Tumba.)*
• **Conduct a community-based (women-focused) assessment of energy needs for domestic and livelihood end-uses within a cluster of villages.**
o Identify energy sources, collection patterns, consumption-expenditure, end-use devices, and cooking patterns for domestic and livelihood activities
o Identify extended use of biodiesel and possible end-use options (beyond water pumping); incorporate user concerns as design inputs into the technology (Participatory Technology Development).
• **Identify customary laws, organizations and institutions operating at meso, micro, and macro level.**
o Understand the dynamics of institutions and organizations, formal and informal that governs issues of access and control over these resources.
o Identify barriers, strategies to overcome the barriers, and associated action plan for implementation.
Part 2: Assess effectiveness of VLB in catalyzing sustainable livelihood opportunities **Activities**
1. Conduct case studies in existing biodiesel field implementations to define
o An effective livelihood strategy incorporating multiple perspectives
o Sustainable livelihood opportunities catalyzed by the village level biodiesel
o Identification of barriers and strategies to overcome them

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A detailed description of the research proposal is presented in APPENDIX IV. This is a modified plan, which was updated as the research progressed. Five tables were developed that listed (a) key questions that the research tried to address; (b) parameters that were studied; (c) sources of existing information; (d) methods used to collect information when data was not available; and (e) the milestones achieved. The tables are a linear representation of an iterative process, which served as a checklist while conducting the research.

3.5. Levels at which data were collected

Data were collected at different levels (household, village, settlement, watershed, cluster and administrative) and across different scales (micro, meso and macro). Figure 3-2 and Table 3-2: indicate the different levels at which relevant data was collected.

Although the focus of the research is a cluster of villages within a watershed boundary, information was collected for levels above and below, in keeping with the Systems Thinking concepts of Hierarchy (Giampietro, 1994), Cross-scale and Multi-level linkages (Kay, *et al.*, 1999). In rare cases such as the entitlements analysis (2.4.3, pg 21), linkages with the National level (two levels above the level where action is proposed) were necessary (Table 3-2), to meaningfully discuss legal and policy regimes for facilitating replication of the village level biodiesel.

Table 3-2: Methodologies and the level of data collection

SLF for VLB Component being studied	Methodology	Level at which information was collected
A. Agroecosystem includes resource base characterization and identifying conflicts related to food, fuel, fodder	Agroecosystem analysis as a basis for NRM	Watershed (cluster) level Level above: Administrative (Regional) Level below: Household
B. Rural energy and livelihood strategies (socio-cultural belief systems, role of women)	Rural-Livelihood-System Livelihood analysis	Household and Watershed level (cluster). Level above: Administrative (Regional) Level below: Individual
C. Appropriate technology includes situated knowledge and production of new forms of knowledge	Appropriate Technology design	Watershed level (cluster) Level above: Administrative (Regional) Level below: Individual
D. Entitlements mediated through institutions, organizations, formal, informal networks. Role of stakeholders, linkages between micro-meso-macro	Participatory processes Stakeholder listing in A, B, C, D.	Administrative.(Regional) Level above: (State) Level below: individual
E. Legal and Policy regime includes existing policies, laws, acts	Environmental Entitlements analysis	Administrative.(Regional) Level above: (State, national) Level below: Household

Gray color indicates the two components that define the context for the VLB.

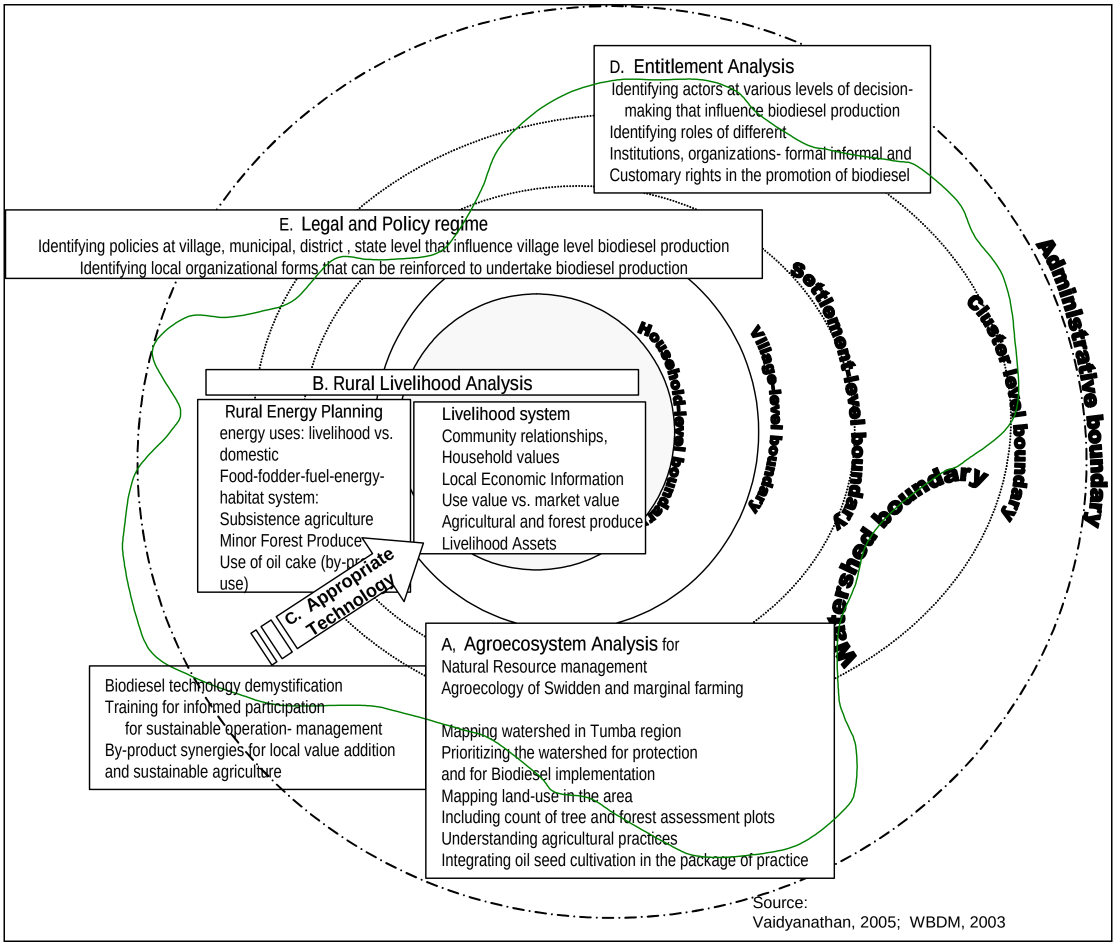


Figure 3-2: Multi-levels at which data was collected

3.6. Methods

Primary and secondary sources of information have been used. Much of what is categorized as secondary sources by this research stem from primary data generated by the CNBFES project, compiled as internal reports or existing in the CTxGreEn database.

Secondary sources of information include internal documents of the NGOs, CTxGreEn and Gram Vikas such as minutes of meetings and internal memos. These were used to reconstruct the timeline of the project. Earlier reports and studies conducted as part of the CNBFES have also informed the livelihood analysis (Mishra, *et al.*, 2007; Updhayay, 2005; Mishra, 2005; CTxGreEn, 2004a; 2004b; 2008; 2009). Spatial analysis of data was carried out using topographical and cadastral maps, and existing remote-sensed images and land use maps.

Fundamental to this research is the idea of combining theory and practice. Depending on whether the emphasis is on theory or on practice, the mode of research may be labeled as

Participatory Action Research or Participatory Learning and Action respectively (Kemmis, *et al*., 2000; Checkland, *et al*., 1998; Stringer, 1996; Reason, 1994, Chambers, 2008). Participatory Action Research, PAR, with reference to the current research, is defined as a process of engaging with the community to reflect, evaluate, plan and then implement solutions based on the shared learning (Chambers, 1992b; Kemmis, et al., 2000). PAR is characterized by a spiral of planning, acting, reflecting, replanning, acting, reflecting, and so on (Kemmis, *et al*., 2000, p.597). PLA is often used to describe Participatory Rural Appraisal, PRA, but is broader and includes other approaches with the aim of empowering people to scale up community action. PRA and PLA are often referred together as they belong to the same cluster of methodologies (Chambers, 2008).

Informal interviews, facilitated meetings and workshops were some of the methods that were extensively used, with interactive participatory methods for gathering information and recording oral history. Journal entries and field notes of key informants have complemented information gathered through mapping, based on Participatory Rural Appraisal, PRA (Chambers, 1992, 2007, 2008). PRA is defined for the purposes of this research as a family of approaches and methods to enable rural people to share, enhance, and analyze their knowledge of life and conditions, and to accordingly plan and act (Chambers, 1992b, p.1).

Structured and semi-structured interviews were used for feedback from key informants. Household data on energy usage and livelihood patterns was collected using questionnaires. These surveys were conducted by village youth who were trained in a workshop which explained the purpose of data collection and guided preliminary analysis of information.

Most of this data was entered into MS Excel Worksheets, and used to validate ethnographic information. See APPENDIX VII and APPENDIX VIII. Planning exercises were done through mapping and design exercises (Chambers, 2007, 2008). See APPENDIX X, APPENDIX XI. Limited amount of forest survey and inventory of tree-oil-bearing species (see APPENDIX IX) was carried out using techniques developed earlier by CTxGreEn. The natural resource survey included laying out random 20m x 25m plots and collecting quantitative data such as: (1) latitude, longitude, and elevation data using Geographical Positioning Systems, (2) temperature and humidity at the centre of the plot, (3) tree species (type and count of tree with girth >30cm, count of tree 20-30cm girth and sapling counts), (4) tree cover, litter cover and other observational data (see Table 7-4). This survey was carried out by the youth in Tumba, trained as parataxonomists through the CNBFES project.

Training programs organized by the CNBFES on the technology ranged from short orientations (one day visits to the production units), to three-to-seven day programs on the socio-environmental and the techno-economic aspects of the village level biodiesel technology package. The CNBFES project also conducted long term residential training programs (3-6 months) for village interns as a part of the technology demystification process. The interns of these programs have contributed to the richness of this research project through their feedback, journal entries and oral histories.

A strategic planning workshop was conducted as a part of this research in February 2008 with participants from other NGOs. The workshop was facilitated using a framework developed by The Canadian Institute of Cultural Affairs, Canada (ICA, 1985; 1998; Spencer, 1998). Outcomes of the workshop are discussed in Chapter 9.

Assessments of the Self Help Groups (See Chapter 6) were carried out using a performance assessment tool developed by SaDhan (SaDhan, n.d), an organization in India which is an association of community development financial institutions. An analysis of roles, responsibilities, relationships and revenue/benefits between stakeholder groups (IIED 2005) was partially carried out. A preliminary stakeholder listing was done to identify levels at which decision making is taking place for the VLB. A further analysis of interrelationships between stakeholders was also completed.

The data collected through focus groups and workshops were compiled into Minutes and Proceedings and used to inform the case studies. Information collected through surveys (see list of surveys conducted in APPENDIX V**)** was compiled in MS EXCEL and added to CTxGreEn's existing database in Mohuda, Orissa, India. Results from the analysis of the data are presented as a part of the narrative in the case studies.

3.7. Tools for analysis

Methods that were used besides those already discussed above are Ethnography (Emerson, 1995) and Action Learning Case Studies (Context, 2008). Other tools used for collecting and analyzing information include Leach's methodology for analysis of Environmental Entitlements (Leach, *et al.*, 1997), Hogger's the Rural Livelihood System (Hogger, 2004) and Mc Gray's Adaptation

Continuum (McGray, 2007). As mentioned earlier (and discussed in detail in Chapter 2 under Conceptual framework), this research uses systems thinking and specifically the concept of self-organizing open systems (Bertalanffy, 1968; Kay, *et al.*, 1999; Brodt, 2001; Waltner-Toews, 2004) as a reference. In keeping with the open systems approach and responding to feedbacks during the research process, tools were needed that responded to the complex nature of the issues at hand. A more detailed rationale for the inclusion of these frameworks is discussed in Chapter 2, Literature review.

3.7.1. Ethnographic study (Tedlock, 2000; Ellis, *et al*., 2000; Kincheloe, *et al*., 2000)

Integrating the lived experience and socio-cultural patterns is an important part of this research. Ethnography in the narrative form has been used to record the process of implementation of VLB, and to make sense of the experience gained in participant observation. Narratives include observations, as well as notes on the researcher's participation in the process of demystification of the biodiesel technology. The ethnographic text is therefore a result of the researcher's engagement with the subject of research, and observation of participation, while being engaged in the community being studied (Tedlcok, 2000).

Multiple sources of information are available in the form of CTxGreEn internal documents that record the CNBFES' community engagement process. Triangulation of information, using the researcher's notes validated by sources from the CTxGreEn database, has helped in developing robust case studies (Chapter 5-7). The objective is to analyze the information critically and draw conclusions that connect the various themes and explore the implications of the issues raised (Emerson, 1995, p. 204).

The work has been a document-in-progress and emerging issues were added as needed. With each step towards further exploration and reflection, preliminary conclusions have had to be modified based on new learning. It should be noted here that the issue of climate variability as a risk appeared important enough to be considered as a determinant of the sustainability of VLB initiative, based on ethnographic analysis. (See APPENDIX VI for a sample of the ethnographic analysis indicating this result.) Although questions and themes formed the backdrop of the selection of ethnographic passages, the analysis relied on the inductive ability of the researcher, and benefited in this case from the researcher acting as a medium for amplifying the voices of the community.

3.7.2. **Action Learning Case Studies** (Context, 2008)

Action Learning Case Study (ALCS) is an exploratory research methodology promoted by the Context International Cooperation (2008). ALCS is premised on 'Civic Driven Change,' in response to disillusionment over current development practice and the realization that changes in society are a complex process (Context, 2008). The ALCS approach, according to Fowler (2008), uses principles of complex systems (Byrne, 1998; Chesters, 2005), action research (Maru, *et al.*, 2005; Checkland, *et al.*, 1998) and grounded theory (Glaser, *et al.*, 1978), a combination of ideas that are also the foundation for the current research. The main steps of ALCS (Context, 2008) relevant to this research include: (1) taking stock of past and current development practice of participants, (2) reflecting through narratives and storytelling combined with interviews of key players and studying relevant documents, (3) distilling good practices, comparing experiences, benchmarking or triangulating based on either practical knowledge or from literature, (4) revisiting the good examples, discussing future action and integrating them into plan/practice/application, and (5) disseminating the findings. The process is iterative and requires recording of facts in a neutral manner in addition to good reflection (Context, 2008).

Using this approach, the case studies that follow in Chapters 5-8 were first reconstructed chronologically and then analyzed using a variety of information sources. The researcher as a participant observer is the main story teller. Lessons have been triangulated with insights from ethnography and proceedings of collaborative workshops conducted with the community on similar issues. The combined lessons learned have then been summarized into a livelihood strategy as a direction for the future. Intermediate conclusions have been shared with the community and other key stakeholders and their feedback was incorporated during the research process.

3.7.3. Use of Environmental Entitlements in Data Analysis

Environmental Entitlements has not only been used as a building block of the framework (SLF for VLB), but also to guide data analysis based on the methodology developed at the Institute of Development Studies, IDS, Sussex.

IDS uses this methodology as a tool to analyze the role of institutions in mediating access and control of resources by communities (Leach, *et al.*, 1997). Institutions are the link between people and the environment (Figure-3-3), and mediate resources at the macro, meso and micro levels (Scoones, 1998; Leach, *et al.*, 1997). Environmental entitlements are the benefits derived by people when they gain legitimate command over resources and can convert these resources into goods and services for their well-being (Leach, *et al.*, 1997).

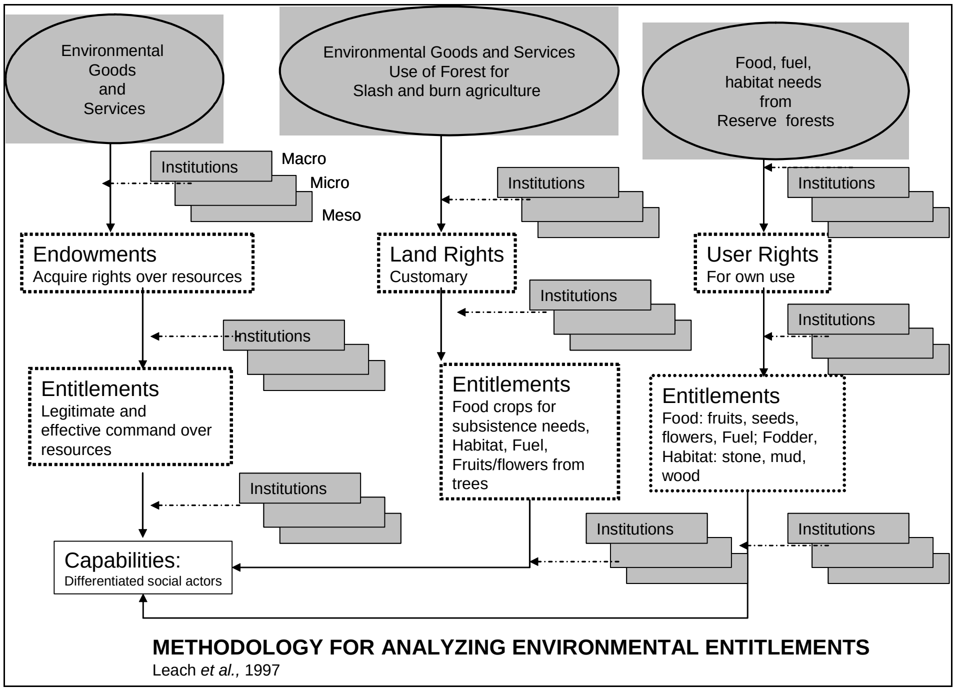


Figure-3-3: Environmental Entitlements Approach to Data Analysis

In contrast to the approach of Amartya Sen (1984, 1987), principally concerned with command over resources through the market channel backed by formal legal rights, the Environmental Entitlements analysis (Leach *et al*., 1997), includes customary laws as well as formal legal rights.

Using the framework as a map, role players (formal and informal) were listed and key inter-linkages identified that could assist in overcoming existing implementation obstacles (see Chapter 8, Section 8.3.2 page 199). For the future, it would be useful to understand the power interplays in the decision making structure from the point of view of the community. This needs in-depth discussion with stakeholders and was outside the scope and timeframe of this research.

3.7.4. Rural Livelihood Framework

Rural Livelihood Framework (Hogger, 2004) RLF is a conceptual framework that offers a multi-focal lens to understand the socio-cultural aspects of a livelihood system. The framework considers livelihoods as a complex whole, and identifies the inner as well as the outer reality of the people on whom the livelihood is centered.

RLF combines the metaphor of a home as a three-tiered entity consisting of a foundation (Base), an inner space (Space) and a roof pointing upwards (Orientation),[8] with that of a nine square *mandala*, a well known cultural symbol in India (and around the world). The RLF mandala (Figure 3-4) read from the right-hand lower corner covers Physical, Knowledge and Activity, and the Emotional basis of the livelihood. Moving on to the second row referred to as "Space", the RLF looks at the Socio-Economic Space at the scale of the village, the Family Space and the Inner Human Space. The topmost tier labeled "Orientation" deals with the Collective, the Family and Individual's visions and aspirations.

The RLF has helped connect the threads of the narratives in the Tumba case study in understanding their traditional agriculture as a socio-cultural and economic identity that ties the individual households to a larger community (See Chapter 7, section 7.4.2 Rural livelihood mapping: farmer's view, page 151). The metaphor of the house has also assisted in collecting information in the narrative form during workshops.

Individual orientation: Visions and aspirations Stories about the individual farmer (husband and wife separately) vision and aspirations for themselves and for their children	Family Orientation: Ancestors, caste, social status Stories about the family's Land inheritance, ancestral practice vis-à-vis today's practice, difference in practice between families/sub-castes, food habits	Collective orientation: Religious tradition, world views and education Stories about the community Festivals, past trends in bogodo, present status and future visions of bogodo in the whole village
Inner Human Space: Integrity, identity, selfishness, compassion Stories about Individual farmer's (husband and wife) association with his Bogodo land	Family Space: Gender relations, solidarity: Stories about the family's Work sharing, role of the women and children Migrants returning for Bogodo	Socio-Economic space: Community organization for Stories about the community's challenges and successes over Land distribution, sharing labor, seeds, tools.
Emotional base: memories and attachments Stories about the husband and wife's attachment to the bogodo and traditional values associated with Bogodo	Knowledge and activity base: Technology, experience skill Stories about the family's knowledge of bogodo practices, tools, equipment, method, skills unique to the family	Physical Base: natural resources, assets Stories about the village/community land used for Bogodo, crops grown, soil fertility, land availability, productivity of land

RURAL LIVELIHOOD FRAMEWORK: Hogger, 2004

Instructions to the researcher

Each workshop participant (Gram Vikas staff) will pick one village and one farmer family.
Try to bring out whatever stories you can concerning the different boxes in the "9-Squares".
It is not necessary to fill all the boxes.
Only those stories that you think are relevant and illustrative of the box needs to be written.
Write the story in a separate sheet of paper using the title from the box which best illustrates your story.
Please do not forget to mention the source of the story and the time (month year) when it took place.
Please write the stories in the language of your choice: Oriya, Hindi or English.

Figure 3-4: Rural Livelihood Framework (Hogger, 2004)

3.7.5. Adaptation continuum to assess VLB as a sustainable livelihood

Adaptation is defined by the UNFCCC as the process by which societies equip themselves to cope with an uncertain future (UNFCCC, 2007). The IPCC (2007) is more specific and defines adaptation as adjustment in natural or human systems in response to actual or expected climate stimuli or their effect, which moderates harm or exploits beneficial opportunities (IPCC, 2007, p. 869). In the case of VLB, where livelihoods are linked to the agroecosytem, livelihoods of communities are vulnerable to the changing patterns of climate. The issues of adaptation and response to vulnerability are therefore important parameters for assessing the sustainability of any livelihood outcome. Responsiveness of livelihoods to long term impacts of climate change are assessed using the framework (Figure-3-5) proposed by McGray (2007). **The framework was included when uncertainty due to climate change emerged as a strong theme during analysis (**see APPENDIX VI).

According to McGray, an adaptation response is shaped by two factors: first the existing capacities of those responding, and second the certainty of information about climate impacts (McGray, 2007). McGray notes two distinct perspectives on how people approach the challenge of adaptation. The first is creating response mechanisms to specific impacts of climate change, and the other is reducing vulnerability by building capacity to deal with a range of impacts. Between the two end points of vulnerability and impacts, are actions taken to reduce vulnerability. McGray uses Figure-3-5 to map adaptation efforts, where the extreme left signifies addressing vulnerability without consciously taking into account climate impacts (as in the case of traditional poverty alleviation, development programs), and on the right extreme are highly specialized activities that specifically target climate impacts. In between are activities that build response capacity through systems for problem-solving and manage climate risk by incorporating climate information into decisions (McGray, 2007).

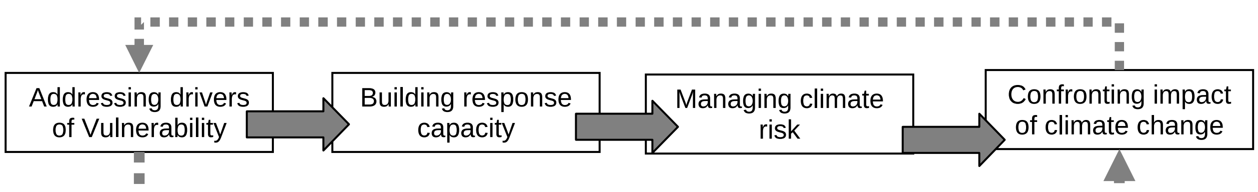


Figure-3-5: Adaptation Framework (McGray, 2007)

This research (see Chapter 8) discusses how livelihoods in the communities of Orissa fuelled by VLB have the potential to span the entire continuum, addressing drivers of vulnerability at one end while confronting impacts of climate change at the other. Resilience of livelihoods is defined in terms of this capacity to span the entire continuum of adaptation approaches.

Adaptation to Climate Change has therefore been included subsequently into the definition of resilience, when discussing sustainable livelihood opportunities.

3.8. Village selection

The approach of the CNBFES project in Orissa has been different in each of the three geographical areas. The Kinchlingi project, launched within the first three months of project initiation, had a technology focus while leaving most of the community development effort to the local Gram Vikas team. In the twin villages of Kandhabanta-Talataila there were initial discussions about a community-based management structure. Workshops were held with the villagers to map their community resources and develop a micro energy plan, based on availability of feedstock and demand for energy services. Most of the community mobilization was left to the Gram Vikas field staff, but with active support from the biodiesel team on a needs basis. Both the earlier sites were suggested by Gram Vikas and pursued in spite of insufficient usable feedstock. Kinchlingi[9] was taken up because a village-level demonstration site was required that was easily accessible. The twin villages of KBTT were selected because they were forest villages with access to sal seeds, a feedstock that later turned out to be a non-starter for biodiesel since it does not yield oil when expelled through mechanical oil expellers. It requires high-tech solvent extraction.

In contrast Tumba epitomized the ideal site for the application, being remote with ample forest seeds in addition to an indigenous agro-oilseed, niger, which is not locally used but rather sold to middlemen for about Rs. 16/- per kilogram. Diesel is not easily available: in order to purchase it, the residents descend anywhere from 300 to 500 metres in elevation (over 9 kms downhill), and then walk another 10-15 kms on the plains (not to mention the return trip back to their hill-top residences).

3.8.1. Research approach in Tumba, the study area

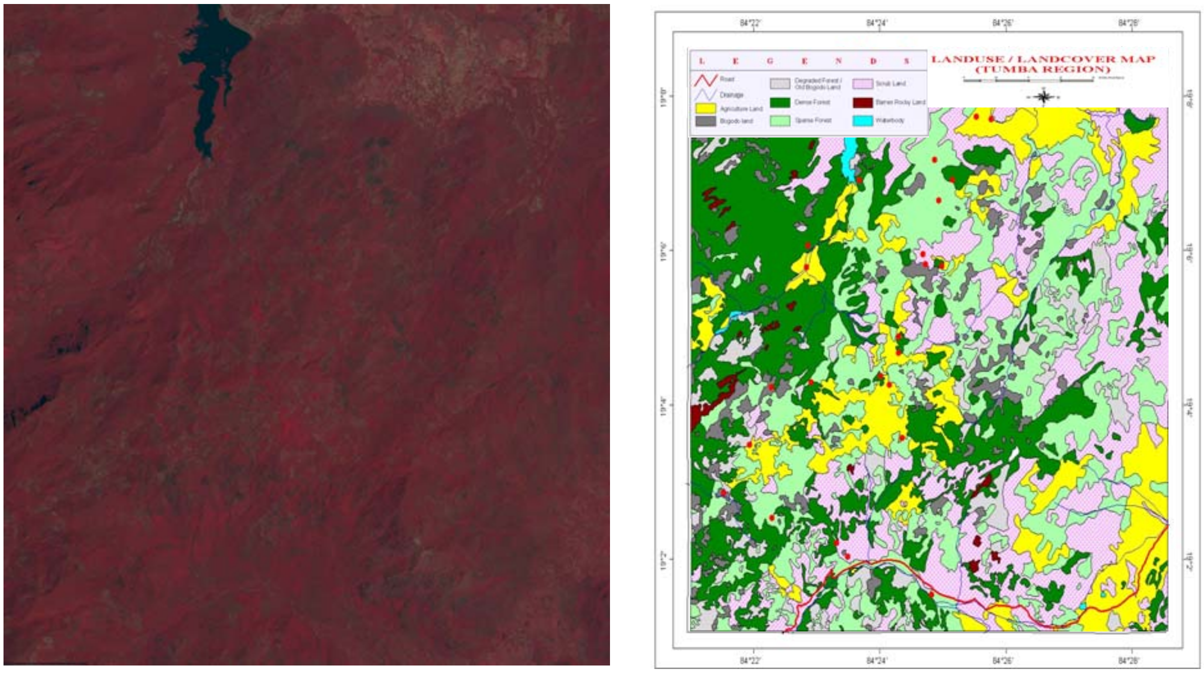


Figure 3-6: Satellite image and land use map of study area in Tumba

(LISS image, 5.8 m resolution. Land use map developed from LISS image by BN Mishra, U of Berhampur, 2006)

The area selected for the research lies within 19° 8.5′ N latitude, 84° 21′ E longitude (Upper left) and 19° 0′ N latitude 84° 29′ E longitude (lower right). All the villages in the study area are situated at elevations of 200 to 1000m above mean sea level (msl) and accessible only on foot from the village of Tadakasahi (elevation 109 m) at the foothills (Figure 3-6, Figure 3-7). Only villages where Gram Vikas is working have been studied for the potential of installing a biodiesel-based energy system. This includes 21 (out of a total of about 48) villages, all of which are inhabited by the indigenous Saura community, practicing a low-input, slash-and-burn form of subsistence agriculture much like *swidden* (known locally as *bogodo*).

All the villages on the Tumba group of hills can be divided into two geographically distinct watersheds, which we shall refer to as the Burataal and Raikhal clusters, each based on the name of the village most centrally located. While the forest and political boundaries are contiguous, each cluster presents its own unique set of political and community organizations. For this reason, the two clusters were discussed separately and a basic livelihood plan developed individually for both. These preliminary livelihood proposals were developed by Gram Vikas field supervisors in Tumba on the 3rd and 4th of March, 2005, using primary data collected by the CNBFES on natural resources and livelihood in 2005 (see APPENDIX X).

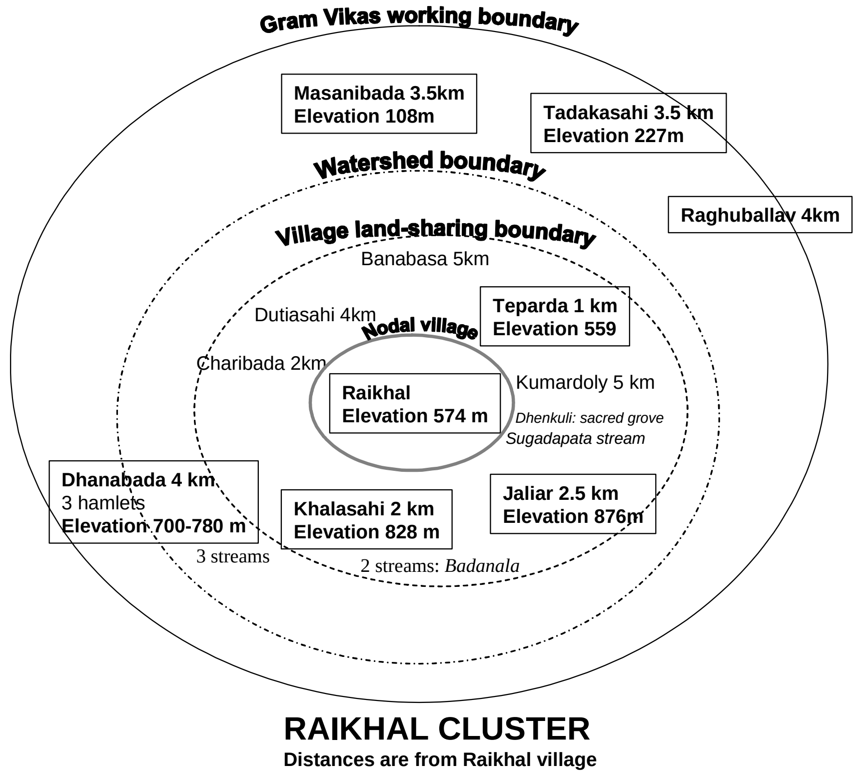


Figure 3-7: Villages in the Raikhal cluster of Tumba

The Raikhal cluster was eventually prioritized by the NGO for implementation owing to the presence of a more responsive community. It is within the Raikhal cluster of eight villages (Figure 3-7) that most of the work of the current field research is concentrated. A workshop was held for the local communities in the Jalior village, a part of the Raikhal cluster of Tumba, from 26-30 June 2006. A watershed plan was developed and overlaid on a land use plan. The forested area within the watershed was demarcated and a baseline natural assessment was carried out. Subsequently a biodiesel demand and supply plan was also developed by the youth of the community and reviewed and modified by the elders in October 2007. This was followed up with intensive workshops in December 2007 and between January and March 2008, to discuss different business models and identify potential first generation green entrepreneurs in the community. Details of this process are discussed in Chapter 7 and 9.

Eventually, in February 2008, a stakeholder discussion was held with other NGOs working in Orissa to present the livelihood strategy in Tumba and discuss the implementation challenges faced by the CNBFES (details in Chap 7, 9). The workshop was held at the pilot plant in Mohuda and helped establish key strategic directions for implementing VLB as a catalyst for sustainable livelihoods in the region. Findings of the workshop (see Chapter 9 for details) were presented to government bureaucrats in a state level policy workshop held in March 2009. The workshop resulted in key recommendations for the way forward for VLB in Orissa.

3.9. Conclusions

Participatory Action Research, Action Learning Case Studies and ethnography are the main methods used in this research. Tools for Environmental Entitlements analysis and for understanding Rural Livelihood Systems as a complex whole complement the action research methodology. The research is located in villages in Orissa, India and focused on developing case studies for two early village implementations of VLB. This is followed by process documentation, also in a case study format, for the third cluster in Tumba, where a livelihood strategy was developed using the framework in Chapter 2 (Figure 2-6). Development of the livelihood plan with the community included visual techniques such as mapping along with other participatory techniques. The ethnographic analysis indicated vulnerability to changing climate patterns as an important theme. The Adaptation Continuum framework was integrated into the toolkit of methods as a way to understand the degree of climate adaptation of the livelihood strategy. Workshops, focus groups, semi-structured interviews and journal entries were the main sources of information. Household surveys to assess energy usage and livelihood patterns were also conducted. A limited amount of natural resource monitoring was carried out for the purposes of developing a baseline for the watershed. However, the research is predominantly based on qualitative methods, with quantitative analysis complementing information as needed.

Stakeholder workshops for strategic planning used pre-tested methodologies. Several workshops were held (APPENDIX V: Data Sources: Workshops and Surveys) with different stakeholder groups including the community, staff members of the partner NGO, other local NGOs working in Orissa, and government bureaucrats (see APPENDIX X and APPENDIX XI, for excerpts of proceedings).

The chapters that follow include a discussion of the context for the first and second village implementation of VLB in Kinchlingi and KBTT, followed by a description of the context for the facilitated livelihood planning process in the Tumba cluster.

4. Context for the Village Level Biodiesel

Biodiesel is the best form of energy for infrastructure-starved communities – these communities do not need electricity as much as they need fuel to run small farm equipment and livelihood machinery. Biodiesel then becomes a boot-strapping technology, fueling agriculture, local value addition and livelihoods….the self-reliant community is able to rise above the threshold of poverty and negotiate with the State and the Market for their rights. After all, water and electricity are entitlements, and the Government of India has resolved to provide these basic infrastructure facilities to all by 2009 under its National Common Minimum Program. The community can continue to use biodiesel as a liquid fuel alternative to diesel, even as they have access to grid electricity. CTxGreEn 2009

Chapter Summary: Village level biodiesel (VLB) is a model being implemented in three communities in the state of Orissa, India by the Canadian NGO CTxGreEn in partnership with its local partner Gram Vikas. Biodiesel is produced using underutilized oilseeds, collected from the forests or grown in community fallows. The oil from the seeds is converted through a chemical process called transesterification, into biodiesel. Small pedal-powered machines produce the fuel in batches of 5 litres. The fuel produced is used for productive livelihood activities and the byproducts of the process (oil cake and glycerin) are value added. This model of VLB is unique in terms of the production process, and in its maxim of 'local production for local use'. Although there are policies in place to facilitate biodiesel production and use at the grassroots, these policies have to be energized and used effectively.

4.1. Orissa, the land and the people

India has six distinct agro-ecological zones[10] and Orissa falls within the sub-humid and the coastal ecosystems. Orissa in India, famous for its 13th Century Sun temple at Konarak, is associated with a rich cultural heritage over two thousand years old. Known previously as Kalinga or Utkal, Orissa, as the state is called today, is on the southeast coast of India (Latitude: 17°.49'N and 22°.34'N Longitude**:** 81°.27'E and 87°.29'E) occupying 450 km of the coastline. With a geographical area of 155,707 sq km (about 5% of the country), and a population of 37 million (2001 census), the average population density is about 238 per sq km, ranging from 64 in some forested districts to 415 in cities.

Orissa has two distinct agro-climatic ecosystems: the coastal and the sub-humid. The sub-humid ecosystem consists of a hilly tract called the Eastern Ghats, with red and lateritic soil and a growing period of 150-180 days, extending sometimes to 210 days. (National bureau of soil survey and land use planning). Eighty-six percent of the total population is rural and dependent on agriculture for their survival. The total cultivable area in the state is 7.9 million ha, of which less than 40% is irrigated. Predominantly an agricultural economy, Orissa is "severely insecure" with respect to food according to the Food Insecurity Atlas of Rural India (MSSRF, 2001).

In spite of being endowed with rich natural resources, including forest and mineral resources, Orissa continues to be among the poorest states in the country. Orissa has a rich biodiversity with forests occupying one-third of the land area, and comprising 7.4% of the total forested area in India. A large percentage of the ethnic communities in the state are dependent on the forest for their livelihood, and live in isolation with little or no government infrastructure.

Today the state is subdivided into 30 districts for administrative reasons. The current research project is based in the districts of Ganjam and Gajapati, which were a unified district (Ganjam) until 1992. Ganjam district as it was called, along with Srikakulam district from the neighboring state of Andhra Pradesh, originally belonged to the Madras Presidency under the British rule. The British had received Ganjam as a free gift (Inam) from the Mughals in 1762. Orissa finally became a separate state as late as 1936 and as a consequence, Ganjam also separated from the Madras Presidency and became a part of Orissa. Telegu, the language of Andhra Pradesh continues to be spoken in both Ganjam and Gajapati, which are also the home of several indigenous[11] forest-based communities.

The research project focuses on one such community, the Sauras that practice slash-and-burn agriculture in addition to settled farming and horticulture. They also collect and sell forest produce for a living.

4.2. Gram Vikas-CTx GreEn Biodiesel partnership

Gram Vikas is a non-governmental organization working in Orissa since 1979. A group of students set out in 1971 to assist war refugees and later continued to help with cyclone relief. Staying on to work on improving local livelihood practices, this group of students slowly began looking at interrelated issues such as community health. By 1979 they felt the need to set up an independent organization. Initially focusing on three core activities, biogas, tribal development and rural health and environment, Gram Vikas has today realigned its goals under the program title "Movement and Action Network for Transformation in Rural Areas-MANTRA." The elements of MANTRA include (1) Enabling infrastructure (2) Livelihoods and Food Security (3) Education and Health (4) Self Governing Peoples Institutions. The entry point of their activity is water and sanitation and they have a target of reaching 100,000 households, ~1% of Orissa, to attain a critical mass. In providing water and sanitation to remote communities, Gram Vikas believes that running water in the washrooms is essential, to ensure that they are used. In order to provide running water in areas with no electricity, alternative energy sources are required. Renewable energy technologies become critical in these cases to enable infrastructure. The CNBFES is one such interface.

CTx GreEn or Community-based Technologies Exchange fostering Green Energy Partnerships assisted Gram Vikas with documentation of their Rural Health and Environment Program in 2002. Later in 2003, during a trip by the team to Kalahandi in Western Orissa, it was noticed that the local seed niger was grown only to be exported to North America as bird feed. Most villages in Kalahandi are remote and do not have grid electricity. These villages were therefore unable to implement the RHEP, which needed a means to provide running water in the washrooms. Gram Vikas needed alternatives to grid electricity, and decided to take the renewables route.

Adding value to locally available underutilized seeds, by converting them into a fuel for pumps, could provide running water in the wash rooms and also spinoff for the local economy. This was how the idea of biodiesel from unutilized and underutilized seeds was born. The World Bank Marketplace Award in 2003 was looking for innovations that would "make services work for the poor," and the "Carbon Neutral Biodiesel-Fuelled Energy System," CNBFES, to provide drinking water and sanitation, seemed to be a good fit. CTx GreEn put in a proposal in the competition in partnership with Gram Vikas for such a biodiesel project in Orissa, India, and on winning the competition, began implementation in February 2004.

4.3. Biodiesel at the "Village Level"

The term "biodiesel" is used very loosely today and could mean anything from straight vegetable oils (SVO) to a 5:95 mix of vegetable oil and diesel, and is even sometimes confused with ethanol, which is a biofuel but not biodiesel (CTxGreEn, 2006; Vaidyanathan, *et al*., 2007).

Biodiesel is prepared from vegetable oil, but involves a chemical transformation, triglycerides to esters, in the presence of alcohol (99.5% pure ethanol or methanol) and lye (sodium hydroxide or potassium hydroxide). Such a change results in the formation of biodiesel, which can be used directly in diesel pump sets and generators, and glycerin, a byproduct that must be removed and either be converted to soap or composted.

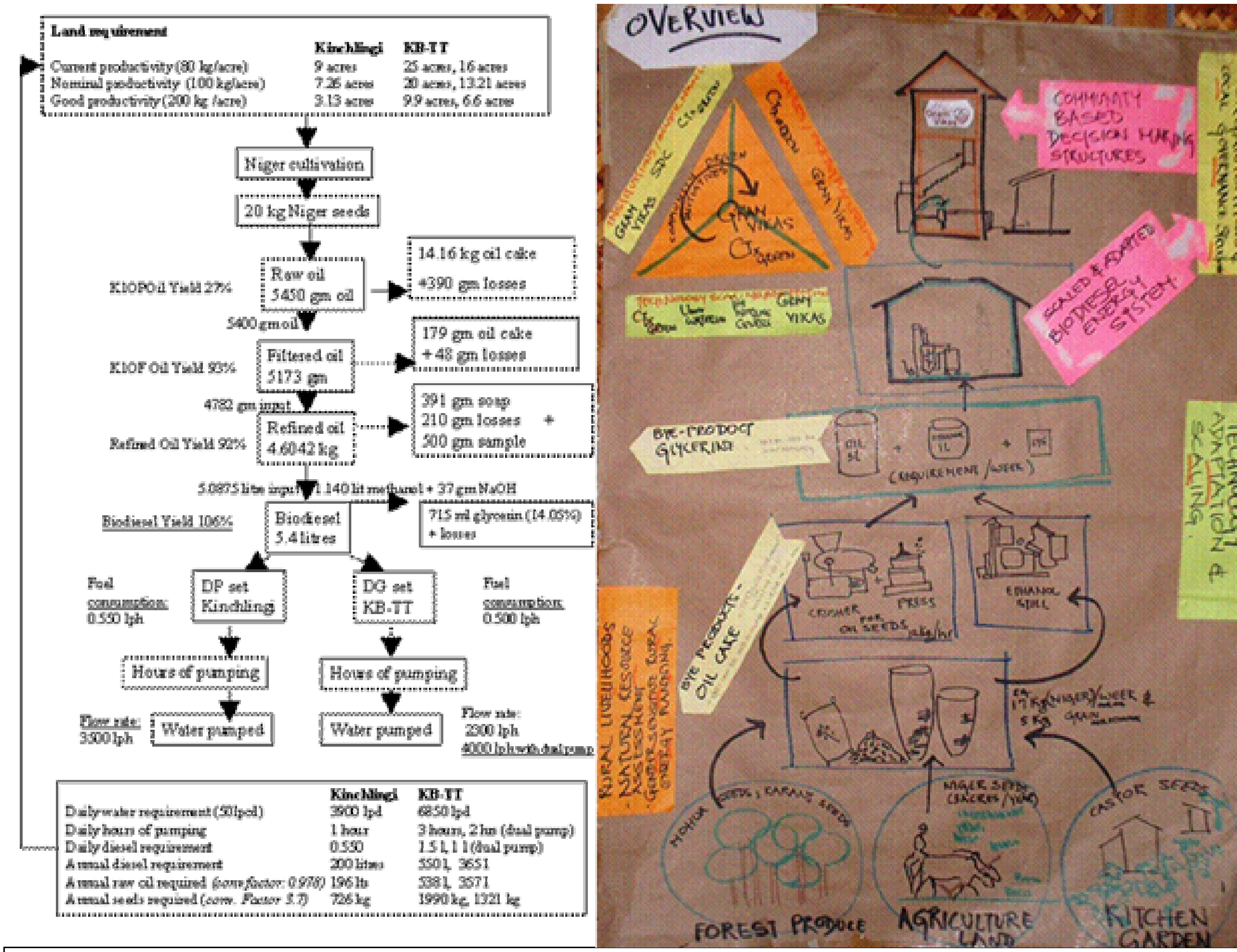
The attractiveness of this chemical transformation option from the engineer's point of view is that oil, which is acidic in nature, is neutralized in the process. The resulting biodiesel has properties similar to petrodiesel, and can be used directly in diesel engines without causing deterioration of mechanical parts. Thus the user does not have to make any major modification to their equipment. For the villager it is perhaps the only renewable energy fuel that can be stored easily and used as and when needed, without incurring great expenses. Biodiesel produced in this manner maximizes local value addition with the lowest cash outflow from the village economy.

Biodiesel is being promoted only as a transport fuel in India (MNRE, 2008). The National Biofuel Policy (2008) has proposed a 20% blend using biofuels, including both bioethanol and biodiesel, by 2017 (MNRE, 2008). At the State level, the Government of Orissa policy on biodiesel (Government of Orissa, GOO, 2008) focuses on converting land identified as wasteland into *jatropha curcas* plantations for biodiesel. Major oil companies and automobile manufacturers (Daimler-Chrysler in particular), in collaboration with the State governments and non-profit organizations, are giving incentives to farmers in the form of plant material, buy-back deals and even upfront subsidies, for growing this species (FIAN-HBF, 2008, http://nabard.org/farm_sector/biof_asp).

The smallest biodiesel production unit in the market today has a capacity ranging from 100 kg to 1 ton and requires between 400 to 4000 kg of seeds <u>every day</u> (assuming an oil yield of ~25%). There is a gestation period of at least 3-5 years for the jatropha plantations. Meanwhile, availability of feedstock is becoming the bottleneck for most biofuel projects.

Unlike most biodiesel efforts in India that rely on promoting j*atropha curcas*, a non-indigenous plant species that is suspected to have allelopathic effects on native species (Ellison, 2009), VLB promoted by the CNBFES is unique in that it sources only locally available and underutilized seeds.

The very small-scale of the technology (5 L and 20 L batch production on a bimonthly or weekly basis requires only 20 to 80 kg seeds per batch), was developed in dialogue with the community. The technology package includes good organic agronomic practices to supplement local forest seeds like karanj (Pongomia *pinnata)* and mahua (Madhuca *indica)*, with niger (Guizotia *abyssinica*), an indigenous oilseed with a short duration growing period that can be cultivated as one among other crops in village community fallows.



The village-scale biodiesel reactor produces biodiesel in small, five-litre batches from a combination of vegetable oil, lye and alcohol. It is a two step process, first of pressing oil and refining it and then of using the oil with alcohol and lye to produce biodiesel. Five minutes of pedaling combines the lye and alcohol into a homogenous solution in a small stainless steel mixer. This solution is added to vegetable oil in a larger stainless steel reactor. An hour of pedalling converts the oil-lye-alcohol mixture into biodiesel and glycerine. A byproduct that can be turned into soap, glycerine has a higher density than biodiesel and separates within two hours. In total, the production process takes about four hours, including one hour of pedaling. (Vaidyanathan, Sankaranarayanan, 2009)

Figure 4-1: Flow chart of the Village level Biodiesel (VLB)

4.3.1. Village-Level Biodiesel in the biofuels debate

At the outset, it is important to distinguish the Village-Level Biodiesel from conventional biofuel models as a “no-conflict, local-production-for-local-use” approach (CTx GreEn, 2008). Biofuels derived from plant biomass include a wide range of fuels, two of the most commonly discussed ones being bioethanol and biodiesel (UN, 2007; Practical Action Consulting, 2009). Biodiesel is itself a term that is used to mean a fuel derived from plant residue and could include fuel produced through transesterification of oil in the presence of lye and alcohol, as in the VLB or, diesel blended with Straight Vegetable Oils, SVOs (IC, 2008; Sankaranarayanan, 2009).

Biodiesel as it pertains to VLB is produced locally and used at the point of production, or within a 15km radius. The scale of the production is small, and the feedstock used is indigenous oilseeds that are underutilized or unutilized. There is therefore no question of plantations displacing food crops or fuel for transportation undermining the food security of poor farmers (FIAN, 2008; FAO, 2008; 2009; UN, Energy 2007; Hazell & Pachauri, 2006).

UN-Energy has outlined nine key sustainability issues concerned with biofuels (UN-Energy, 2007). These are: (1) Ability to provide energy services to the poor, (2) Agro-industrial development and job creation potential, (3) Health and gender issues, Implication for the structure of (4) Agriculture, (5) Food security, (6) Government budgets, (7) Trade, (8) Climate change and (9) Impacts on biodiversity and natural resource management. The report, 'Sustainable bioenergy: a framework for decision makers,' includes a preliminary assessment of biofuels feedstock and examines the soil, water, nutrient and climate requirements of 18 crops and their impact on natural resources. Various issues of small-scale production and use, including economies of production, are discussed. The report recognizes the intersection of different sectors in dealing with biofuels, including agriculture, forestry and energy, requiring cross-sector dialogue for policy making. According to UN-Energy (2007), liquid biofuels are a better substitute for the transportation sector than for heating and electricity. This is because better alternatives are available for heating and electricity. The cost of reducing GHG emissions by using biofuels is found to be relatively expensive, and the economic viability is assessed compared with the price of biofuels under prevailing oil prices. The cascading effect of biomass (using the biomass for various uses and then using the wastes for energy), and the enhanced possibilities for carbon sequestration by storing soil carbon through organic manures, opens up a whole new dimension of looking at biodiesel production systems.

The cascading and sequestration potential are applicable to VLB, but the most important benefit of VLB is that it is "local-production-for-local-use", and uses biodiesel for productive purposes only. While "the ability to provide energy services to the poor" is only one of nine sustainability issues suggested by the UN, with the VLB approach that is the central issue. None of the crops identified in the "preliminary assessment of biofuel feedstock" in the report (UN-Energy 2007) is relevant to VLB, which uses unutilized or underutilized locally-available oilseeds such as karanj, mohua and niger. The UN report's contention that biofuel is best used for transport because other options are available for heating and electricity, is countered by the argument in favor of VLB:

that biodiesel is ideally suited for infrastructure-starved communities, and can boot-strap the economy, moving into agroservices once the basic amenities of water supply and electricity are available through other sources. The fuel from the VLB is easy to store (as a liquid in containers), and can be used with minimal changes to enduse devices that ordinarily use diesel. There is therefore immense scope to use VLB to provide agroservices in remote rural areas.

In the case of VLB, the scaling up is not of enhanced production capacity but of replication of VLB with respect to the agroecosystem as a whole. Therefore, sidestepping most of the debate on biofuels while being cognizant of the issues being discussed, the focus of this research is on biodiesel to fuel sustainable livelihoods. The emphasis is not necessarily substituting existing fossil fuel sources (petroleum-based or coal-based), but in augmenting development, especially in infrastructure starved areas, without enhanced emissions.

4.3.2. Positioning the Village Level Biodiesel as a small-scale bio-fuel/energy initiative

In order to position the model being discussed (VLB) in the current practice of small-scale biofuel applications, other similar experiences have been compared. In addition to introducing other small-scale biodiesel applications currently being promoted, this analysis also contributes to lessons for the implementation of VLB in Orissa.

The CNBFES has been showcased by three reputable organizations (Table 4-1), each with their own sectoral focus on the sustainability issues concerned with biofuels as outlined by the UN Energy (UN 2007). These three organizations are (1) WISIONS, focusing on resource efficiency, (2) FAO-PISCES, on livelihoods and (3) ENERGIA, on women empowerment. Taking advantage of the existing foundation, where case studies published would have followed elaborate criteria for selection, this research uses the inventory of projects compiled by the three organizations to compare VLB. The objective is to understand similarities and differences in approach, and position VLB among other similar biofuel applications.

Table 4-1: Organizations that have showcased VLB

	Published by	Sectoral focus
1	WISIONS (2006) of Sustainability, the Wuppertal Institute for Climate, Environment and Energy	Promotion of resource efficiency projects
2	Food and Agriculture Association of the Untied Nations (FAO) and the Policy and Innovation System for Clean Energy Security (PISCES), (Practical Action Consulting, 2009)	Rural livelihoods, food security, agriculture
3	ENERGIA (2009), The International Network on Gender and Sustainable Energy supported by the International Union for the Conservation of Nature (IUCN) and the South African National Energy Research Institute (SANERI)	Gender mainstreaming of rural energy

WISIONS’ (WISIONS, 2006) focus is mainly on resource efficiency. Replication potential, durability, economic and technical viability and sustainability were the other criteria used for selection of projects. In their document entitled ‘Sustainable Biofuel production and use, options for greener fuels’, the projects included are from Ghana, India, Austria and Indonesia.

The Ghana project demonstrates best practice in organic farming to produce and supply vegetable oil from palm kernel. The Austrian project in the City of Graz collects and recycles waste vegetable oils and converts them to biodiesel for the city’s buses, thus reducing exhaust and emissions. The Indonesian project is a multi-feedstock bioethanol production plant aimed at finding a solution for the country’s need for petroleum fuel. The Indian project, VLB model, provides an energy source in non-grid connected villages using locally-produced biodiesel.

The four projects exhibit the potential of biofuels using different feedstock and for a wide range of uses from transportation to generating heat and electricity. The uniqueness of VLB among the other projects showcased is its use of locally-available resources to provide for the subsistence needs in remote villages. In this model, the **distance between the producer and the consumer is removed, aiming for maximization of benefits within the local economy, without increase in fossil fuel consumption.**

The FAO-PISCES report (Practical Action Consulting, 2009) “Small-scale bioenergy initiatives” includes cases from Asia, Latin America and Africa. Fifteen case studies from India, Sri Lanka, Kenya and Tanzania explore the linkages between small-scale bioenergy initiatives and livelihoods. A range of bioresources are used as feedstock, and the end uses are also vastly different. The analysis of the cases is elaborate, following a Market systems perspective (and Market mapping) to understand the actors, support services and enabling environment that contribute to project success or failure. The actors are further qualified using a 4Rs approach (Relationships, Rights, Responsibilities, Revenue) to understand the power dynamics, after which an impact analysis (in terms of human, physical, natural, social and financial impacts) is done for each project.

Out of the fifteen cases, there are eight case studies that are based on liquid biofuels and/or biodiesel. Of these, the most relevant for comparison with the VLB model are (a) the Mali, India and Guatemala projects for the provision of electricity using jatropha as feedstock, (b) the micro-distillation unit in Brazil and (c) the Thailand jatropha-based units for providing biodiesel for tractors (presently) and for byproduct utilization. All these projects share similar timelines and are in more or less similar stages of implementation.

The Mali and India jatropha projects are primarily rural electrification projects while in the Guatemala project farmers have an additional source of income through the sale of jatropha seeds. Emphasis is on growing of the feedstock and the benefits accruing to farmers from the sale of the feedstock. This is the point of departure of VLB, which is probably the only community-driven initiative using locally-available, unutilized, underutilized feedstock not requiring long gestation periods for cultivation like jatropha.

There are interesting similarities between VLB and the biodistillation unit in Brazil. The micro-distillery project has a two-fold focus: (1) the distillery and related systems and (2) the stove as an end-use device. This is similar to VLB, where the water pumping has two components: (1) the biodiesel production system and (2) the end-use devices ranging from pumps and generators to small agricultural equipment. The Brazil project has two parallel streams of technology dissemination, one for the stove users and another for the ethanol producers. The ethanol production is currently with the project promoters and their focus is on encouraging the use of the stove. This dichotomy does not exist in the CBFES, where VLB is an integrated package including production as well as end-use devices. The separation of the fuel production from the service could be an input into the VLB enterprise model in Tumba.

The Thailand case is built around byproduct utilization and the use of the fuel for generating electricity for farm equipment such as tractors, and for transportation. The scale of the project as anticipated is much bigger than VLB (73,000 litres of biodiesel per annum and a 500 kW small-scale power plant versus 2kW to a maximum of 10kW of VLB). The Thailand model is expected to grow into a cooperatively managed model in contrast to the community-based approach of VLB. The other more important difference is the role differentiation in the Thailand project for each and every activity ranging from (a) growing feedstock (b) producing the fuel (c) selling fuel and byproduct and (d) using fuel and other products. The cooperative is eventually expected to take over the role of the technology finance provider. VLB has several overlapping roles, with the community being the producer and user of the products, and the emphasis being on decreasing resource outflow from the local economy to enable local value addition. The similarity is the mix of enterprises with community support (SHGs and farmers cooperatives), which ensures more equitable sharing of resources, reducing chances of a monopoly.

ENERGIA's publication "Biofuels for sustainable rural development and empowerment of women" includes case studies from Asia and Africa- Cambodia, Sri Lanka, India, Nepal, Ghana, South Africa, Uganda and Zimbabwe (ENERGIA, 2009). These case studies are examples of biofuels for sustainable livelihoods and for local energy sources in rural areas of developing countries. Special emphasis is placed on women, who in these countries play a key role in all facets of agricultural activities. Five of the seven case studies use jatropha as the feedstock, necessitating growing it as a plantation crop. Three of the projects discussed are relatively large scale agrobusiness models, with either the State or Private Sector (Market) as a key driver. Four projects, in Cambodia, Ghana, Uganda and Nepal, present interesting possibilities for cross learning for the VLB project in India.

The project in Cambodia although it relies on jatropha plantations and is premised on an entrepreneur supplying electricity, has interesting similarities. **The project has concluded that to be economically viable the energy produced should cater to economic activities and not just for provision of domestic electricity.** They have established that the cost of biodiesel is 37% less than petrodiesel (having replaced diesel in the generator sets that were in use), but more importantly the major cost (95%) is the cost of labor, and they now do not have to pay money to "outside sellers to buy standard diesel (ENERGIA, 2009, p.12)."

The use of biodiesel in Uganda for a Multi-Function-Platform system, MFP a small diesel engine mounted on a chassis that generates electricity to power equipments, has parallels with VLB, which also uses biodiesel for pumps, engines, tillers *etc*. This UNDP project is replicating the success of the MFP in Uganda in west Africa. Previous applications tried by UNDP in other regions of Africa include multiple livelihood applications ranging from a water pump and a rice and maize mill, to a milk chiller coupled to the MFP. All of these use biodiesel produced from jatropha. The project in Uganda is still in the feasibility stage. The details of how the fuel is produced, and whether it is Straight Vegetable Oil or transesterified biodiesel are not clear from the discussion presented by ENERGIA.

In the Nepal project, farmers will use jatropha oil for running irrigation pump sets, and in the Ghana project, a women's group is using a 70-30% mix of jatropha oil and diesel to run equipment to make shea butter. The emphasis, as in the VLB, is on using biodiesel for livelihood activities.

Conclusions

In both the FAO-PISCES as well as the ENERGIA cases, biodiesel is the means to fuel livelihoods and the emphasis is on local value addition. Biodiesel in all these cases is thus a productive input into another chain (Practical Action Consulting, 2009, p.23). **The projects differentiate between the user of the fuel and the producer of the fuel**.

It appears that in almost all of the biodiesel-based projects that have been discussed in the case studies by the three organizations, the fuel used is straight vegetable oil. There may be simplicity in being able to use the oil directly in the machines, but engines that use Straight Vegetable Oils are not readily available in the market. The advantage of using a refined transesterified fuel is that it can be used in any diesel engine (with minimum modifications). **This widens the choice of the end uses, but more importantly, leverages the existing network of diesel engine suppliers**.

Refined transesterified biodiesel as produced through VLB is better suited for small, mobile applications whereas Straight Vegetable Oil, SVO, applications, even after extensive engine modifications, are best for stationary uses (CTx GreEn, 2008; Practical Action Consulting, 2009). It is possible to use oils blended with diesel when SVO is used directly in diesel engines, but that also presupposes that diesel is easily available. This can be an issue in many remote locations.

VLB in its present form in the CNBFES locates the community at the centre of the development, relying on volunteers, Self-Help-Groups or first-generation green entrepreneurs raised from the local community. Microplans and feasibility studies are developed and conducted with the community, and members are involved even in the technology development process. The hope is that the community will take up the production of biodiesel. In most of the other cases (Brazil, Uganda, Thailand) the technology proponent continues to be involved in the project. The Cambodia case is the most interesting and encouraging, as the entire facility is run by a home-grown local entrepreneur.

Another interesting conclusion from the case studies is that all over the world, biodiesel and biofuel are being seen as alternatives to diesel. Governments are promoting them with the main aim of import substitution and insurance against rising fossil fuel prices. Even in Brazil, where the regulation of bioethanol is well established, according to the experience of the micro distillery project (Practical Action Consulting, 2008), policies are focused on transportation and do not include household uses of bioethanol.

The above examples further emphasize the point that livelihood initiatives that create local self reliance, and can potentially achieve development without increased emissions, are being ignored in the policy-making arena. This is the case, not only in India, but all over the world. This establishes the relevance of the current research, beyond Orissa and India, to a wider context.

4.4. Legal and policy regime defining the context for VLB

With the 73rd amendment to the Constitution of India, there has been devolution of power to the grassroots. The practice of decentralised decision making, however, is only slowly becoming a reality. In keeping with the drive to build an informed civil society at the grassroot, there are several provisions in the existing policy regime that can be instrumental in making the transition to decentralised energy production easier. There are two specific acts that have special provisions for indigenous communities and can leverage local economic development. These are ‘Panchayats Extension to Scheduled Areas’ act 1996 (PESA) and ‘The Scheduled Tribes and other traditional forest dwellers (Recognition of forest rights) Bill, 2006.’ In addition to these, and with respect to the production of Village-Level Biodiesel, clarity is needed about provisions under:

a) The Orissa Forest Act, 1972, and Forest laws in operation, which have clear guidelines for transaction of forest produce including collection, sale, transport, fixation of price *etc*.
b) The Orissa Excise rules, 1976, which lay the basis for both the purchase and the production of alcohol (required for biodiesel)

Other policies that are relevant to VLB are:

c) The National Action Plan for Climate Change, 2008, which addresses climate change through eight core national missions, where biofuels are covered under the "Solar mission"
d) The National Rural Employment Guarantee Act (NREGA), 2005, which provides livelihood security for households in rural areas through a guaranteed wage employment of 100 days every year
e) Policy Guidelines for Raising of Energy Plantations and Biodiesel Production, Govt. of Orissa, 2007, which makes a token mention of small-scale biodiesel production.

4.4.1. The biodiesel policy in India

India has a national policy on biodiesel and every province has also been encouraged to develop their respective policies. Although the Government of Orissa is the first in the country to have a biodiesel policy in place (GOO, 2007), it has been formulated keeping in mind the jatropha based agroindustrial large scale models aimed at providing fuel for transport . The policy of the province of Orissa outlined under the "Policy guideline on raising energy plantations and biodiesel production, (GOO, 2007)," estimates that there is potential for 14,000 KL of biodiesel / annum in the province which could utilize 0.6 million ha of wasteland, and generate 100 million person days of employment and 42,000 tons of organic manure. There is a big emphasis on the promotion of jatropha, a non-indigenous species. Although the policy explicitly states that only wastelands will be used for cultivation, the subsidies being made available are easing out food crops in many parts of the state, enough to have raised a hue and cry from local activist groups (FIAN, 2008; OXFAM 2007). The policy contains the following provisions on the small-scale biodiesel production (GOO, 2007, Section 7.0, p.5 of resolution 5345, Dt. 23Aug07):

1. Small biodiesel production centres will be encouraged in rural areas for different local applications like water pumping, village electrification, *etc*.
2. There is no minimum size for a biodiesel facility and small decentralized biodiesel facilities do not require dedicated technical staff; they can be operated by locally-trained nontechnical staff
3. The Indian Oil Corporation (IOC) has agreed to buy the entire biodiesel yield produced in the state, subject to quality and regulation of supply.

There is no reference to (a) livelihoods, (b) local production for local use or (c) tax exemptions for purchase of alcohol. Nor are there any provisions to assist the "small biodiesel production centres," although there is a lot of emphasis on facilitating credit for raising jatropha plantations and linkages with the bank National Agricultural Bank for Agricultural and Rural Development to obtain the same. The role of farmers in the proposed scheme is only to provide the raw material, and their training is limited to learning how to raise the plantations. Processing centres are envisaged as large-scale units: the oil expeller proposed in the 'model seed procurement centre' (GOO, 2007, p11) has a capacity of 5MT per day and runs on a 40HP motor. It is easy to see that when the discussion is around 5000 kilograms of seeds per day, an 80kg per day unit feeding a 5L/batch biodiesel reactor in a VLB system appears insignificant, even though economically more viable.

Even the newly drafted National Biofuel Policy (MNRE, 2008), approved by the Union Cabinet on the 11 September 2008, is premised on "an indicative target of 20% by 2017 for blending by biofuels." There is emphasis on the use of degraded marginal lands for biofuel plantations and on use of non-edible oilseeds. Only indigenous feedstock is permitted for use in biofuels and there is no allowance to import oil. Yet the policy is silent on the concept of local production for local use. The Ministry of Petroleum and Natural Gas announced a purchase price for biodiesel at Rs. 25/litre effective January 2006, stating that "*Only those biodiesel manufacturers who get their samples approved and certified by the oil companies and get registered as authorized suppliers will be eligible for assured purchase of product*." (Hindu, 14/10/2005). The Indian Oil Corporation envisages using the purchased biodiesel as a 20% blend for diesel for transportation purposes. The price fixed for biodiesel (Rs. 25/litre in 2006) includes the cost incurred for purchase of raw materials (oilseeds, alcohol and lye), for production, for testing and for transportation to the purchase centre (which for Orissa is located over 300 kms away from the CNBFES project sites, in the neighboring State of Andhra Pradesh).

The issue of waiving the excise duty has been discussed by CT_x GreEn with the State bureaucracy for the last three years, but without success. A study was conducted with the help of the Enviro Legal Defence Firm to understand the legal feasibility of Village-Level-Biodiesel production. A clear case has been made on behalf of producing biodiesel for productive livelihoods and subsistence activities over transportation fuel. The argument has also been made that alcohol used for productive livelihood activities should not be taxed in the same manner as consumptive alcohol. Moreover, alcohol is a raw material but biodiesel as a finished product does not contain alcohol. The study recommends that "there are two possibilities that can be applied to advantage to facilitate rural biodiesel initiatives: (1) Exceptions provided under the

Medicinal and Toiletries Preparations (Excise Duties) Act and (2) Exclusive Privilege Clause to obtain exemption on duties." (Upadhyay, 2006)[12]

A case has also been made under the Panchayats Extension to Scheduled Areas, PESA act (MPR, 1996), where there are special privileges to Schedule tribes (indigenous communities) in Scheduled Areas (Reservations). Under PESA provisions each person is exempt to brew between 7-18 kg liquor from rice or other cereals for bona fide consumption but not for sale. In Scheduled Areas, prior approval and permission for manufacture or sale of any intoxicant is decentralized and provided by the Gram Panchayat (Village Government) in concurrence with the Village Administrative bodies, usually at the level of the Ward (a conglomeration of villages) (Upadhyay, 2006).

Similar rules apply for the procurement and collection of forest produce, which has now been released from the State monopoly and is within the purview of the Gram Panchayat. Under the Joint Forest Management, the Village Forest Protection Council (called Van Suraksha Samiti: VSS) and the Forest Development Agency (a State agency) have a shared stake in the village forests. However, the Gram Sabha (village council) and the VSS together can regulate procurement and collection of forest produce. The constitutional role of the VSS has thus been legitimized through the panchayat legislation enacted under PESA (Upadhyay, 2006).

It appears therefore that there is a policy climate conducive to the promotion of biodiesel as an alternative fuel. How to best leverage existing policies to promote village-level production-and use in catalyzing livelihoods is the question to be addressed.[13]

4.5. Brief history of the CNBFES project- a prelude to the research

Starting with the pilot plant at Mohuda (which is also doubling as a resource centre for biodiesel), biodiesel production units were established in Kinchlingi in Nov 2004 and in the twin villages of Kandhabanta and Talataila in December 2004. While a (bio) diesel pump set was installed in Kinchlingi early in February 2005, daily water pumping could start only in May 2005 after completion of the water tank in the village. In spite of several challenges, the village of Kinchlingi ran the biodiesel pump set for over three years, using more than 450 litres of biodiesel to pump over 2,191,418 litres of water, until gravity flow arrived in April/May 2008. The village wanted to retain VLB in the village for another two years, in spite of now having an alternative water supply, as insurance in case the gravity source and the stream supplying their village went dry. In consultation with the CNBFES team, the village decided to use the equipment for providing lighting. The change over took over 6 months, and in January 2009 biodiesel was used to run a generator and provide lighting to the village of Kinchlingi.

In the second set of villages, Kandhabanta and Talataila, a (bio) diesel pump set was not suitable since the water table dips below 40 feet in summer. A biodiesel-fuelled generator set was required to generate electricity that would drive the ½ HP submersible pump. Biodiesel-fuelled water supply started in July 2006 in Kandhabanta-Talataila and continued for about 10 months, during which period water was pumped and supplied for 148 days, consuming approximately 90 litres of biodiesel. Over 130 kWh of electricity was generated and 488,000 L of water were pumped in KBTT. The biodiesel-fuelled water pumping system has since been replaced by a gravity-flow water-supply system. Biodiesel pumping will be used in the summer months when the streams may run dry. In addition the community would now like to use biodiesel for home lighting.

In the third area of implementation, Tumba, a cluster of eight villages is the focus. CT_x GreEn and the Gram Vikas field teams worked closely with the villagers in assessing underutilized oil-bearing trees in the forests. A livelihood proposal was developed for VLB in the community, with watershed management as the first activity. The community in Tumba has identified small livelihood activities like oil expelling and water pumping for irrigation as the niche for using biodiesel. This research facilitated a livelihood planning exercise for the eight villages in Tumba. The process was informed by lessons from the Kinchlingi village in the Anandpur project area and the Kandhabanta-Talataila villages in the Rudhapadar project area.

Biodiesel has been developed from different oilseeds, *viz* niger, karanj and mohua, at the pilot plant at Mohuda. Another role of the pilot plant is to develop good operating practices to manage and monitor the technology and its impact on the community. The thrust over the last two to three years has been to train barefoot technicians (usually 7th and 8th grade drop-outs) from the local community to monitor quality of the fuel, operate and maintain machines, log data and most importantly run the unit as a sustainable enterprise.

4.6. Basis for a biodiesel-based micro energy plan for livelihoods in Tumba

The approach of the CNBFES project in Orissa has been different in all three geographical areas. The Kinchlingi project, launched within the first three months of project initiation, had a technology focus, leaving most of the community development effort to the local Gram Vikas team. In the twin villages of Kandhabanta-Talataila, there was discussion around the management structure, and a workshop was held with the villagers to map their community resources and develop a micro energy plan based on availability of feedstock and demand for energy services. Most of the community mobilization was again left to the Gram Vikas field staff, but with active support from the biodiesel team on a needs basis. Both the earlier sites were suggested by Gram Vikas and pursued in spite of insufficient usable feedstock: Kinchlingi because a village-level demonstration site was required that was easily accessible, and Kandhabanta because it was a forest village with access to sal seeds, a feedstock that later turned out to be non-starter for biodiesel as it does not yield oil through mechanical oil expellers but requires high-tech solvent extraction.

In contrast, Tumba epitomized the ideal site for the application, being remote and having ample forest seeds. In addition it has the indigenous agro-oilseed niger, which is not locally used but sold to middlemen for about Rs. 16 per kilogram. The communities in Tumba, the Saura tribals, are dependent on the forest for their livelihoods. Besides the sale of minor forest produce, their mainstay is a form of slash-and-burn agriculture called bogodo. This form of subsistence agriculture promotes multiple high nutrition crops and is a low-input agriculture, but is not sufficient in meeting their food requirements. Residents of the Tumba cluster face food shortages and seasonally migrate to cities. There is almost no infrastructure available in the form of roads, electricity, primary health services or any form of communication. Residents trek down anywhere an elevation of between 300 to 500 metres (over 9 kms downhill) and then walk another 10-15 kms on the plains for supplies not produced in the village, and then make the return trip back to their hill-top residences. Gram Vikas has been working in 21 such villages since the 1990s through its integrated tribal development program. The CNBFES initiated work in the Tumba cluster in June 2004 through an intensive survey of the forest, followed by an inventory of oil-bearing trees in 2005-06. A study of bogodo, the local traditional agricultural system, was also conducted through a participatory workshop with five farmer families in August 2004. This was a preamble to the more involved activities that were to follow.

4.7. Conclusion

The communities in the villages of Orissa, India in the sub-humid agroecological zone form the context for the development of VLB as a catalyst for sustainable livelihood opportunities. Orissa is well endowed with natural resources, yet it is one of the poorest states in India. Agriculture is the main livelihood here, yet the state has been characterized as being severely food-insecure by the MS Swaminathan Research Foundation. The focus of this research is on infrastructure-starved remote communities dependent on the forest to supplement subsistence forms of agriculture. The CNBFES project is being implemented by two field-based NGOS, CTxGreEn (Canada) and Gram Vikas (India), in three communities. VLB is central to the CNBFES, and has been developed with the view of integrating it into the existing livelihood system of the communities. The aim is to positively spinoff multiple and diverse livelihoods based on the local resource base. VLB was developed through knowledge exchanges with the local community and has the following key features: the fuel is produced locally for local use, sources only locally-available and underutilized seeds like karanj (Pongomia *pinnata),* mahua (Madhuca *indica)* and niger (Guizotia *abyssinica),* and the byproduct, oil cake, is promoted for use locally as an organic fertilizer. The scale of the technology is very small (5 L and 20 L batch production on a bimonthly or weekly basis requiring only 20 to 80 kg seeds/batch), and includes good organic agronomic practices for <u>short duration</u> alternatives that can be grown in village community fallows to supplement local forest seeds. Biodiesel is produced through a chemical process called transesterification, which combines oil with alcohol in the presence of a catalyst, lye, in a pedal-powered machine. The purpose is to have a good quality fuel that can be used in existing end-use devices like diesel engines and pump sets without major modifications. Biodiesel in this form minimizes cash outflow from the villages, and encourages uses in productive livelihoods instead of consumptive transportation. The premise of VLB is therefore different from that being promoted in policy arenas globally by the UN, nationally by the Government of India or regionally by the State Government of Orissa, all of whom are promoting biofuels mainly for transportation purposes. VLB puts forward a model of augmenting development without increasing emissions. While the livelihood context for promotion of VLB is fertile, there also exists a regime within the realm of the national and state policies, presently dormant, that can be used to leverage development of VLB to catalyze grassroot local economic development through its local-production-for local-use approach.

The chapters that follow include a discussion of the first and second village implementation of VLB in Kinchlingi and KBTT respectively, followed by a description of the facilitated livelihood planning process in the Tumba cluster.

SECTION II

Knowledge exchange and action learning case studies

When production and consumption both become localized, the temptation to speed up production, indefinitely and at any price, disappears. Mahatma Gandhi on Village Development (n.d)

Summary of the three case studies

The developments of VLB in Kinchlingi, KBTT and Tumba are chronologically presented in the case studies that follow. The three case studies include a description of how resources in the three separate contexts were used by different actors and through different decision making processes. Each village had its own strategy while adopting the VLB and this led to different outcomes in each case.

The Kinchlingi case study discusses the evolution of the technology. Biodiesel was initially used in a pump set for water pumping, and later in a generator to provide lighting. The village adopted a volunteer model, and over the four years validated the techno-economics of VLB. The technology-community relationships are highlighted, including the role of women in promoting technology acceptance. The highlight of the Kinchlingi phase of VLB was the adaptability of the technology.

In the twin villages of Kandhabanta and Talataila, KBTT, a Self Help Group model was proposed. The configuration of the technology was different from Kinchlingi and included a generator and an electric pump in place of the diesel pump. The context of KBTT was more complex involving two villages, Kandhabanta and Talataila. The challenges of dealing with changes in the technology specifications, coupled with a different management system, led to a strategy that was different from Kinchlingi. The cost of water supply was calculated based on the data generated from running the unit in the village, and was found to be marginally lower than Kinchlingi. KBTT is better suited for VLB in terms of agroecosystem characteristics. Yet technology innovations assessed for KBTT were finally implemented in Kinchlingi, because of the readiness of the community in Kinchlingi. The Self Help Groups in KBTT need to be strengthened in order to take up their role in the management of VLB. The Village Executive Committee and the forest protection committee (Van Surakhsa Samiti) also have a role in the management structure of VLB in the Self Help Group model. A cluster approach including five neighboring villages is proposed for the way forward. The case of KBTT is an example of how a good plan can get compromised during implementation.

The case study of Tumba is different again, firstly because it involves a cluster of eight villages, and secondly because VLB has not yet been implemented here. The development of a livelihood strategy with the community is the highlight of this phase. The strategy being proposed for the way forward is a three-pronged approach including sustainable agriculture, value addition and biodiesel-fuelled services. The emphasis in Tumba is on setting up an oil expelling enterprise, privately owned but supported by SHGs. It is proposed that the SHGs could act as an interface between the market and the banks and reduce the risk to the oil milling entrepreneur. Strengthening the SHGs to take up this role, and to effectively reduce the outflow of their oilseeds by value adding and using oil and oil cake locally, is needed for the success of VLB in Tumba.

While this research documented the development of VLB in Kinchlingi and KBTT, it facilitated the livelihood planning exercise in Tumba.

Guide to reading the case studies

The case studies have been organized using Figure 2-6: Functions of the SLF for VLB, page 29, mainly to emphasize the feedback loops and the iterative nature of the narratives. The building blocks of the framework, SLF for VLB, are not used to organize the case studies because themes overlap. It is therefore difficult to restrict the discussion to one or the other of the blocks.

Context specific conclusions, pertinent to the case studies are included in the respective chapters. Conclusions of a more generic nature and those related to the framework, SLF for VLB, are summarized in Chapter 8.

5. Case study of VLB catalyzing sustainable livelihood opportunities: Field installation 1

Successful innovations are a complex process of learning and adaptation.

Douthwaite 2002 in Hall, Yoganand, Sulaiman & Clark, 2003, p.103

5.1. When cash income takes over subsistence livelihoods. The Case of Kinchlingi

Almost nothing made sense about selecting the village of Kinchlingi for installing the biodiesel unit except the villagers' willingness to take a risk. Yet this village has been a mutual learning ground, both for the Biodiesel Project, CNBFES, and for the community.

This case study traces the development of the project over 5 years and discusses how the project responded to feedbacks and continually went back to the drawing board. Adjusting to the intricacies of science and the intrigues of community, in a context where relationships between people, directly or indirectly involved, were constantly being redefined, the sustainability of the livelihood here depended on the ability of the innovation system (VLB) to constantly adapt. Using the Sustainable Livelihood Framework, SLF for VLB, (Figure 2-5 and Figure 2-6, page 29), we now reflect back on the experience to understand underlying patterns of relationships and the historical as well as the institutional context governing these relationships. In this light we see the VLB as an interactive learning process (Hall, *et al.*, 2007).

Narratives and the chronology of events are provided that help in understanding (a) the role of the technology in promoting value addition and land regeneration, and (b) the ability of the community to manage the system independently. There is also some reflection on the role of women in planning and implementation of a technology that obviously benefits them. In the process, the narratives contribute to a better understanding of the latent processes between various people involved, and to identify strengths, opportunities and challenges of the approach. In particular the narratives throw light on the basic question being discussed by this research, whether the Village Level Biodiesel (VLB) can catalyze sustainable livelihood opportunities, reduce vulnerability and enhance the adaptive capacity of the community with minimum damage to the environment.

A simple timeline of relevant events in Kinchlingi has been reconstructed in Section 5.2. The purpose is to identify the key events, agencies involved in mediating these events, and their role and interest in the project. This is followed by analyzing the patterns of relationships between the different role players and understanding process outcomes that emerge. These are important lessons in terms of opportunities and challenges for the way forward with the Village Level Biodiesel as a catalyst of sustainable livelihoods in another area. The dynamic nature of the village level implementations is represented in Figure 2-6: Functions of the SLF for VLB, page 29. Themes from the figure have been used to organize the narratives in the following sections, to emphasize this dynamic nature of the case studies.

5.2. Chronology of events in Kinchlingi

Time	Activity
May 2004	First visit by the Kinchlingi villagers to the Mohuda pilot plant: Knowledge exchange.
Aug-Sep 04	Washroom construction.
Sep-Oct 04	Water tank construction.
Nov 04	Biodiesel reactor installed in the village. Production of biodiesel begins.
Feb 2005	An appropriate pump was installed on 05Feb05 after detailed testing from 16Dec04 to 05Jan05 (one month delay in selecting and procuring the correct pump set).
May-Dec 05	Daily water pumping continues. Niger sown in one acre. Diesel engine functioning without problem. 105 litres of biodiesel used out of 123 litres produced, for 118 hrs of pumping.
Jan06	Poor niger harvest: only10 kg harvested due to late sowing.
Jan 06 to Dec 06	Continuous water pumping. Problems encountered in the pump (Nov 06, foot valve leaks). Diesel engine functioning without problems. 157 litres of biodiesel used for 258 hours of pumping. Alcohol-free biodiesel promoted by CNBFES for use in Kinchlingi.
Jul – Aug 06	Niger sowing initiated in 3 acres (13.6 kg sown).
Oct 2006 Nov 2006	41 batches of biodiesel produced in Kinchlingi (230 L). Production shifted to pilot plant as local niger oil is now being used and requires refining. Training of villagers on refining initiated at Mohuda.
Jan 2007	141 kg niger harvested. Record harvest of ~80 kg /acre in one plot (benchmark for Kinchlingi but 100kg/acre is the average expected yield, with yields going up to 200 kg/acre in some areas of Orissa, with no external inputs).
Feb 2007	Training of 2 village level operators (1 girl and 1 boy) at Mohuda on refining along with refresher training on the entire process.
Jan –Mar 07	Daily water pumping continues. Foot valve replacement in Mar-Apr 07. Thirty three litres of biodiesel used for 49 hours of pumping. Diesel engine regular maintenance organized. Diesel engine functioning without problem.
Feb 07	Oil pressing demonstration organized. 88 kg niger seeds pressed between 12 villagers. 21 kg of oil expelled. 19 kg oil, after filtration available for refining and conversion to biodiesel.

Mar/Apr 07	Money contributed into community fund by villagers to buy seeds: Rs100/hh. Salt purchased and exchanged for karanj (Pongamia *pinnata*) seeds in neighboring village. Karanj seeds were pressed and a small batch of biodiesel prepared from the oil. A sample was tested in the University of Kolkata to confirm successful conversion into biodiesel. Scaling-up of recipe is in the pipeline.
Jul07-Dec07	Niger sown in time in a total of 2.4 acres (4 separate parcels). Harvesting completed. Drying/threshing of seeds ongoing. 110 kg was harvested (104.7 kg after cleaning and drying) – the harvest was less than the 141 kg harvested in 2006-07 Data collection and monitoring of practice is ongoing including assessment of soil fertility, growth rate and community participation. Biodiesel pumps, operation/maintenance training for village trainees is ongoing. Self-Help-Group members involved in feedstock collection/cultivation (and in biodiesel production).
Dec07-May08 Apr 08 May 08	Pump operated by villagers from Jan-Mar 08 independently, without the barefoot technician. Basic log-keeping was also done by one of the villagers. Barefoot trainer from Kinchlingi deputed to Tumba for the oil mill business profitability demonstration in Raikhal (details are in the section on Tumba cluster). Seeds harvested in Kinchlingi were cleaned and pressed by the Maa Dwaarashuni Oil Mill as part of the business profitability demonstration at Raikhal, Tumba. 96.5 kg seeds pressed @ Rs.1.90/kg and 21.5 kg of oil filtered and ready for use as biodiesel. 8.2 kg seeds kept aside for sowing in 2009. Gravity flow water system initiated by Gram Vikas to supply Kinchlingi (16 households, hh) and Laupur (8 hh) replaces biodiesel pumping. Since there may be a drastic reduction in flow from the gravity flow source during the hot/dry season (May-June), biodiesel will continue to be a back-up water source. Discussion initiated with the community of Kinchlingi on future use of the biodiesel reactor and pump set. Villagers want to retain biodiesel system for another two years. Lighting through biodiesel-fuelled battery-charging of LED lighting systems, irrigation, oil expelling and tilling are some possibilities for use of biodiesel, besides pumping during the summer months. Villagers have agreed to grow niger this year also. They will try to acquire at least 4 acres of land and sow in a timely manner. About 200 kg karanj was purchased for Rs. 1,200 (by villagers) from neighboring village for conversion into biodiesel. Detailed costing of the service provided through biodiesel over the past 3 years was shared with the village community in a workshop (full costs, credits and byproduct synergies, and village/BD project contributions).
Ripple effects of Biodiesel in Kinchlingi	Ripple effects of the biodiesel in Kinchlingi village include a karanj nursery initiated by the Forest Department (30,000 saplings) for planting in the Kinchlingi Reserve Forest. Kinchlingi Van Suraksha Samiti (VSS) members are serving as caretakers of the karanj nursery, paid for in full by the Forest Department.

Apr-Jul08	Discussions are held with the villagers on the future of biodiesel in the village, during and after demonstrations of the multipurpose tiller at the pilot plant in Mohuda. The multipurpose tiller is an additional service that can be provided by the biodiesel production unit. The Bhairabhi Self Help Group in Kinchlingi could take up production of biodiesel to supply local needs. In the short term the village of Kinchlingi has decided to use the existing infrastructure available for biodiesel production and use for the provision of electricity. With grid connection imminent, a three-month trial period has been agreed to, during which costs and benefits will be reviewed and the way forward decided accordingly. The three-month period is Jan-Apr'09. An electricity committee is formed; the village headman Barika, and four others: Nakula, Yudhisthira, Apili and Basanto are part of it. Interestingly there are women representatives always……perhaps a Gram Vikas influence. Ramesh, the barefoot technician trained at the biodiesel unit in Kinchlingi, has set up a rice hulling operation near Kinchlingi. The machine uses diesel currently and he is willing to switch to biodiesel if the SHG in Kinchlingi decides to produce and sell.
Jul-Aug08	Biodiesel-based tiller was demonstrated in the village. Villagers are trained to operate the tiller. Niger is sown in the field of three farmers and privately by Subarna, also from Kinchlingi (as a cash crop). Sano and Fakira are trained in tiller operation at the Mohuda pilot plant.
Sep-Nov08	Training of the Self Help Group in Kinchlingi is initiated. Soap making using glycerin introduced as a possible microenterprise. The strength of the group was evaluated to understand if they had the drive to take up such a business activity. A young girl from the village is being trained as a potential barefoot technician.
Oct08	House wiring for electrification is completed in all 16 houses and the VLB unit. The homeowners decide which room they want the light fixture in. Meanwhile the government program "Rajeev Gandhi Goan Vidyutakaran Yojana" for providing free house wiring to "Below Poverty Line households" has erected poles in the village, indicating that there is intent to electrify. The supervisor from Gram Vikas anchoring the project resigns. There is more direct interaction of the CNBFES technical team from Mohuda with the villagers because both barefoot technician and the supervisor have left. Disturbances within the community surface.
Dec 08	Niger is harvested. This year the harvest all over Orissa has been poor. Rains during the flowering season have reduced yields. Only about 35 kg was harvested, much below the anticipated 180 kg. Agronomist at the research station (Semliguda, Orissa) blames the change in climate patterns and recommends seeds with shorter growing period.
Jan 09	Tariff collection for the three month trial period: Rs. 30 per month is agreed. Villagers pay up to Rs. 100/hh for the entire three month period. Lighting using the diesel generator is commissioned on 24Jan09. Discussion is held about purchase of LED lamps so that a hybrid system of electrification can be installed. The price at which Gram Vikas is selling these is Rs. 1500 for a light and a solar panel; Rs. 750 for the lamp only is suggested to the village. The villagers negotiate a price of Rs. 600. The number of people wanting to purchase the light varies, the last count being 11. Finally on the 29th of January, 12 people come up and take the lamps and a three month installment

	for paying for the lamps is agreed to. The three people from the village without the LEDs are Subarna, the widow, Agadu's family who migrate to Chennai for work and come back only for a few months every year and Biswanath's family who are unable to afford the light. One house (the 16th hh) in Kinchlingi is rented out to a migrant farmer who has also not purchased the lamp.
Feb09-Apr09	The electricity department of the State Government has delivered wire and concrete poles and has asked the villagers to draw the wires to their village. The electricity wiring is contracted out and the person who has received the contract sends wiremen (electricians) to supervise the work. The village is supposed to provide support in the form of unskilled labor. The electricians only supervise the work. They have already, while delivering the poles, appraised the village about the layout for the poles. Now they supervise extending the wires up to the village. The new alternative hybrid biodiesel + LED system for electrification is being slowly established in the village. It is better to call it a system for lighting than for electricity, because the end use of consequence to the village is only lighting. The electricity committee, consisting of five people (two women and three men), is responsible for collecting the tariff and the installment payment for lighting. The committee has also assigned two people, one from each side of the village, to be responsible for the biodiesel unit. The two people assigned are Sano and Nakula. Sano has been trained on how to run the generator, but not Nakula. Sano feels that he volunteers for everything (his name is always proposed by the villagers) and agrees reluctantly. Two interns take turns and work with a barefoot technician, Pradipta. Pradipta has worked with the generator set in the village of Kandhabanta and is familiar with its operation, although the part with the LED interface is new. Apr09 There is some movement from the electricity department (Govt. electrification drive). Two electricians are guests of the village for two days. They run out of some materials. Sano immediately arranges for the purchase, contributing money from his pocket (!!) The villagers have also pooled their money to provide the men with meals while they work to finish the job. The job of the electricians is to fix the meters and the sockets, extend wires inside the house (in the verandah of the units) and leave extra wire as needed, enough to connect the house to the nearest pole. The next step is for the local government official to verify and authenticate status of all the "beneficiaries" to check if they are 'Below Poverty Line Households' and then sanction the electrification. After this the line will be "charged" and connected to a transformer, and the electricity will be commissioned. The villagers have paid Rs. 50 for the connection and will be paying a monthly tariff of Rs. 30 for the single 60W incandescent bulb that has been provided to them. This light is in their front porch, not even inside their houses. If the villagers want to extend the lighting they have to do so at their own cost.
Apr-Jun 09	A training program is held in Kinchlingi on the lighting component of VLB. Boys from Kinchlingi and from the neighboring village participate. Two boys aged 15/16 from Kinchlingi take interest and start running the charging unit. They are currently logging and making sense of data, reporting discrepancies, in addition to measuring voltage of each of the LED lights (16 in all) and

	running the generator to charge the battery bank. A graduation ceremony is held and certificates given to all the training participants. The two boys, Raju and Suresh are formally appointed as being in-charge of the unit and each is rewarded with a bicycle labeled "Pedal Power." A meeting is held with the villagers to decide how to proceed after April 09. They are currently paying a tariff of Rs. 30 per month, after having deposited Rs. 100 for three months of electricity. The money (Rs. 30) is intended as tariff for electricity, but goes into a maintenance fund which the Project Coordinator (PC) employed by the NGO partner tells the villagers, is being held for emergency repairs that may be needed for the gravity flow system. If they want electricity they should pay another Rs. 30/- The villagers argue and try to bargain but the PC is adamant. Finally the village decides to take a month at a time and pay Rs. 30 for water and Rs. 30 for electricity from May onwards. In order to conserve biodiesel and reduce costs, the one hour of CFL lighting through the mini-grid is discontinued and biodiesel is used to charge the battery only once in three or even four days. Three people who have not purchased LEDs are loaned LED lights for the evening. They thus get light and continue to pay the tariff. Biodiesel consumption is reduced by a third. The boys are managing the unit on behalf of the village. Raju goes to school and assistance is being given in the form of books. Suresh helps his father with farming, because of which he has had to drop out of school. He is happy to have a chance to be able to hone his skills through the LED charging unit and learn about biodiesel, pump sets and generator sets. In the event that electricity comes to the village, the battery can continue to be charged using AC power and the LEDs used as emergency flash lights.
Jul-Aug 09	The boys are running the unit independently. In case of an emergency they know where to get technical advice. Work is ongoing to set up an alliance with other local NGOs and a rural training institute, "Jagananthprasad Institute of Technology and Management," JITM, to develop Kinchlingi as a hub for producing biodiesel for local use. The oil press that is in the village was used to press sunflower oil for local use. Some customers from close by villages also came, but the competition with local oil mills is something to be considered. The oil mill owners provide transportation to pick up farmers, and meals during the time they are waiting for the oil to be pressed. Although the mill owner does not charge a milling fee, the oil cake is left behind. For every kilogram of seed pressed there is at least 750 gm of oil cake. The price of oil cake even at ~Rs6/kg (may be higher for sunflower), would be about Rs. 5/- while the milling charge that they would have to pay is about Rs. 3/-. But the sheer convenience of having the milling arranged attracts the farmers who do not make the effort to work out the economics of the operation. There are a few boys in Kinchlingi who might be interested in taking up oil pressing as a business, but they would prefer a motorized press (engine fuelled by biodiesel) to the hand press.

5.3. The context

We reached Kinchlingi village around 10 in the morning. The village was deserted. People had left to transplant rice: some in their own fields and others either as share-croppers or as laborers in other people's fields. We need to find out what they earn in each case. How much paddy is harvested and what wages do they get as daily laborers. As we entered the village Ramani and Ramesh proceeded to the well after picking up some tools from the biodiesel production room in the village. Someone would have to descend into the well. Sasikala, the Gram Vikas supervisor, was looking for rope to fabricate a temporary scaffold which would then be lowered into the well. I ran into Ganapati from the Saura part of Kinchlingi, who was just returning from his field to the village. His wife Apili and foster son Mangala were still working at transplanting rice in their own field. Ganapati says he can get up to 20 bags of paddy (~80kg of rice per bag) from his land of 2 acres if the monsoon is good (~1ton/acre), and 18 bags are sufficient for his family of four people. Sasikala was asking him to bring a rope because they had to go inside the well to pull out a badly installed leaking pipe which had affected the water pumping. Journal note dated 18Aug2006

This is <u>not</u> a typical day in the life of the two-year-old Village Level Biodiesel Unit. Yet these were the days for which one had to be prepared. As soon as it is rice transplanting time, no one is available in the village even if their water supply system has broken down and needs to be repaired. On such days women use water that is stored and later go to the stream or well. Ramesh, the barefoot technician employed by the Village Executive Committee (whose salary is subsidized by VLB project) is seen to be a part of the NGO rather than of the village. Organizing people has become one of his main tasks besides logging data for the project. He often has villagers willing to help him, but has to ask for assistance as people do not volunteer on their own.

Kinchlingi is a village with 16 families and a population of 73, half of whom are Saura tribals converted to Christianity while the other half, mainly Pradhans, belong to a marginalized section of society designated as the Scheduled Caste (under the 73rd Amendment of the Constitution of India). Almost all the families have income levels of less than a $1 a day.[14] Only half the households in the village own land, mainly small holdings ranging from 0.5 to 2 acres, while the other half earn their living through sharecropping or as casual laborers. The dependency ratio of the village is about 1:3 *i.e.*, every earning member has roughly 3 mouths to feed.[15] The Sauras here practice a form of slash-and-burn agriculture similar to the Sauras of the Tumba region, with the difference being that they rotate between limited plots of land and are back to the same plot in 3 years or less. Sometimes they use the same plot two years back to back, and a few of them are gradually moving to stable agro forestry practices, growing cashew[16] as a cash crop. Kinchlingi is attached to a reserve forest and the village has formed a forest protection committee (locally called the *Van Suraksha Samiti*, VSS) to jointly manage the forest with the Forest Development Agency. A forest assessment conducted in the vicinity of the village revealed that there was not enough feedstock in the form of underutilized oilseeds for producing biodiesel. With the village having very little land, private or community, growing seeds was not going to be easy. Fallow land would have to be identified and negotiations undertaken with the owner to allow growing and harvesting. Why then was the village selected?

The village of Kinchlingi was selected after an earlier village Sandigoan, suggested by Gram Vikas, fell through. Sandigoan was no different from Kinchlingi and the only reason for selecting it was that Gram Vikas staff felt that it would be easy to motivate a small village with just 8 families. The village was to be a demonstration of the technology, and in the first 4-6 months the CNBFES project was going to subsidize the cost of feedstock. The village biodiesel plant here would be a test of the technical feasibility of the project. The only criterion was that the selected village should have a Village Executive Committee for managing the water supply and sanitation, and be willing to implement the program and build washrooms and a water tank. A readily available source for pumping water but no access to grid power meant that an alternate energy source was needed to provide running water in the washrooms. It is here that biodiesel water pumping fit in**.** The Sandigoan community was not willing to implement the washroom program and the Gram Vikas field staff decided to explore the idea with Kinchlingi, a village in the neighborhood. The villagers in Kinchlingi were willing to implement the water supply and sanitation program provided they had an independent water supply system. In anticipation of possible conflicts the community of Kinchlingi did not want, as previously proposed by Gram Vikas, to share water with a neighboring village. Biodiesel appeared to fit the bill and the villagers felt that in future they could collect or barter seeds from neighboring resource-rich villages or even acquire community land and grow seeds. Kunnu, one of the women in Kinchlingi, summarized the intent of the VLB on the day of the initial meeting: "*We should not rely only on the forest seed but cultivate seeds so that we can be in control, rather than rely on people outside*." The women in the village immediately launched into the construction of the washrooms, and most times filled in for the men who had migrated to the city for work, in order to complete the infrastructure on time. Even as washrooms were being completed, biodiesel was produced in Kinchlingi using a pedal-driven biodiesel reactor within 9 months of the launch of the biodiesel project.

5.4. Processes followed: actors, resources and their relationships

5.4.1. The biodiesel-agriculture link

Karanj (Pongomia *pinnata*) and mahua (Madhuca *indica*) are two forest species, while niger (Guizotia *abyssinica*) is an agro-oilseed, all native to Orissa, currently underutilized, and selected by the project as potential oilseeds for use in the production of biodiesel. There are a large number of karanj trees within 10km of Kinchlingi, in the neighboring cluster of Kerandi. In Kerandi, karanj seeds are bartered for salt even today. In Kinchlingi however, no one collects karanj although they collect small quantities of mahua. Kinchlingi does not have any community land.

The villagers have used community and private fallows belonging to other neighboring villages to grow niger for producing biodiesel consecutively for three years; 2008 was their fourth year in a row. The first-year harvest yielded just 10 kg seeds in one acre, probably because sowing was very late. In the second year four separate plots were sown, including one field where niger was privately sown. The community put in about 138 person days of their labor and harvested a total of 142 kg in 3 acres. Although the average yield turned out to be about 43 kg/acre, the contribution from one community plot measuring 1.16 acre was over 88 kg. Sowing that year was done during the correct window (15Jul-15Aug). The costs incurred by the community were only for hiring the tractor or the plough, and the costs incurred for the oil-seed were as low as Rs. 6/kg, in contrast to Rs. 15-Rs 18/- that was paid to purchase seeds the previous year. The niger fields were used in rotation and the farmers were being encouraged to plant intermediate green manure crops such as sunn hemp (Crotalaria *juncea*) and dhaincha (Sesbania *bispinosa)*. Niger, when used as a mixed crop with other legumes, is known to add to the soil nutrition instead of taking from it (Rao, *et al.*, 1996). It is evident from this experience that it is possible for the village to grow niger as an annual crop for their biodiesel needs.[17]

A portion of seeds from the harvest in 2007 was kept aside for sowing in 2008, and the remainder, 76 kg, pressed using a manual oil press in the village. This oil after filtration and refining produced enough biodiesel to last over 50 days. It is estimated that for one year of water pumping needs, the village will require about 500 kg of seeds which can be grown on 5-7 acres of land, provided: (a) good quality seeds are used (b) sowing is done in a timely manner and (c) weather conditions are amenable for a good harvest. An assessment of the quality of the current seeds was done mainly by checking germination rate and weighing 1000 seeds. The seeds had a good germination rate of over 90% but their weight of 3.2 g/1000 seeds was below that of the benchmark of 4.3 g/1000 seeds. This has a bearing on the oil content of seeds, which in the case of Kinchlingi was about 24% (below the benchmark of 30% recorded on the manual oil press at the pilot plant in Mohuda with seeds from another source). Productivity of the crop and oil yield affects the cost of oil, which has a bearing on the cost of biodiesel. **Good harvest, low cash outflow and high oil yields all together reduce the cost of the end-product, biodiesel.**

In 2008-09, although sowing was done in a timely manner, the niger harvest all over Orissa was damaged by early rains during flowering. Kinchlingi had estimated that they would be able to harvest at least about 180 kg seeds, but could get only 38 kg clean seeds. Since agriculture is such an integral part of VLB, and agriculture is affected by changing weather patterns, an insurance against poor harvest is needed. **Tree oilseeds such as karanj, coupled with short duration oilseed crops such as niger, can ensure a constant supply and reduce vulnerability to changing climate trends.**

5.4.2. Land and technology: fuelling the local economy

A regular exchange existed between the village and the CNBFES project team from the start of the project in early 2004. This included inputs from the community into the machine design (the oil press requires too much effort, the bicycle seat in the biodiesel reactor is too high, can the reactor tank where oil is poured be lowered, and so forth), and knowledge exchanges about availability, collection, drying and storage of local forest oilseeds. Land was identified for sowing niger communally. Orientation and trainings were organized for the village youth in the hope of enlisting them as future biodiesel technicians. Finally one boy, Ramesh from a neighboring village, Latigoan, was identified for intensive training and to support the village in the operation and maintenance of the biodiesel unit. Ramesh was also involved in the training of other villagers. He was the barefoot technician appointed for VLB in Kinchlingi. The Kinchlingi community decided that they would run the unit by volunteering time. Their in-kind contribution is referred to in discussions that follow as *sweat equity*.

The distance from the well to the water tank is over 200 metres horizontally and water has to be pumped over a height of 10 metres to the water tank, after lifting water from a depth of 6 metres inside a well. A lot of effort went into sizing the diesel pump set so that the operating costs were low. The daily water consumption in Kinchlingi was never over 3000 L, making the per capita water demand about 40 litres per capita per day. **The water was regulated:** water was pumped for about an hour almost everyday into the water tank. Supply to the houses was turned on for an hour in the morning and an hour in the evening. Ramesh did the water pumping with the help of a village youth, but water supply was turned on and off by the villagers themselves. One person had been assigned the responsibility and (s)he removed the regulating valve after closing supply each day as a way to control access. The village of Kinchlingi needed between 11-13 litres of biodiesel every month for water pumping, which could be produced in roughly 2-3 batches and required every household to volunteer once every month. In November 2004, a roster was set up by the villagers requiring every household to be represented. There were several subsequent discussions on how to collect tariff for the remainder of the material costs. Monthly contribution of one bundle of firewood, or Rs. 30-50 per household was initially anticipated, but the cash collection for water pumping was sporadic. With the gravity[18]-based water supply system imminent, there was initially some uncertainty about the future of the biodiesel system. This was resolved the day gravity flow arrived.

When the water from the gravity flow system finally arrived in April 2008, the village had decided to retain the biodiesel unit for at least two years as a back-up. They also resolved to continue planting niger, the feedstock that they had been cultivating to process into oil for biodiesel. With biodiesel not being needed for water pumping, the CNBFES team discussed several alternative uses for biodiesel with the community of Kinchlingi. A biodiesel-based multi-purpose tiller was demonstrated for ploughing, and the possibility of oil expelling using manual and biodiesel-based engines was discussed, both as entrepreneurial activities. The villagers felt lighting was a more immediate need and suggested using a biodiesel generator.

Ramesh the barefoot technician also moved on in August 2008 to become an independent entrepreneur and set up a rice huller within a few yards of Kinchlingi**.** His training in biodiesel engines and pumps inspired him to set up a diesel engine-based huller. The Self Help Group in Kinchlingi loaned him a small part of the money needed to set it up. He hopes to one day change over to biodiesel (which only requires a simple alteration of rubber fuel pipes to plastic ones), and procure the fuel from Kinchlingi, if the SHGs produce biodiesel.

5.4.3. Biodiesel water pumping: proving socio-economic and techno-ecological viability

A workshop was organized as a part of this research with the community of Kinchlingi in July 2008 roughly two months after gravity-flow water supply replaced the biodiesel-based water pumping. The workshop summarized the four-year water pumping statistics and also worked out the cost of producing biodiesel, highlighting costs that stay in the economy and those which filter out. Over the four-year period, Kinchlingi had used over 450 litres of biodiesel to pump 2,191,418 litre of water (Table 5-1). The biodiesel pump set is perhaps the only pump in India (and the world) to have run for 690 hours on 100% transesterified biodiesel fuel.

The cost of production of the biodiesel was calculated over the period (2005-08) for the 465 litres that was supplied by VLB production unit for pumping water in Kinchlingi (only 452 litres was used in the pump). The pumping statistics are summarized in Table 5-1.

Table 5-1: Summary of the hours of pumping (23May05 start of daily supply until 15Apr08)

Year	Pumping Hours	Water Pumped, Liters	Biodiesel Consumption, Litres
2004			27
2005	116	405,008	97
2006	258	842,050	149
2007	236	725,582	148
2008	75	218,778	44
Total	**684**	**2,191,418**	**465**

Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2: Overall cost of biodiesel at Kinchlingi (June 2005 to March 2008)

	Item description	Quantity	Unit	Debit	Credit	Balance	
1	Biodiesel raw material cost	465	Litre	26,070		26,070	
2	Cost contribution of BD project (methanol, NaOH, SMS)				6,751	19,319	
3	Credit for soap and glycerin				1,088	18,231	
4	village contribution *cash/seeds)					18,231	
	2006 Niger seeds	107	Kg		1,709	16,522	
	2007 Niger seeds	116	Kg		1,856	14,666	
	2007 cash contribution	100	Rs./hh		1,500	13,166	Rs./hh/mo
5	Amount due/hh (without subsidy)	15	Hh	34	months	1,738	51
6	Amount due/hh (w/subsidy for MeOH, NaOH, SMS; credit for soap and glycerin)	15	Hh			1,215	36
7	Amount due/hh (w/subsidy as in 6, and credit for seed contribution)	15	Hh			878	26
8	Water pumped	2,191,418	Litres				

9. Details of cost calculation for water supply	unit	Cost	
A. Cost of water per litre (without subsidy)	Rs./L	0.01196	2.4x Mohuda water cost
B. Cost of water per litre (with subsidy/credit as in 6)	Rs./L	0.00836	1.7x Mohuda cost
C. Cost of water/litre (w/subsidy/cr + seed contrib'n.)	Rs./L	0.00604	20% more than @ Mohuda

@Cost of seeds, Rs.16/kg since cost of BD also calculated at Rs.16/kg (source: BD cost_04_08_GV_RS_Rev3.xls).

One of the assumptions made for the cost calculation was that the sweat equity component of the project would not be valued (in Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2). It was agreed that the time the villagers volunteered could not be simply equated to their wage, as it was a contribution to building a community asset and not a labour component alone. The value of byproducts soap and glycerin was assigned based on prevailing rates, even though they were not being sold. It was agreed that the community should have the benefit of credits from byproducts, even though these were not being marketed at that time. Byproduct costs were deducted from the cost of production (Item 3 in Ref. BD cost_04_08-GV-RS-rev3.xls Table 5-2). Since it was a learning project for CTxGreEn, the cost of chemicals, which was initially very high, was absorbed by the project, even as a request for duty waiver for alcohol was being put forward to the government (Item 2 in Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2). In the long run it is hoped that both alcohol and lye are locally produced (alcohol from wasted and underutilized fruits, available in plenty in the forests, and lye from ash). CTxGreEn has tested these processes in the laboratory and they will be scaled up when there is an opportunity, after VLB is well established (Upadhyay, 2005; CTxGreEn, 2006).

The volunteer time put in for the production of fuel was over 370 hours, and niger seed grown and contributed by the community (2006-2008) in Kinchlingi was about 223 kilograms. Seeds purchased from the cash contributed increased this by another 100 kilogram, bringing the amount of seeds contributed to roughly 20% of the total consumption. The contribution of the project (25%), the subsidy for the byproducts (4%) and the villagers' non-cash contribution towards the feedstock (20%) reduced the costs and therefore the tariff by almost 50% to Rs. 26/month (See Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2). The cost of pumping water, calculated with project subsidies (Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2, Item 9A-9C), was found to be only about 20% higher than the subsidized cost paid by consumers on the Gram Vikas campus in Mohuda, where water is pumped using electricity. This is highly commendable for a self-reliant system.

Without subsidies, the cost of biodiesel in Kinchlingi was calculated to be Rs. 57/litre. Assuming waiver of duties for alcohol, and credits for soap and glycerin, this cost can be reduced to Rs. 45/litre. If niger is substituted by karanj for oil, the cost of biodiesel can be further reduced to Rs. 20-26/litre, provided seed contribution is made by the villagers. Karanj (Pongomia *pinnata*) is available in other village clusters near Kinchlingi, but not in their own forest. The forest department is carrying out large scale afforestation programs using karanj saplings in the village forests.

The Kinchlingi biodiesel water pumping is considered economically feasible. There are some hurdles to cross in terms of (a) lobbying for policy changes for duty waiver on alcohol for productive purposes, currently taxed at the same rate as consumptive alcohol, and (b) in setting up a market for byproducts.

Technically too, VLB has stood the test of time. The history of pumping in the village is summarized in Table 5-1. There have been minor maintenance problems, most of which were resolved by a local plumber. The fuel consumption is roughly 0.6 litre per hour (water discharge rate of 3500-4000 lph) and the water pump coupled to a 3.5HP water-cooled engine has proven to be more rugged than similar sized engines that are air cooled. The trend in water consumption by the community has remained uniform, which is perhaps due to the water supply being regulated. The economics of pumping water was calculated and discussed with the villagers in the workshop held in July 2008. **The capacity of VLB to recycle resources in the local economy is very high**. In considering the material cost of producing biodiesel, there are two parts: the first is the cost of refining the oil, and the second is the cost of producing biodiesel from the oil (See Figure 4-1: Flow chart of the Village level Biodiesel (VLB), page 55). Table 5-3: Cost analysis of a typical batch of biodiesel from niger seeds, presents the cost calculation for a litre of biodiesel. The negative numbers in the table indicate the potential proceeds from the sale of byproducts. These are referred to as credits as they reduce the overall cost of biodiesel. In considering the first part, 86% of the cost of refining the oil is the seed cost (Figure 5-1 and Table 5-3). The credit for oil cake derived as a byproduct when the oil is pressed is about 15%, and the oil cake can be used as organic fertilizer or livestock feed locally. The cost of chemicals and filtering agent is about 10%, and the credit for soap, which is another byproduct of the refining process, is 7%.

The refined oil is one among three inputs for biodiesel, and contributes 83% of the cost of the biodiesel. The share of alcohol, the second ingredient used for producing biodiesel, is about 17% of the cost, while lye contributes to about 2%. Credits from glycerin are about 2% and roughly balance out the cost of lye. Less than 15% of the cost of making biodiesel, therefore, leaves the local economy, while the rest stays and regenerates it. Production process additions such as recovering alcohol from the fuel or locally brewing alcohol for making biodiesel can help reduce the outflow even further.

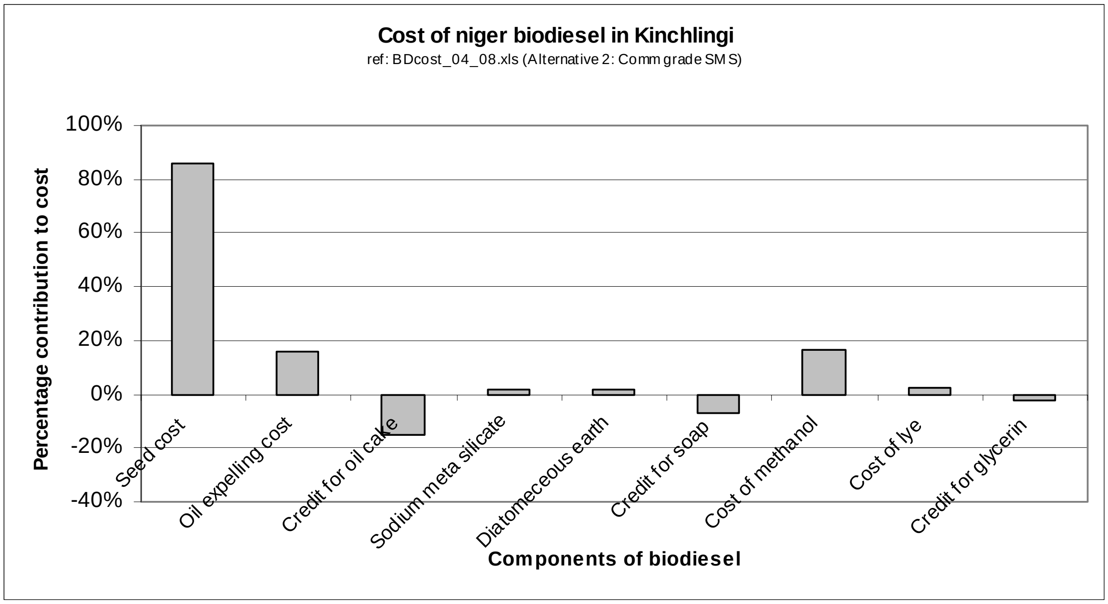


Figure 5-1: Cost of niger biodiesel in Kinchlingi (Only material costs included)

Table 5-3: Cost analysis of a typical batch of biodiesel from niger seeds

	Item	Quantity	unit	Rate Rs./unit	Total cost Rs.	Percentage contribution	Assumptions
Part 1: cost of refined oil produced at the level of the village	Seeds	16	kg	16	259	86%	Cost of seeds is based on prevailing market price
	Oil expelling	16	kg	3	49	16%	Cost in the nearest town.
	Credit for oil cake	11	kg	-4	-45	-15%	Cost of oil cake is at least 50% higher. This cost is assumed to be at the village
	Chemicals	0.10	kg	46	5	2%	Sodium metasilicate
	Filtering agent	0.23	kg	20	5	2%	Diatomaceous earth
	Credit of soap	0.54	kg	-40	-22	-7%	The cost is based on potential. Currently it is not being sold
	Refined oil				**251**	**83%**	This is the cost of refining at the village level
The quality of the biodiesel is assessed at the pilot plant, and has properties similar to diesel.							
Part 2: Cost of biodiesel with refined oil input from Part 1	Refined oil	4.5	kg	55	**251**	83%	Locally refined oil
	Alcohol	1.1	litre	46	50	17%	Alcohol is purchased with duty
	Lye	31	g	0.23	7	2%	
	Glycerin	0.7	kg	-10	-7	-2%	Potential selling price. Soap making has just been initiated
	Biodiesel	4.6	kg	66	301		Biodiesel is produced on the 5L pedal driven reactor
	Biodiesel	5.3	litre	57			

This costing assumes a volunteer-operated unit where the labor is sweat equity, a contribution from the community. The capital cost, a contribution from CTxGreEn, is also not included. It is assumed to be an entitlement that the government should be obliged to provide in support of decentralized self-reliant energy systems, especially since the renewable energy system contributes to meeting the government's mandates (National Advisory Council, 2004).

The diesel generator set from the second village installation in KBTT was moved to Kinchlingi in January 2009, and has functioned without any major problems. The generator set has an air-cooled engine in contrast to the water-cooled engine in the pump set. Water-cooled engines are more forgiving, and it has become clear that the engine from the water pump can be coupled to an alternator to produce electricity. The water used for cooling the pump used to go back into the well. In Kinchlingi if the engine were to be disconnected from the pump and coupled to an alternator to generate electricity, it would also have to be moved away from the well. In that case a system for recycling the water may have to be put in place.

The engine from the pump was tested for about a month to generate electricity in Kinchlingi, when the original air-cooled engine was sent for servicing. The water-cooled engine works with less noise and even produces less smoke in comparison to the air-cooled counterpart. The villagers who are trained are very comfortable handling the generator both with the air-cooled engine and with the water-cooled one (where the pipes for cooling water have to be additionally fitted to the water supply everyday).

Phase two of the biodiesel project is the electrification phase, best described as the lighting phase. Although electricity is being generated, the end-use provided is only lighting. There was the promise of grid electricity through the government program (Rajeev Gandhi Gram Vidyutkaran Yojana, RGGVY, Biju Gram Jyoti Yojana, BGJY)[19] but instead of waiting the community decided to try lighting with a hybrid system: a biodiesel generator charging a battery bank which in turn charges 17 Light Emitting Diode (LED) lights.

The idea of a hybrid system was born out of the need to provide **maximum benefit at minimal operating cost**. The community was accustomed to organizing fuel for one hour of water pumping. Changing over to additional hours for lighting would double or even increase by threefold the fuel consumption. Retaining the same level of fuel consumption, with only a generator fuelling a mini-grid meant only one hour of lighting. This too did not seem meaningful. The configuration that everyone was happy with was the generator running for one hour and charging a battery bank that in turn charged 6 Volt LED lights, one for each house (which could be used for up to 10 hours with no additional charging). Everyone in the village therefore enjoyed one hour of illumination with CFL (Compact Fluorescent Lamp) lighting through the mini-grid. Those that had purchased the LEDs (75% of the village) could have extended hours of illumination through the battery bank. The marginally-subsidized LEDs at Rs. 600/- were purchased on a no-interest installment basis, spread over 4 months. This was another example of an innovation in the technological system to suit the context.

5.4.4. Lighting, Tilling and other futures

Even before the transition was finally made to the biodiesel generator for lighting, costs and benefits were discussed with the community in July 2008. As part of this research, and complementing the work in the field, operating costs were calculated (based on assumptions), and the likely tariff communicated to the villagers in a workshop (Table 5-4). The government's rural electrification program, the RGGJY and the BGJY, their fit with the biodiesel-based lighting, and the rights and responsibilities of the villagers were also discussed. In addition to the fixed tariff, one of the conditions for the VLB-based lighting program was growing or collecting seeds, pressing them locally and thus paying for at least part of the cost.

Table 5-4: Transcript of workshop poster discussing lighting (July 2008)

Lighting
1 hour lighting = 0.65 ml biodiesel
Fuel cost = Rs. 57/litre x 0.65l = Rs. 37 per day (Cost used to calculate pumping costs)
Cost for the year = Rs. 13,523
Seed cost @ 80% of total cost = Rs. 10,819 (About 800 kg seeds @ Rs. 15/kg)
Costs to be paid excluding seeds = Rs. 2705
Cost per household if seeds are grown = Rs. 120 per annum or Rs. 15/month
Rs. 5/ month for maintenance = Rs. 20/month
If half the seeds are purchased (additional Rs. 30/hh needed), tariff = Rs. 45/month
Trial Experiment for 3 months (Aug-Sep-Oct)
Seeds needed for 3 months = 180 kg
Tariff to be collected for the three months Rs. 15/hh for one hour of lighting
Contribution to maintenance cost Rs. 10/hh (Rs. 25)
Rs. 10/hh additional for charging LED light (Rs. 35)
Workshop notes/feedback
Review costs at the end of three months

At least two to three families that migrate seasonally had already left the village for work, and would return only after 6-9 months. They were not present during the discussion on tariff. The number of households willing to participate in the lighting scheme was reduced to twelve, increasing the burden of costs to be shared. Fewer people also meant that there were fewer hands to cultivate niger. All the same, motivated by the Gram Vikas supervisor, Sasikala, the village decided to take up lighting for the trial period of three months, and the community went ahead with growing the oilseed crop, niger. Unfortunately in 2008, although niger was sown in about 3 acres of land and the expected harvest was 180-200kg, the harvest turned out to be just 35kg, 20% of the amount needed. Three months of electricity required 180 kg seeds of niger (Table 5-4). Oil was expelled from these seeds in the village and converted to biodiesel. The villagers decided on a tariff of Rs. 30/month, and paid Rs. 100/- in advance for three months of lighting.

During the July 2008 workshop, estimated costs and revenue of a multipurpose biodiesel-fuelled tiller were also shared with the community (Table 5-5). The idea was to promote more uses of biodiesel for livelihood activities, rather than for only subsistence needs (such as provision of drinking water and electricity). The workshop was also meant to introduce the village to the potential of taking up biodiesel as a business, providing not just the fuel, but a service in the area. Lack of timely inputs for tilling and irrigation have been a setback to the agriculture in the area, and the tiller is a multipurpose device which can double as a mobile irrigation set as well as a ploughing, threshing device.

Table 5-5: Transcript of workshop poster discussing tiller (July 2008)

Tiller
Tilling: 1 acre, 2.5 hour
Fuel cost = Rs. 57/litre x 2.5 hours = Rs. 142 per acre
Acreage possible per day 2 – 3 acres
Hours required = 5-7.5 hrs
Costs incurred
Rs. 426 (fuel) + Rs. 400 (for driver + helper) = Rs. 826 +5% maintenance Rs. 40
= Rs. 866 approximately Rs. 900
Tractor charges per hour Rs. 500 (amount paid in 2007. It used to be Rs. 350/hour in 2006)
If we charge Rs. 300/hour
Income = Rs. 300 x 7.5 = Rs. 2250 per day
Expenditure = Rs. 900
Profit = 2250-900 = Rs. 1350
Workshop notes/feedback
Recalculation to be competitive with the tractor:
At Rs.300/h for the tiller, the cost of tilling will be Rs.750/acre, whereas for a tractor, which does 1 acre/hour, the hire charges will be Rs.500/acre. Revising the rate for the tiller to Rs.200/hour, the cost of tilling is comparable to the tractor at Rs. 500/acre and reduces the income to Rs.1500 per day from Rs.2250 (@ hiring charge of Rs. 300/hour) and the profit is correspondingly reduced to Rs.600.

While the comparison was made in the workshop with tractors (Table 5-5), it was pointed out by the community that a valid comparison would be with the commonly-used animal-drawn plough. The quality of tillage with the bullock is preferred by most farmers to that of the tractor, which turns over much more soil and causes the heavy wheels to compact the soil rather than aerate it. Based on the demonstration of the tiller that the community had participated in, they felt that the quality of the soil tillage with the tiller was comparable to that of a bullock-driven ploughshare. They also felt that using a tiller was more efficient with respect to the time spent in the activity. For the service delivered therefore, the tiller scored higher than the tractor and scored more than the bullocks in terms of efficiency. The cost of using a tiller was marginally higher compared to the plough when hired at Rs. 300/hour. But the villagers felt that the hiring charges could be marginally reduced to make it more favorable.[20] When asked if anybody was interested in running the tiller as a business, there was some hesitation. The incentive provided by the government, a 40% subsidy on the cost of Rs. 100,000/-, was not appealing. Most of the men felt that the government would release the subsidy only after the loan was completely paid out. In general there is some trepidation among the Kinchlingi community to take a loan from the bank to start an enterprise.

The three-month trial period (Jan-Apr09) of lighting in Kinchlingi was the basis for the project learning about costs and benefits of such an electrification program through biodiesel. The Kinchlingi experience also highlighted the challenges that need to be overcome for sustainability of operations and for replication of the VLB. The community purchased the LED lamps but did not pay any of the costs towards the electrical wiring for the houses. House-wiring costs were provided by CTxGreEn. The only other capital cost was that of the biodiesel generator, but this was also loaned out from KBTT. The Rajeev Gandhi Grameen Vidyutkaran Yojana (RGGVY, translated as the Rajeev Gandhi Rural Electrification Program) sponsored by the Central government and its off-shoot, the State-sponsored Biju Gram Jyoti Yojana, are efforts to prioritize rural electrification. While the former program only targets settlements with a population greater than 300, the latter includes those villages with populations less than 100. Kinchlingi has been selected for electrification in combination with another village Latigoan, but progress towards commissioning of electricity is very slow. Electrical poles were put in place in January 2009, home wiring completed in May 2009, but the connection to the transformer and charging of the lines is still pending as of July 2009.

The cost of producing biodiesel for lighting was less than that calculated during water pumping (Table 5-6), even though the cost of chemicals is not subsidized by the CNBFES in this phase. There is a reduction in costs because of higher seed contribution. As the share of seeds goes up the cost of biodiesel becomes comparable with petrodiesel. The village had contributed 20% of the actual seeds consumed in the 3-month period. This brought down the cost of biodiesel to Rs. 36 per litre. A higher value was allocated for glycerin, which the CNBFES team is now able to convert to soap. The team has also developed the ability to recover alcohol from the process, which could further reduce the cost. **Byproduct synergies reduce the burden of costs on the community**.

Table 5-6: Details of biodiesel-electricity generation in Kinchlingi

(niger bdcost for KCNH electrification 19Mar09.xls)

Electricity generation period				Cumulative consumption		Cost
Months (2008)	Start date	End date	Total days	Fuel (L)	kWh	Rs.
January	24	31	8	3.6	2	128
February	1	28	28	19.0	10	676
March	1	31	31	14.0	21	498
April	1	20	20	9.0	43	320
Total			87	46	76	1622
Cost per/litre						36

Under the RGGVY[21] electrification scheme, the government charges a flat rate of Rs. 30/- for one 60W bulb per household consumer. In comparison, the cost per month per household of independently generating with biodiesel is Rs. 36/- (Rs. 1622/15hh/3months), which is roughly equal to the present cost of a litre of biodiesel in the village. The cost of producing on your own is therefore comparable with the cost of consumption from the grid. Electricity from the grid includes several hidden subsidies, is less reliable and has very high environmental costs. The mix of fuel source for the grid in Orissa is 47% thermal and 53% big hydro projects (many of which still have to resolve the issue of relocation of communities and submergence of land) with less that 0.2% from renewables (Orissa Electricity Regulatory Commission, 2008). The techno-economics and the land regeneration potential of biodiesel have been tested adequately in Kinchlingi. The community has been party to the entire process of technology assimilation, and is aware of the benefits and the challenges. The bigger issue for sustainability is, however, who among the villagers will run the unit since the **volunteer model also needs a prime-**

mover. For the handful of villagers who are more forward-looking, it is an additional responsibility. As far as running the unit as an enterprise is concerned, as already mentioned the men in the village are averse to taking a risk, and although the women as self-help-group members seem interested, they are not yet a coherent and united group. An electrical committee has been formed with 3 men and 2 women, mainly for collecting tariffs and discussing issues about the management. But they are not yet proactive. Piped water supply undoubtedly reduces the women's work, but there are possibly more ways in which they can contribute and benefit. During an informal feedback session in Kinchlingi village (22-24Feb07), the women recounted stories of difficulties faced earlier when there was no piped water supply. Everyone, especially the women, are unanimous about the benefits that the village has enjoyed so far. But it is not clear if women have had a larger share in the roles and responsibilities of the process, and the share of labor required to keep the biodiesel unit running. Their ability to make decisions is usually tested to its limit, and though they are active in the decision making, they often choose the path of least resistance, leaving critical issues up to the men. What has emerged, however, is their **role in motivating their children to be open to participate in the technology** adoption process, resulting, as will be seen later, in two young boys running the unit in the village.

5.5. Decision making processes and interlinkages established

5.5.1. Who decides and who benefits- the role of women in the project

In all seasons (summer, monsoon, rain, wind) we were bringing water from the river and drinking it. Many a time I have fallen down while bringing water. After the pump came we had water for drinking and bathing. It will be good if we get gravity flow, then again if we do not get gravity flow it is still alright as we have the biodiesel machine. ***Rohini Behera****.*

In summer we used to dig small pits near the river and bring water (as the river would run dry). During rains often our feet would slip. It was very difficult to bring water. Now that we have the water pump it is very convenient. If the machine breaks people who know how to operate it will come and repair it. If I learn I will definitely do what's needed. Regarding gravity flow……whichever is convenient we will go for that. ***Rambha Sabar***

If everyone in the village wants to keep the pump we will keep it. Otherwise we will go for gravity flow and send the pump to a village where there is no facility for drinking water. We will do whatever the entire village decides. We did not go for gravity flow before because we did not think it possible. We are a small village and did not think it possible (to mobilize the resources needed). ***Apili Sabar***

We used to bring water from the river for drinking and bathing. In summer the stream dries up and we would dig holes in the riverbed and use a cup to fill our vessels, filtering it using a muslin cloth. It was difficult to carry our utensils filled with water and climb up. We then dug a well: people assisted and we built it up with stone masonry. Gram Vikas executed the work with the villagers (one person per household helped). Once the well was built we also built our toilets and bathrooms, and then started pumping using biodiesel. If the pump breaks down, the villagers will get together, collect money and get it repaired. Mangala (a village boy) is learning to repair and will be able to set it right. If everyone agrees to gravity flow we will go for it; otherwise not. ***Uttami Pradhan.***

ANANDPUR Integrated Tribal Development Program (ITDP) and VL

Narrative presentation by Sasikala Tripathy, cluster coordinator in-charge of Kinchlingi VLB, December 2004
Translated from Oriya by Mr. Arukh, Gram Vikas staff

Anandpur ITDP comprises 21 villages; Sandigaon and Kinchilingi are two of them with 8 and 16 households respectively. It was first decided to start the biodiesel program at Sandigaon. The people of the village at first agreed to implement the program. Accompanied by Urmila aapa and Geeta Didi from Head Office, we visited the village Sandigaon on 19.5.2004 for discussion with the people and to prepare the activity plan. The villagers said: there are a few families in the village; there are no trees; seeds cannot be collected; they won't get wages and so on. So we returned with disappointment. We felt demoralized.

We thought it could be possible at Kinchilingi. We discussed with the Manager, Urmila. In the evening we sent information to the villagers to say that a meeting will be held on the next day. Next morning we reached there. A meeting was held with the cooperation of the villagers. The proposal for implementation of the biodiesel project was put forward and it was agreed to by the villagers. Different aspects of the program were explained to them with the help of posters and a micro-plan was drawn up. Women participation was more than men. It was proposed that the SHG (Women) would take the responsibility of implementing the biodiesel program. The proposal was agreed to by the members of the Group. The season for collection of oilseeds was over. With the help of GV staff the villagers have since managed to collect 42 kg oilseeds.

The biodiesel-based water pumping is primarily to supply drinking water and for sanitation, as a part of Gram Vikas' Water Supply and Sanitation program. Washrooms have to be constructed before the biodiesel production can begin.

From the next day 12 families of the village cleaned the field and started laying bricks and this created confidence in the minds of the villagers. A training camp was organized at Mohuda. Four persons from the village and four staff members were sent for the said training. They saw the machines and production of biodiesel. The visit had a positive impact. People showed interest and worked with sincerity.

There are some mischief mongers in every village. In this village also there are three such fellows who create problems in drunken condition. However, they were controlled and they also laid brick. When the laying of brick was in progress, rainy season set in. It rained. 1200 pieces of brick were damaged due to rain. Yudhistira, a villager, had laid 1000 bricks. It was damaged by rain. However, they were advised not to feel helpless. People and Gram Vikas staff worked collectively to avoid damage to the raw brick. There were tarpaulins in Gram Vikas office. The staff covered the raw brick to prevent damage by rain. The assistance provided by Gram Vikas staff changed their minds and it created enthusiasm. They worked sincerely.

It was the time when the people worked in the fields to harvest food for the year. If they work here on the biodiesel project instead, they will starve. If they go to the fields, work here will come to a halt. This problem stood in the way. The three mischievous fellows again raised their voices and started rebuking. They said they will not lay brick any more. A meeting was held. The matter was discussed with the committee members and members of SHG. <u>After all what more could the women do</u>? Kunnu Pradhan is the secretary. Her husband is working in Hyderabad as a laborer. Who will lay brick for her? Who will bring stone for her? She asked her husband's brother to help, but he didn't. She spoke of her problem to Gram Vikas staff and they persuaded her husband's brother to help her. He agreed. Kunnu surely is a woman but so far as physical labor is concerned she works equally with a man. She prepared her bricks. She collected stone one by one, with her hands. She helped others in their work. She went to Hyderabad to bring her husband home. She returned with her husband. They started construction work for toilet and bath room. In a week's time they laid the foundation and also got the roof slab cast.

Another similar case is that of Uttami Pradhan, president of SHG. Her husband, a drunkard, is of little help to the family. He will be found in an inebriated state most of the time. If Uttami, who happens to be the president of the SHG, does not construct toilet and bath room, she will be defamed.

So she and her daughter worked very hard in order that laying bricks and bogodo work go side by side (bogodo is a form of swidden or slash-and-burn agriculture). It was not possible to neglect bogodo because that would cause starvation to the whole family. She is no less than a man in physical work. If she went on *wage labor any day, she worked for the toilet in the evening that day and made sure that she wasn't lagging behind. There are some women in the village that can beat the men in brick-laying.*

Raw brick was burnt. Laying the foundations went on speedily. If people worked two days in bogodo (slash-and-burn), the next two days were devoted to construction of toilets and bath rooms. In 15 days time nine families got their roof slabs cast.

A meeting was convened to discuss sustainability of the program because Gram Vikas might provide support for this year only and the villagers should think of the ways and means to continue the program. Pursuant to decisions taken in the meeting, people cultivated castor and niger for oilseeds. The plants grew well. They were happy but the happiness was marred by the damage caused to the crop by heavy rain and storm. So they think they will collect mahua and neem seeds well in advance and cultivate castor and niger again to meet the requirement. In case of shortage, they will buy seeds by raising subscriptions.

By now, work for 15 toilets and bath rooms is in progress. Well is cleaned. Construction of pump-chamber and machine-room is in progress. Two women from the village have attended the (biodiesel) workshop held at Mohuda.

The **village decisions are taken as a group**, especially those pertaining to an external project. The staff of the local NGO, however, plays a major role in catalyzing these processes. There is no doubt that the benefit of the technology is in reducing drudgery for women. Their role in initiating the process of change is also considerable. The bulk of the work falls on their shoulders, especially the labour. If the pump stops working and there are not enough men volunteering on the repair job, the women slip back into bringing water from the stream. Decision making is still in the domain of the men. Although there are women representatives in the Village Executive Committee (VEC), they play a marginal role and are often overruled by men. The seat for the ward member (in the local government) from Kinchlingi is reserved for women, but it is the husbands who participate in place of their wife, and this seems acceptable.

The Self Help Groups (SHGs) were initiated as credit and saving groups, and consist of only women members. These forums are expected to facilitate increased participation of women in decision making. Eleven women from Kinchlingi are part of the "Maa Bhairabhi" Self Help Group. The group was initiated in 2001 and was dormant for some time. The group was revived in 2005, after which the members started saving more regularly. Currently they save Rs. 20 per month. The belief that economic independence will make the women more vocal with respect to their rights is the basis of the Self Help Group movement. The idea is also to encourage women to leverage money from banks to do business. Four women of the Maa Bhairabhi SHG have in the past used the money to buy and trade forest produce and even made substantial profits after paying back the principal and the interest on time. Yet there is **hesitation in taking loans as the group is still unsure of their ability to return the money**. Very often it is the NGO staff that discourages the women from taking loans as the collection can become their “headache.” The women depend on the NGO staff to organize meetings and give the group direction, often relying on them to settle internal disputes. All record keeping is maintained by the NGO staff, as there is no one who can read or write among them. Minutes of the meeting in 2007-08 were being written by the daughter of the SHG president, Tulsi, guided by the Gram Vikas supervisor. But Tulsi got married and has not been in the village since November 2008.

A diagnostic tool developed by the organization SaDhan (engaged in the promotion of community level microfinance), was used to assess the SHGs performance. The assessment was carried out by CTx GreEn (CTxGreEn, 2008b) to benchmark the Kinchlingi SHG with similar groups across the country. It also helped to identify training needs of the Maa Bhairbhi SHG. The tool (SaDhan, n.d) has seven assessment indicators:

1. **Group constitution** (Purpose, Group Composition)
2. **Organizational discipline (** Regularity of meetings in last 6 months, Attendance at meetings, Participation of members in decision making, Regularity of monthly (total) savings)
3. **Organizational Systems (**Rules, Regulation, Periodic election of office bearers, Book keeping and documentation)
4. **Financial management and performance (**Management of group funds, Loan quality, Track record with lenders)
5. **External linkage (**Linkages with banks, Financial institutions and Cluster federations)
6. **Activities/services undertaken by groups** (Social and community action by SHGs)
7. **Level of self-reliance (**Fund management, Decision making, Conflict management, External linkages, Record keeping)

While there is value in looking into all the indicators, for our purpose it may be only relevant to look at the ‘level of self-reliance within the group’ (indicator 7). Scores have been assigned for each criterion in Table 5-7 and the justification for the same included in column 1 under the criteria. With a score of 10 out of 25, it is easy to see that the women members of Maa Bhairabhi are **not self-reliant in managing the affairs of the group**. Self Help Groups promoted by OUTREACH, an NGO in South India, were found to be more independent with respect to fund management, decision making and conflict management. But even in the case of OUTREACH, it was found that many older SHGs continue to rely on the NGOs for external linkages and record keeping.

Table 5-7: Excerpt of Self Help Group Evaluation sheet: Indicator 7, level of self reliance

(Source: Internal evaluation report. CTxGreEn, 2008, prepared by Zalucky and updated by Vaidyanathan)

VII. Self-reliance in managing affairs				
Criteria Narrative to explain assigned score	Description of score	Max score	Score	Assigned score
a. Fund Management The group takes decisions, but always relies on advice from Gram Vikas staff.	Self Managed	5	5	2
	Federation/Community Assistance		3	
	NGO/Promoters Assistance		2	
	Any Other		0	
b. Decision Making The group said they have not had any conflict, but if they did, like all decisions, it would be settled by the group at a meeting. Since Jan2009 they have not held meetings because of discord between two members.	Self Managed	5	5	2
	Federation/Community Assistance		3	
	NGO/Promoters Assistance		2	
	Any Other		0	
c. Conflict Management Sasikala, the Gram Vikas staff says that she is the first line of contact, but she gets the women involved as much as possible when dealing with the bank.	Self Managed	5	5	2
	Federation/Community Assistance		3	
	NGO/Promoters Assistance		2	
	Any Other		0	
d. External linkages Sasikala (up to Nov08) has kept all the records with Tulsi's (the president's daughter) assistance. The group said they would like Tulsi and Sunita from the village to be trained in record keeping with the new Gram Vikas Supervisor.	Self Managed	5	5	2
	Federation/Community Assistance		3	
	NGO/Promoters Assistance		2	
	Any Other		0	
e. Record Keeping The group completely relies on the Gram Vikas staff to maintain their records for the bank.	Self Managed	5	5	2
	Federation/Community Assistance		3	
	NGO/Promoters Assistance		2	
	Any Other		0	

The only business activity that the women have engaged in together is the tamarind business. Although four women took the loan to buy the tamarind together, they then worked individually (de-pulping it at home whenever they had the time). Women help each other in such activities, yet formal working together over extended periods is rare except for their own cultural events. It has also happened in cases such as niger cultivation and harvesting.

The Self-Help Group Maa Bhairabhi at Kinchlingi will require special training to independently run an enterprise. The women in the SHGs are, not surprisingly, always hesitant when a new enterprise idea is broached because to them it is more work in ever increasing amounts**.** However, they have not been able to perceive themselves as entrepreneurs employing men to work for them. This shift may take several years of working and demonstrations.

5.5.2. Management of VLB- four years of biodiesel-based water pumping

Before (the GV-CTxGreEn biodiesel project) we would go 3-4 kms to bring water. (We had) no water, we did not have biodiesel nor did we know how to run the machine, how to pedal to make fuel. Gram Vikas taught us how to use oil to make biodiesel to pump water. Now we have learnt. The water was polluted, we could not drink. Animals would drink from the source. Cow dung, leaves, and branches everything would fall into the same water, an open source and we used to drink that water. The government did not do anything for us: nothing done at all, no facilitation. With GV first and now on our own, we worked together and are staying together in the community and as a family. We were using kerosene lamps (Dibbi) and so light (electricity) was suggested. We were waiting for the government to electrify our village. Instead of waiting and continuing to stay in the dark we opted for lights (using biodiesel). At first, some people were willing while others were not. All were ultimately cajoled to opt for the generator-based illumination. (Light is) useful for women, not for men. Women can go out with light and go to the washroom. It was earlier difficult to go out in the dark at night.

We ploughed and harvested niger together, kept the harvest in one place and cleaned it as a group. We decided not to sell (the niger seeds) as we use it (the oil converted to biodiesel) to pump water. These seeds were pressed and converted to biodiesel. Initially we did it in Mohuda (Gram Vikas Head office), but later in the village. The people there helped us and we moved ahead. Women cleaned, weeded and sowed seeds harvested and guarded the seed. The machines, Kunnu and others went for training I don't know about it (laughing). Oil converted to biodiesel is used now for current, thru the machine (generator) and for charging solar (LED) lights. We would not have understood, Mohuda people came and taught us. We lived with a lot of difficulties. **Uttami Pradhan resident of Kinchlingi**

Note: Underlines are phrases indicative of decision making processes; boxes indicate tools/techniques/technological implications.

The partners involved and their interrelationships are examined to understand the strengths and weaknesses of VLB as a catalyst for sustainable livelihoods. Key events and main players have been identified from Section 5.2 (Chronology of events in Kinchlingi) and listed in Table 5-8 to understand what factors have governed the diversification of VLB beyond water pumping. These actors (Table 5-8) have then been mapped on the five tenets of VLB as a sustainable livelihood in Figure 5-2. This gives us an idea of where the thrust of the work has been and what areas may have been ignored.

Table 5-8: Key events and main players: case of Kinchlingi

Key events	Main players/Participants
Running a biodiesel production facility	Bhairabhi Self Help Group, Gram Vikas supervisor, Barefoot technician, CTxGreEn staff
Water pumping using biodiesel	Community of Kinchlingi, Gram Vikas supervisor, Barefoot technician, CTxGreEn staff
Management of the biodiesel unit	Village youth recruits, Barefoot technician, CTxGreEn staff
Forest dept. plants karanj saplings	Forest department, VSS-Village Forest protection committee
Female barefoot-technician recruited	Kinchlingi community
Workshop on "Biodiesel water pumping" a historical perspective	Village representatives, Self Help group representatives, Gram Vikas supervisor, Barefoot technician, CTxGreEn staff
Agro services: multipurpose tiller	Entrepreneur, Gram Vikas supervisor, Barefoot technician, CTxGreEn staff
Barefoot technician sets up rice huller	Local entrepreneur as a spin-off, barefoot technician

Key events	Main players/Participants
Tiller training	Two Kinchlingi villagers (of them Sano is a prime mover)
Niger harvest	Villagers
Workshop on costs of tilling and electrification	Village representatives, Self Help Group members, Gram Vikas supervisor, Barefoot technician, CTxGreEn staff
Niger sowing using tiller	Gram Vikas staff, Tiller agency, Villagers from Kinchlingi and neighboring villages
Soapmaking from glycerin, an orientation to running a business and assessment of the SHG	CTxGreEn intern, Bhairabhi Self Help Group, Gram Vikas, SaDhan (microfinance know-how), Fabindia and Deckle Edge (outlet for handcrafted products)
Discussion on lighting: numbers, which room and at what time	CTx GreEn team, Gram Vikas supervisor, Village women and village men
House wiring	Electrical contractor, villagers
External electricity poles	SOUTHCO contractor for Government's RGGVY village electrification program, Below-Poverty-Line Households (all except the widow in Kinchlingi are eligible) in Kinchlingi and Latigoan
Staff turnover at Gram Vikas, village of Anandpur	Supervisor, Accountant
Lighting through biodiesel	Village Electricity Committee, Gram Vikas staff
Village lighting, Biodiesel production	LED supplier, Generator-set supplier, Village Electricity Committee, Gram Vikas supervisor and Project coordinator, community of Kinchlingi (LED and CFL consumers), children of Kinchlingi
Training in the new system	Barefoot technician (from KBTT), Youth from Anandpur village, CTxGreEn, children, youth from Kinchlingi
Protocol for lighting	CTx GreEn staff/intern, Village committee representative, two people from the village
House wiring (Govt. Program)	Village representatives, Home owners, Electrical contractors
Training	Kinchlingi, Anandpur youth, CTxGreEn team, Barefoot technicians
Graduation ceremony	Jagannanthprasad Institute of Management JITM, Kinchlingi community (including participants of training program), Gram Vikas Staff, DFID rep, CTxGreEn staff
Kinchlingi as a hub for biodiesel production	Jagannathprasad Institute of Technology and Management (JITM), Local commercial oil pressing units, farmers, Youth-potential oil press entrepreneurs

The roles of each of the partners involved in various activities in Kinchlingi, when mapped along the five building blocks of the SLF for VLB (Figure 2-3 and Figure 2-5), show strong linkages have been established in some areas while others need more strengthening. There are reasonably strong linkages between components of agroecosystem, appropriate technology and rural livelihood, but the link with entitlements is weak (Figure 5-2). With respect to Kinchlingi, there has been no activity in the realm of legal and policy issues at all. The presence of the forest department in the village has initiated some latent activity like forest regeneration using karanj seedlings. For further replication these two areas will need more attention: (1) Strengthening of village level institutions like the Self Help Groups, which can catalyze local livelihood initiatives based on biodiesel like the rice huller (run by a barefoot technician) or a biodiesel oil expeller, tiller *etc*. (2) Enabling policies to ensure that there is no undue burden such as excise duties for alcohol used in biodiesel or levies for use of forest seeds. The local NGO, Gram Vikas in this case, plays a very important role as an anchor to foster entrepreneurship in the community, drawing in partners that can then build on the local presence. Their active role is crucial because communities such as Kinchlingi, which have for generations been dependent on "middlemen" for all their livelihood supports, are practically "zero-generation" entrepreneurs[22] who have to be gently cajoled into taking risks, and whose risks have to be covered so that the process of livelihood reinforcement is successful. Presently the risk averse Kinchlingi community and "tribal development" oriented Gram Vikas staff are supporting this village, but are comfortable with promoting a volunteer-driven program in the village for VLB instead of an enterprise model. The strengths, obstacles and challenges that the volunteer-driven model presents are important to understand for the way forward with VLB.

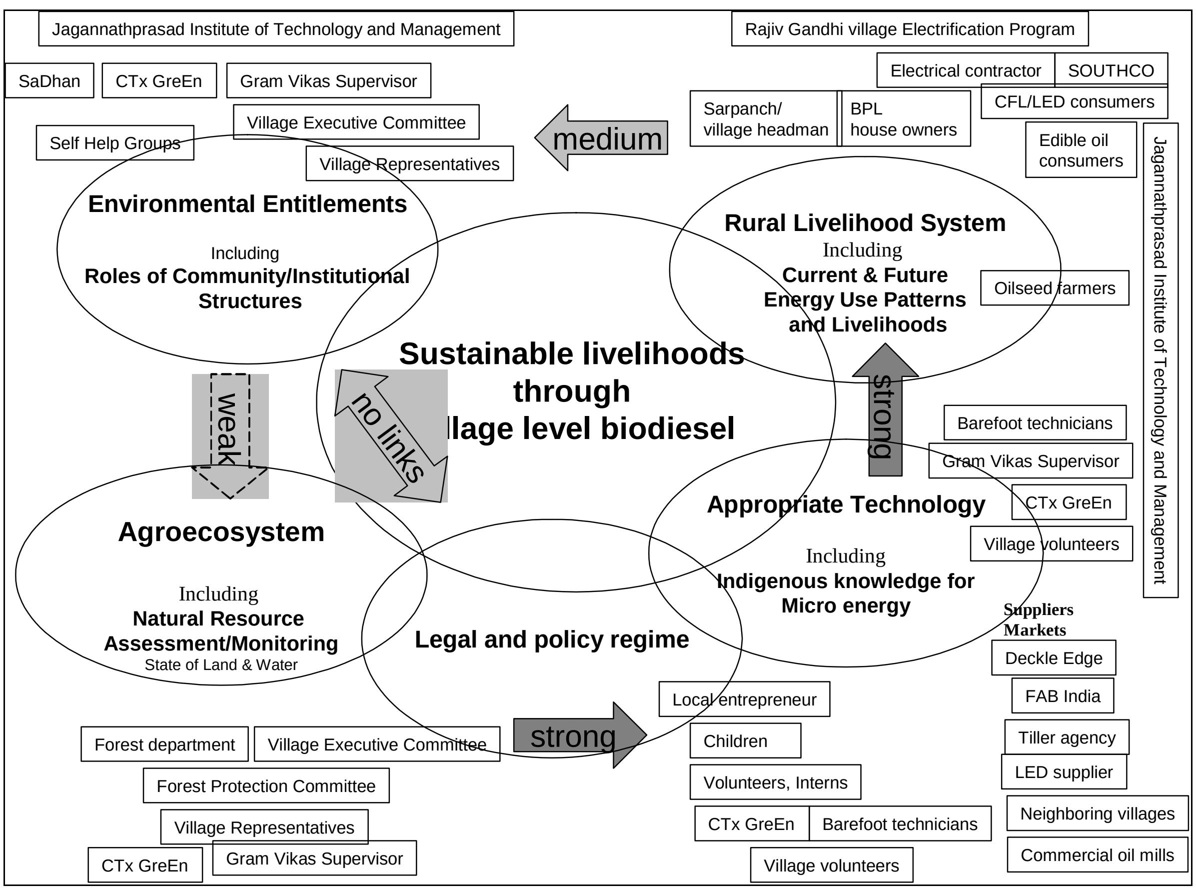


Figure 5-2: Agencies involved, their focus and partnerships/associations

5.6. Livelihood strategies: Volunteer Run Model in Kinchlingi

5.6.1. Water pumping, sweat and tears (Journal extract)

November 2004
The bicycle drive is assembled and then the drives and the reactor vessels are put in place: a smaller one for mixing the lye and alcohol and a larger 5 L one for mixing oil with the lye-alcohol mixture. With the stainless steel reactor vessels and the bright yellow drive, the gear-shift mechanism is adjusted and the adjustable seat fixed. The oil and the alcohol are measured volumetrically, while lye is weighed in the sparkling new physical balance. All is set to produce the first batch of biodiesel: only volunteers are needed. But <u>none of this can move ahead without a puja</u>, <u>a prayer to the Gods</u>: flowers and vermillion paint adorn the machines. A lemon is strung onto the handle bars to ward off the evil eye and incense sticks lighted and a prayer recited. And then volunteers line up and the first batch of biodiesel production is initiated in the village. Everyone takes a turn: 75 km to be pedaled as per the odometer on the bicycle drive and <u>everyone has a go pedaling at least 5 kms, guided by the few who had been trained at the pilot plant in Mohuda</u>. After the pedaling activity is over the crowd subsides but re-assembles after an hour, to see the glycerin being removed and the biodiesel tapped. Everyone is feeling victorious, and someone in the crowd says: "We can make our own biodiesel." <u>A roster is quickly created</u> and it is decided that they will stock up biodiesel in anticipation of the water pump which will arrive once the water tank is built and the individual washrooms are ready. There is renewed enthusiasm to finish the washrooms, and it is agreed that one person from every household will be available once a week for biodiesel production.
May 2005
The water tank is being built. A 5 HP irrigation pumpset is purchased for trials and water pumped from the well. Water reaches the village but there is not enough head to pump it to a temporary watertank placed on the roof of a building. The volume of flow is good but there is not enough suction head. Back to the drawing board, because the supplier's advice is to use a 10 HP water pump. <u>That will never do as the operating cost will be high:</u> fuel consumption can be as high as 2litre /hour. After going through all permutations of pumps and engines a 3.5HP pump is selected. The running cost can be as low as 0.5litre/hour. Will it achieve the requisite head? A trial pumping is arranged in the village. And yes it works! (This entire process of pump testing started on 16Dec04 and finished on 05Jan05; pump selection, procurement, setting up and proving feasibility took a month with installation on 05Feb05; then there <u>was debate about the water tank location</u>. The water tank was finally finished in May 2005.)
June 2005
<u>A tour is organized to the biodiesel producing villages and a workshop held</u> with the project coordinators from Gram Vikas to discuss future operation and management of the units. Each of the coordinators works with the technology team and calculates the cost of operating the unit, feedstock needed and the best model for managing the unit. <u>We try to convince the Kinchlingi team that they should have an entrepreneurial model. They think that the community can contribute labor but they do not have disposable income to pay tariff.</u> A volunteer-run model is worked out and a base amount is established for each household: sweat equity as contribution for production, growing or collecting feedstock, and some basic tariff to pay for other chemicals.
July 2005
Niger oilseed cultivation is initiated on a one-acre plot near the village, using local seeds.
August 2005
There are two weddings in the village and so extra water is needed. The concerned households pay a token amount for the extra water.
December 2005
There is government road building activity in the village; money from the government is paid to the village committee for the contribution made by the villagers in the form of labour. The village committee decides to put the <u>money into a fund to pay for biodiesel</u>.

January 2006
Niger is harvested. It is a bad harvest of about 10 kilo.
July 2006-Nov 2006
Niger is sown in three pieces of land in a staggered manner. The first field yields 86 kg, which works out to be about 78 kg/acre, almost 8 times more than the last harvest.
January – February 2007
A girl and a boy are deputed from the village to learn bookkeeping and oil refining at the pilot plant
The manual oil press demonstration takes place at Kinchlingi. All the oilseeds harvested are pressed in the village and feedback about the machine obtained. It is a three day demonstration. The first day a few volunteers trickle in and help with the machine assembly. On the second day in the first half it is again the same men who volunteer to press the oil.   In the afternoon there is the loud noise of people arguing. The villagers are arguing with the Gram Vikas supervisor. They say that they realize that the technical team has come all the way to assist them with pressing their oilseeds and so they should support them. But they feel that it is always the same people that volunteer. In their words: 'After all we lose a day's wage, while those not participating do not and they benefit from our involvement in the biodiesel activity.' It is decided that for two days, even if only a few volunteer with the oil pressing, the rest of the village will assemble and watch. Everyone in the village sacrifices 2 days of their wage. It seems pointless to have so many people sitting (and singing to keep themselves occupied) in front of a serious production centre. But then if these are the norms of a volunteer-based system, then they have to be honored.
Mar 2007
Checking the fuel in the diesel pump set, Ramesh and Mangala (a Kinchlingi youth volunteer) fit the handle to the diesel pump and crank it. The engine purrs softly and then there is some white smoke and the familiar smell of cooking oil. They wait to hear the sound of water being drawn up by suction and pumped to the water tank, but nothing happens. Mangala climbs up to the water tank and realizes that there is no water flowing.   Something seems wrong. They stop the engine and find that one of the joints is not tightly screwed on, which is causing the leak. Ramesh descends into the well, pulls out the galvanized iron pipe, and removes the socket where the joint is leaking. He gets the socket fabricated at a town 30 kms away, and the next day replaces the socket and lowers the pipe into the well again. Sano from Kinchlingi can descend easily into the well but is away and it is the first time for Ramesh. It is also the first time that after diagnosing the problem, Ramani (the CNBFES Project Manager) has asked Ramesh to assemble the pipe on his own so that minor problems can be dealt with locally.
April-May 2007
Mangala is given the charge of running the pump set when Ramesh is away. He agrees to start the pump but is averse to any record keeping. All the same he manages to check levels in the fuel tank before and after pumping and also the water level in the tank, and record the information. As he starts the pump on a hot summer day, the engine comes alive but there is no water being lifted. Panicking he tries once more but with no success. Someone in the village remarks that Mangala has broken the pump while Ramesh is away. This is the last straw for Mangala. He hands the pumproom key to Ramesh at the project office and declares that he is never going to volunteer again.
Having assessed the problem and responded to questions on the telephone from the Mohuda pilot plant, Ramesh is confident, that the foot valve at the bottom was not the problem but that an elbow joint is leaking. He descends into the well and rectifies what he perceives as the problem. His attempt yields some results-water pumping is resumed. The next day when he starts the pump the problem recurs. A second descent into the well is again successful in getting the pump started. A plumber who has only worked on submersible electric pumpsets tries to diagnose the problem and finally realizes that it is indeed a leak in the foot valve, The foot valve is replaced and water pumping is resumed but not before Ramesh's patience is worn out.

Note: Underlines emphasize indications of decision making

5.6.2. From pump to generator: the pangs of transition to lighting

Day Four of providing lighting

Field notes: HyunJung Park: Intern at the Gram Vikas-CTxGreEn Biodiesel Project: Feb 1, 2009

Basanta, Satya and Parbati were cooking in their respective kitchens. Parbati was the only one using the LED light in the kitchen. The LED lights belonging to Satya and Parbati' were on in the other parts of the house. Basanta was cooking in the darkness and told me that they can use kerosene lantern if needed (she lights up the wick lamp, but the wind blows it off). They are only 'boiling/heating' the food and the light from the fire is enough to make sure that the pot does not boil-over. It is also only the fourth day since they have started using the LED lights.

In Haribandu's house, Jamuna and the children were inside the house lighted with the LED. (It was heartening to see that Jamuna was using the light) At 6:35 pm, I went to Upendra's house. Uttami and Saraswati were cooking in their outdoor kitchen, in the back verandah. They were using the kerosene lantern and the LED light was turned on inside the house, which was empty. I asked them why they were not using the LED lights (found it difficult to form the sentence in Oriya though) and they said we have kerosene here.

Should we train them how to use theLED lights so that they can enjoy full benefits?

The location of the fixed CFL lights was discussed with the men and women separately. Cooking is done in an open verandah outside in the early evening hours and the food is stored in an internal kitchen cum dining space. Some women initially wanted the light in the outside verandah space, but relented and decided that the middle room would be the best if there was to be only one light fixture, as that was the room where they usually used a lantern instead of a wick lamp. It was also the room where they ate their meals and spent time as a family.

We were witness to the introduction of lighting into the life of people whose living pattern was dictated by the sun. Women are more accustomed to cooking before it is dark and only reheat food in the late evening. Only in rare cases is cooking started after sunset. For reheating or cooking in the dark, the women continued to use kerosene lanterns or wick lamps. The LED light (which is a mobile lantern), though a better source of illumination, was left to light the other rooms, even when there is no one in the room. Women prefer to leave the luxuries for others in the family, even at the cost of their own discomfort.

The time for the one hour of CFL lighting through the mini-grid was decided on the basis of the time the villagers ate their evening meal and was only used for that. Most of the villagers preferred the LED light because it gave them the flexibility to switch it on and off as needed instead of being tied to the fixed hour. There were only three houses that had not purchased the LED lights, and in these houses they used the CFL minigrid lighting for eating. After their meals, most of the villagers would sit outside while the CFL lights still burned inside for the remainder of the hour. Monitoring the LED lanterns[23] brought to light other factors. Children seemed to be the most fascinated with the LED lights. They were used on the low setting as a nightlamp, used as a flashlight to go into the fields or to go to the washroom at night. In some cases women used the light for depulping seeds or to do other income generation activities. The full potential of the lights is only slowly being explored. One of the women lent her light temporarily to her daughter, a new mother, in a neighboring unelectrified village. The girl had come to stay with her mother during her pregnancy and after her child was born had gotten used to the convenience of the light. At this point in Kinchlingi, lighting is more of a luxury only slowly lengthening the workday of the women. As was observed by one of the biodiesel team members, an orientation on the potential uses of light may be useful. Then again, a shift in lifestyle can never be sudden. It may be best to allow the adoption process to take its course.

The energy use pattern and the future aspirations of the villagers are both deeply entrenched in village politics and power struggles among the more influential at any given point of time. This became obvious during most of the feedback sessions held with the villagers. Being a very small village with two distinct identities (the tribal Sauras and the Schedule Caste who are mostly Pradhans), small disputes within the village tend to polarize the village. What is even more interesting is that of the 15 houses, there are only seven distinct households: four of the nine houses on the non-Saura side are relatives, and even in the remaining five, two families are related. On the Saura side three of the five houses belong to siblings from the same family. Including other residents in decision making such as the guards from the forest department and the tenants of the house that is rented to people from outside the village, could increase diversity of opinions and reduce monopoly. This is important, especially as Gram Vikas is slowly withdrawing from active community involvement. **The active role of the children is another way to reduce tensions and bring in an intergenerational commitment to community building. This has been seeded almost intuitively through the biodiesel-based charging activity in the village.** Since the Saura women leave for work early, the children from that side of the village started bringing the LED lights to the charging station, located on the non-Saura side of the village. The children on the non-Saura side also automatically started collecting all the lights from their side of the village and bringing them over. This interaction made two of the boys curious enough to want to learn how to use the multimeter and understand how, by measuring the voltage in the battery, the biodiesel team was ensuring that the batteries were always fully charged and thus increasing the life of the battery. These two boys, Suresh and Raju, are today managing the charging station in Kinchlingi.

5.6.3. Anticipated and emerging roles and responsibilities in an adaptive environment

The roles and responsibilities of different actors in such a model (constantly adapting with changing needs and demands) are discussed below in the context of the Integrated Tribal Development Program (ITDP) of Gram Vikas in the Anandpur project area. A workshop was held (6-9 June 2005) to design the VLB approach in the different project areas (see APPENDIX XI). As a first step, the synergies of VLB with the existing program areas of Gram Vikas were identified. The linkage diagram Figure 5-3 was presented for Kinchlingi by the Anandpur Gram Vikas team.

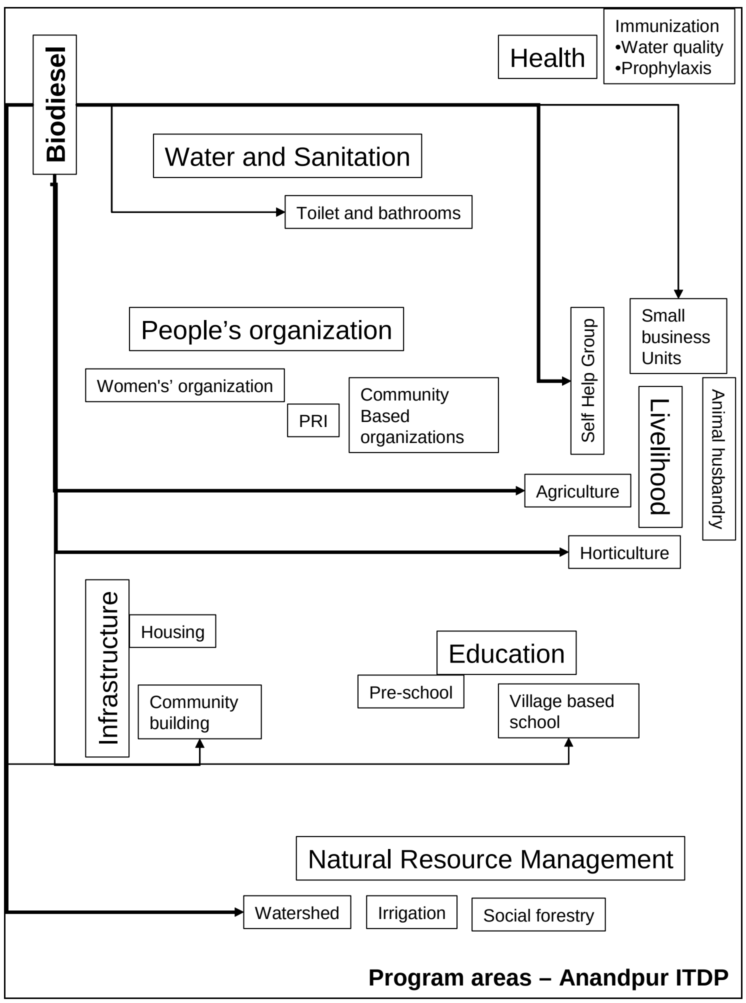


Figure 5-3: Synergies of VLB with Gram Vikas program areas

The strongest links to existing Gram Vikas programs were foreseen with land-based livelihoods pertaining to agriculture and horticulture, and Natural Resource Management (NRM), galvanized through civic processes (People's organizations), particularly women's' groups and Panchayati Raj Institutions (Village level organizations, recognized political entities). The proposed plan formulated for Kinchlingi was to focus on water pumping and not electrification (Table 5-9), as the local Gram Vikas team felt that the village would eventually be electrified, being less than a kilometre away from an existing transformer. In the planning exercise conducted during the workshop, the focus of the Anandpur Gram Vikas team was on building up the Self Help Group to support activities in Kinchlingi through income generation opportunities.

Table 5-9: Proposal for Kinchlingi by Gram Vikas Anandpur project staff

Proposal for Kinchlingi by the Anandpur group April 2006
Our group has proposed only water pumping as end product and not electrification (lighting).
Reason
Electricity is available in the nearby village (Deula) 1 km away, so Kinchlingi may be electrified.
We require pumping to utilize the available local seeds.
In case of gravity flow coming to the village we can still use biodiesel in emergencies and in the summer.
For extra income of SHG we are proposing a seed grinder and a big-sized oil press.

The different roles that were foreseen in the implementation of such a proposal were listed, and the village organization most suited to take responsibility was identified (Table 5-10). The Village Executive Committee was seen to be the technical hub working with the village operator and the technical team, while the machines were to be run on a voluntary basis, supervised by an operator. The Self Help Group was given the responsibility of seed collection and byproduct marketing.

Table 5-10: Anticipated roles and responsibilities for VLB in Kinchlingi

Activity	Responsibility
Anticipated (2006)	
Water pumping	Operator and Village Executive Committee
Grinding and reactor operation	Trainee operator and youth volunteers
Seed collection	Household, Self Help Groups, Area committee
By product marketing	Village Committee, Self Help Group, Gram Vikas facilitator
Technical expertise	Biodiesel (VLB) team and Village Executive Committee

Compared to the tasks that were initially set out, many new roles have emerged as well as new role players, such as the youth volunteers for running the charging station and the committee for tariff collection and management (Table 5-11). Jagananthprasad Institute of Technology and Management (JITM), which has a rural development school, can play a crucial role in anchoring the technology and providing supports and diversification. The Self Help Groups are the keystone to the success of VLB. In their current form, they have the right intentions, but not the capacity to independently manage seed collection and byproduct marketing as was envisaged in the plan (Table 5-10).

Table 5-11: Actual roles and responsibilities for VLB in Kinchlingi

Activity	Responsibility
On the ground (2008-09)	
Water pumping	Barefoot technician and village volunteers (as anticipated)
Oil Press Market outreach is needed both to contact farmers with oilseeds and to promote the enterprise.	Barefoot technician, Biodiesel team, youth volunteers (as anticipated)
Reactor (and related accessories) Making biodiesel using the reactor	Barefoot technician, Biodiesel team, youth volunteers (as anticipated)
Seed collection, growing SHG is not playing an active role although the women loosely see themselves as representing both SHGs and households.	Household, JITM facilitator, Barefoot technician, Biodiesel staff. Gram Vikas staff are no longer facilitating this activity. The area committee (an informal conglomeration of VECs of villages in a cluster) could play a very crucial role but this also needs facilitation by Gram Vikas staff.
Byproduct marketing With the old supervisor having left, SHG strengthening activity has come to a grinding halt	Training was initiated for the Self Help Group with the assistance of the Gram Vikas facilitator and Biodiesel team (on enterprise management and orientation to soap making)
Technical expertise for changing needs	Biodiesel team, Village representatives appointed by the committee, LED suppliers, Generator supplier
Charging station including biodiesel generator, battery, chargers and LED lights	Village youth volunteers, Biodiesel team, Village Committee
Tariff collection and management	Gram Vikas, Biodiesel team, Electricity Committee (3 men and 2 women committee)
Policy lobbying This activity should lead to passing a resolution for waiver of permit fees and excise duty, for accessing grid electricity, and accessing benefits for VLB.	JITM, RCDC, State government bureaucrats from the departments of agriculture, Panchayati Raj (rural development) and Science and Technology

It is interesting that the “volunteer-driven” model is also referred to as the “sweat-equity” model. As it turns out, a lot of blood, sweat and tears go into making the production of biodiesel and its use a “community” effort (Section 5.6.1 page98). As has often been remarked in such initiatives, it is always a few who end up doing most of the work while the others enjoy the benefit. A common complaint is that volunteer fatigue can set in and erode the effort completely. What is worth noting is that Ramesh, after all the effort that he put in (Section

5.6.1), went on to be the first tribal youth in the area to become an entrepreneur. He has now set up his own diesel engine-based rice huller and feels that if biodiesel is locally available, he can easily shift from using diesel to biodiesel by making small modifications to his equipment. He is also sure that biodiesel locally available will be cheaper for him than having to purchase it at a premium from outlets in a town 11 kms away. The closest retail outlet for fuel is at least 25kms from Kinchlingi. His preference for a diesel engine was because of his experience with biodiesel pumping in Kinchlingi and also because electricity supply is erratic in the area.

In fact, there are several latent benefits of such a volunteer model. The volunteer model in Kinchlingi has set into motion a parallel autocatalytic process that is in the end beneficial to the community. Therefore, although VLB entered into such a volunteer-based relationship only because it was the first village implementation and the idea was to learn from both the local NGO and the community, there are obvious merits of a volunteer model.

5.7. Outcomes

During the June 2005 meeting, the project staff identified indicators (Table 5-12) that would show whether the synergies proposed in Figure 5-3 with the (1) SHGs, (2) Agriculture, (3) RHEP and (4) People's organization were being reinforced. Table 5-12 also tabulates the status of the achievements, which are discussed briefly below.

Table 5-12: Synergies proposed and expected outcomes

Linkage	Indicator	Status of achievement (June 2009)
SHG	Increased money power, credit worthiness, adequate income	In danger of breaking down
Agriculture	Niger productivity 200 kg/acre	May be picked up by individual farmers
RHEP	Preventable disease avoidable	Incidence of water-borne disease may have reduced
Peoples organization	Strong village committee for smooth operation of VLB	Young village boys are managing data entry and daily management of VLB lighting unit

The RHEP linkage was achieved, washrooms and the water supply system are in place and the VLB supplied water for three years while the village waited for a gravity flow system to materialize. The incidence of waterborne diseases such as diarrhea and cholera was reduced according to baseline data collected by the Gram Vikas staff.

With the infrastructure in place, the local NGO Gram Vikas is now considering withdrawing from the area after working there for almost 2 decades. While they have built infrastructure in the form of washrooms and houses, the community that they nurtured and the organizations that they have initiated (VECs, SHGs) are in a transition phase, still trying to understand their new roles. Currently the SHG in Kinchlingi has stopped meeting, although they still continue to save money. There is attrition in the member strength because of migration. There is a danger that the women's group, which has some very enterprising women, may break down if not brought together for a common purpose. The soap making enterprise from glycerin, the byproduct of biodiesel, may be a way to use the knowledge of medicinal plants that the women of Kinchlingi have as a means to reinforce the group. An orientation has been provided but more work is needed.

Niger productivity reached 80kg/acre in on plot in 2007 where it was sown in a timely manner. The target was to cultivate at least five acres to be able to harvest roughly 500 kg of seeds for Kinchlingi's annual biodiesel needs. Niger was sown in three acres and a total of 141 kg was harvested. Salt was bartered and 200 kg of karnaj seeds were exchanged, to fill the gap. This year the community may not cultivate communally; however there are individuals who have asked for niger seeds. There is a lot of potential to strengthen the agriculture base by supporting interested farmers through timely inputs in the form of teaching best practices, such as using oil cake as manure and providing a means of tilling and irrigation, all of which can be provided through VLB.

A grassroots process of strengthening of organizations may be in place, with the younger generation of Kinchlingi taking an avid interest in understanding the fundamentals of any change in their village. The young boys in the village are now managing the biodiesel-based lighting unit, recording data, trouble shooting and communicating with the biodiesel team as needed without help from Gram Vikas. This group needs to be carefully nurtured by the Village Executive Committee, so that they can support them technically for more than the current activity.

5.8. Conclusions based on the SLF for VLB

The adaptiveness of the technology to the changing needs of the community is clearly exhibited in the case of Kinchlingi. VLB has the ability to move from water pumping to tilling to lighting, and because it is responsive to local requirements, the community has the ability to absorb each of its new forms. An important lesson from the VLB experience in Kinchlingi is that byproduct synergies reduce the burden of the technology on the community and increase local recycling of wealth. In relation to agroecosystems, the lesson learned is that good feedstock yields imply low cash outflows and therefore more robustness in VLB. To reduce vulnerability the composition of the feedstock could include tree oilseeds (like karanj) in addition to short duration oilseed crops on fallow land. It appears that when the livelihoods of the community are fragile, people resort to strategies like migration; over 10% of the village of Kinchlingi migrates to urban centres for work. While there is opportunity for enterprises locally, in terms of both supply of raw material and demand for services, the community is risk averse and hesitant to take bank loans to set these up.

Reflecting on the five building blocks of the 'SLF for VLB' framework (Figure 2-3, page 17), in the case of Kinchlingi it may be concluded that the agroecosystem was not conducive to the introduction of the technology. There was a strongly expressed need from the village because of lack of grid connectivity and the need for a water supply system independent of the neighboring village, to safeguard against the possibility of future conflicts jeopardizing access. By self-regulating water supply and by requesting that the biodiesel equipment be retained for two years as a backup to the gravity flow system, the community indicated its inherent ability to safeguard against vulnerability. The choice of lighting over setting up an enterprise is perhaps dictated by the extent that the community is able to take risks (they are confident of their ability to repay Rs. 700 for the LEDs, compared to Rs. 100,000 for the tiller).

VLB has the ability to foster multiple livelihood opportunities in the form of water pumping, lighting, electricity, ploughing and other multiple functions that the 'multipurpose tiller' is able to offer. The byproduct synergies also ensure other small-scale economic opportunities. The confidence generated by VLB has contributed to one of the barefoot technicians becoming an entrepreneur (supported by technical reinforcement through VLB and some financial support from the SHGs). It is interesting that the same factors could not generate an enterprise in Kinchlingi. The politics in the community have to some extent dictated this. Strong players in the village community have clearly moved the direction of VLB towards more volunteer-based and community-supported endeavors where risks are shared, rather than to individual enterprise with localized risks.

The roles of stakeholders involved in Kinchlingi, when mapped along the five building blocks of the SLF for VLB, show strong linkages between components of the agroecosystem, appropriate technology and rural livelihood. The link with institutions and community arrangements is relatively weak (Figure 5-2). It can be concluded that even volunteer models need prime movers. Currently the NGOs have played an important role in this respect. NGOs have also been responsible for providing external linkages and maintaining formal documentation, both of which are important factors contributing to the growth of any group that extends its relations beyond the confines of its own village (for purposes other than socio-cultural). It can only be surmised that if these skills were transferred to the community the community members would be more open to the idea of an enterprise. The mindset of the NGO staff, who are averse to the idea of facilitating loans for the community for fear that the burden of recovery will fall on their shoulders, is reflected to some extent in the mindset of the villagers.

The role of the group in decision making appears to be very strong, and could be leveraged through the process of information sharing that is already taking place due to VLB. The role of the women in such a process of change appears to take place (or not) at two levels. The first level is as a group, but this is often dictated by the prevailing group dynamics. Many of the decisions external to the house continue to be dictated by men. Women (in Kinchlingi) are as yet unable to break-out of their stereotypical roles. Forums like the SHG could be used to present noncontentious topics about the impact of the technology on lifestyle patterns, as a way to discuss more controversial issues such as their roles in a changing environment. The second process of change which occurs at the individual level appears to have, at least in the case of Kinchlingi, positively reinforced VLB. This is the influence that the women have on their children's role in participating in technology adoption. This has an impact not only on the intergenerational commitment to the technology, but also helps to develop a strong level of expertise within the village. Two areas identified for further attention are (1) strengthening village level institutions like the Self Help Groups, which can catalyze local livelihood initiatives and stem migration to cities and (2) incorporation of enabling government policies that could reduce undue burden on the community. There are trends to indicate that the community is resilient, as is the technological system. A vulnerable agroecosystem can be reinforced through livelihood strategies, some of which have been suggested by the community.

The other important factor for ensuring resilience is improving connectedness between institutions to enable more entitlements within the community. This is a weak link in the case of Kinchlingi. The case study has also demonstrated the iterative loop of the development process and the benefits and challenges of responding to an everchanging context, where technology is only a means to an end.

The next chapter uses the SLF for VLB to analyze another case study with its own typical socioeconomic context, but in the same agroecological region as Kinchlingi.

6. Case study of VLB catalyzing sustainable livelihood opportunities: Field installation 2

By surviving and growing, lichens prepare the way for other forms of life and for a greater diversity and abundance of species of all kinds.

Jim Lotz in Lichen Factor, P.252

6.1. Enough for today, tomorrow is another day! Case of Kandhabanta-Talataila

The only brick and concrete house in Kandhabanta until 2006 was the three-room house built with government subsidies that belonged to Gandhi, the president of the village. This was used as the field office of Gram Vikas and doubled as a community building and school. Similarly, in Talataila the only brick and concrete building was the community hall. The thatch roofs and mud walls of the houses in the twin villages of Kandhabanta and Talataila (KBTT) are testimony that the villages had not participated in Gram Vikas' massive housing program of the 1980s. Loans[24] for permanent housing were being offered by Gram Vikas, and all their core villages of action had been convinced to accept them. Recovering the loans has been one of the biggest challenges for Gram Vikas supervisors. That the villagers did not have to repay housing loans (unlike in Kinchlingi) meant that the biodiesel program would come to KBTT with no previous baggage.

There are only a few suitable tree oil species in the local forest with seed oil suitable for converting to biodiesel, making the site at KBTT less than ideal. Several other factors however, such as the availability of private and community fallows, excellent liaison with the forest department on issues of access over forest produce, and the community's own ability to take risks, proved to be clear advantages that encouraged CTx GreEn to decide on KBTT as the second village installation for VLB. While Kinchlingi was expected to be a demonstration of the technology and focused on technical aspects, KBTT was to provide CTxGreEn with insights into community-based rural energy planning. The initial meeting with the KBTT villagers to get their agreement to participate in the CNBFES program was followed by systematic surveys of the agroecosystem (including community, livelihoods and the natural resources), most of which were conducted by members of the community. Discussions with the community and related stakeholders were carried on even as the washrooms were being constructed under Gram Vikas 'Rural Health and Environment Program (RHEP). The villagers provided continuous input into the design of the biodiesel technology system.

This case study explores these anticipated and emergent relationships between community, livelihoods, environment and technology and their respective linkages at the micro and meso-levels through formal and informal mediating structures. Although both villages share the same agroecological base, the historical and livelihood context of KBTT is different from Kinchlingi. This resulted in further innovation in the technology system as well as in the management model, both of which are discussed below. The roles of different partners in building relationships have been analyzed to understand factors that were mutually reinforcing and those that caused a setback to VLB.

The twin village of KBTT was the testing waters for VLB, but many of the benefits from the technology were reaped by Kinchlingi, where most of these trials were finally implemented.

6.2. Chronology of events in Kandhabanta

Mar - 2004	Quick survey of villages in the cluster: pre-feasibility Survey with barefoot engineers
Jun - Dec 04	Washroom construction under RHEP Sal seeds collected by villagers. Seeds not useful for biodiesel
Jun - Dec 04	Biodiesel team established in Kandhabanta to survey cluster Project Coordinator (PC), Gram Vikas, initiates niger sowing
Sept - 2004	Mohua seeds exchanged for oil: Project office purchases seed from villagers Water pumping demo in Kandhabanta using biodiesel
Oct 2004	Exposure visit to Pilot plant by village representatives Energy Planning workshop in the village
Nov -2004	Discussion on role of Self Help Groups- workshop facilitated by Achla Savyasachi
Nov -2004	Forest survey initiated with Forest Development Agency, Ghumsur North Division Tree counting of oil-bearing seeds in common lands initiated
Dec -2004	Oil from Mohua seeds expelled in a commercial oil press and stored in village Biodiesel machine installation and commissioning
Jan - May 05	Water tank construction: pre-cast concrete rings assembled on community building roof Niger seeds collected from villagers (100 kg given, 120 kg purchased back by PC)
May- Sep 05	Pipeline between Kandhabanta and Talataila initiated (didn't finish until Mar 06)
Jul -05	Purchase of generator for KBTT and testing mono-block and submersible pumps
Nov-Mar 05	Testing performance of generator with different grades of biodiesel at pilot plant
Jan 06	Very poor niger harvest
Mar-Apr06	Submersible pump stolen from GV Mohuda well 1 km pipeline between two villages finally completed

Apr-06	New pump purchased (delivered after 3-4 week of placing order)
Jun-06	Visit by KBTT members to verify existence of DG set Date fixed for the dispatch of the generator
May-Jul 06	Different fuels tested in the new generator
Jul -06	Generator installed in village, water pumping starts
Sep-06	Generator breaks down after 41 days of running when handled by villagers (Aug 25-27, 2006). Repaired on site (air-vent screw damaged). Decision to take machine and change piston rings (also changed piston itself as the head was corroded; there had been tell-tale excess smoke in the generator exhaust for a few days before the break-down.)
Sep-06	Niger sowing initiated in community and on private land
Dec-06	Generator testing with different fuels. Fuel quality upgraded: biodiesel made alcohol free before using in generator KBTT villagers come for training and to prepare biodiesel at the Mohuda pilot plant
Jan-07	122 kg niger harvested, average yield is about 30 kg/acre
Dec-06 - May-07	Water pumping resumed using biodiesel generator Water pumping one hour in the morning. Water supply in the morning and afternoon, 148 days pumping in ~5 months
Mar-07	Oil pressing demonstration organized. 99 kg niger seeds pressed between 15 villagers. 22 kg oil collected after filtration available for refining and conversion to biodiesel Gravity flow work ongoing. Meeting held to discuss future of biodiesel. Villagers do not want to give up the machines and suggest lighting as an alternate use
May-07	Gravity flow tapped and biodiesel pumping retired. Not planned in advance: Water tank punctured midway to bring in water from the gravity flow as level diff insufficient to allow water flow to original inlet on top of the water tank (level diff source = 201m, KBTT Tank = 216m (incl. height of tank). Water tank empties out in 15 minutes, and one row of villagers do not get water. Water available to Talataila easily when valve closed as the village is 21 m below KBTT and 35 m below the source Gravity flow tapped and biodiesel pumping retired after ~6 months of pumping
July-07	Feasibility assessment of LED-based lighting linked with 1.5 hours pumping daily was carried out in Jun-Aug 2006. Visit by Practical Action, Sri Lanka, followed by a partnership to provide battery charger
	Survey of other potential uses of biodiesel being explored: irrigation and lighting top the list of requests. Rs. 20-30 per month suggested as tariff by villagers. System design to accommodate this is in progress
Aug07- Dec07	Niger cultivation in 3.1 acres of community land (2.4 acres in Kandhabanta and 0.7 acre in Talataila). Harvesting completed, drying/threshing of seeds is in progress. 122 kg of niger harvested (113 kg after cleaning & drying). Training of biodiesel barefoot technicians and community members belonging to Self-Help-Groups. Beekeeping training organized for the biodiesel barefoot technicians. Bees are essential in niger fields to ensure good pollination of flowers. 3 bee boxes were initiated in the niger fields: two in the pilot plant (Mohuda) and one in Kandhabanta. In future beekeeping as a livelihood activity will be integrated with niger cultivation.

	The goal is to have one bee colony per half acre of niger cultivated (for biodiesel).
Jan08-May08	Barefoot technician deputed to Tumba cluster to participate in the business profitability demonstration. Intensive training on bookkeeping (production log/double entry /stock keeping and log book entries) conducted for the trainers. 113 kg niger pressed in the Maa Dwaarashuni Oil mill in Raikhal, Tumba and 28 kg of oil filtered and ready to convert into biodiesel. Demonstration conducted at KBTT of a DC-DC charging system for LED lights (a biodiesel generator will charge a large battery bank first) and feedback on the choice of LED lamps also recorded. Detailed costing of the biodiesel-fuelled generator and submersible pump-based water supply service, between July'06 and May'07, finalized for discussion with the villagers. Credits for byproduct synergies initiated and village and BD project contributions included in the costing.

6.3. The context

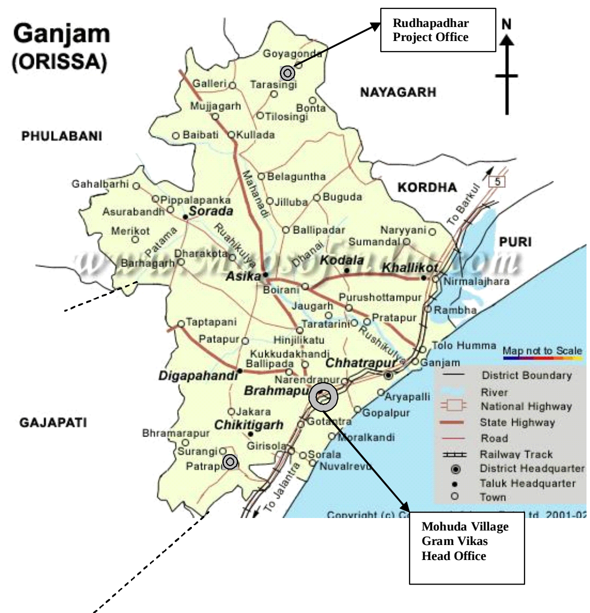


Figure 6-1: Project location in Orissa

The villages of Kandhabanta and Talataila (KBTT) are located in the Khetamundali tahsil of Jaganathprasad block in Ganjam district at 20°03.414'N latitude and 84°47.460'E longitude (Figure 6-1). Barely half a km apart the two villages are surrounded by 8 small hills (max elev. 546m) and are in close proximity to Reserve Forests. The Kandha tribals that reside in both these villages are, to this day, dependent on the forest to supplement food and income. This dependence has decreased to a large extent with the tribals now practicing settled agriculture for their food requirements. Some of them have even started growing brinjals (aubergines/eggplant) and cashew as cash crops. The villages together have 31 households (21+10)[25] and a population of 135 (96+39). This excludes the four households (18 members) in Talataila who are considered transient (squatters) and not included in any of the village activities. The villages together have a nonearning dependent population of 61 (children: 44 and old people: 17), making the earning: dependent ratio, 1:1.4. House sizes range from 60 to 240sq.ft. and the entire habitation occupies only about 1.2 acres, with an additional 5 acres of kitchen garden space distributed among the 31 houses. Between them KBTT have 152 acres of agriculture land, of which 36 acres is lowland, 16.1 acre middle land that is cultivable for at least one crop, and 100 acres that is upland usually used to grow cashew or left fallow. Holdings in the lowlands where most of the rice is cultivated range in size from 0.5 acre to 1 acre and the average productivity of rice is 0.8 ton/acre. According to a survey conducted in 2004-05, the village produced roughly 28 tonnes[25] of rice that year. A wooden ploughshare drawn by bullocks is the most common way to prepare the fields. Crops are rainfed and harvesting is done manually using a sickle. Chemical fertilizers have been introduced to the villages but the input is usually limited to 50kg/acre.

Food is cooked using fuel wood (~ 2 kg per capita/day)[25] and night lighting in homes is with crude lamps that use kerosene (3 L per family/ month).[25] In addition flashlights using disposable batteries are used as mobile lighting and the two villages together consume 190 batteries (1.5 volt) every year.

Most of this information was collected through primary household surveys carried out to develop a baseline to complement this research (see APPENDIX VII and APPENDIX VIII).[25] An extract of some of the data is presented in Table 6-1.

Table 6-1: Summary extracted from household energy survey conducted in KBTT

Description	Unit	Minimum	Maximum	Average
Family size	Number	2	7	4.4
Energy				
Fuel collection	hours/day	0.5	4	1.63
Fuel Processing	hours/day	0.25	1	0.77
Wood consumption in cook stove	kilograms/hh/day	3	15	7.13
Kerosene consumption for lighting	litres/hh/month	2	6	3.16
Battery for flashlights (only in 9 houses)	number/annum			12
Agriculture				
Land (only rice paddy land included)	Acres	0.5	4	1.4
Rice production (in 2004)	Kg/hh	500	2800	990
Productivity of rice (2004)	tons/acre	0.4	1.2	0.8
Data was collected in 2004-05 and included 31 households in 2 villages of KB and TT with a total population of 135				

Gram Vikas has been working with these two villages since 1990 through the Integrated Tribal Development Program (ITDP) and is involved in three Self Help Groups, a grain bank in each village, schools, health counseling and community infrastructure such as ponds, planting of crops, *etc*. RHEP was initiated in 2004 in the two villages for which a combined Village Executive Committee (VEC) was formed (registered under Societies Registration Act, 1860).[26] This committee is entrusted with the task of overseeing construction of the toilets and bathrooms and subsequently with the operation and management of the Rural Health and Environment Program (RHEP) in the village. The committee has equal representation of men and women.

Since these villages are situated near Reserve Forests where no human intervention is allowed, it will be difficult to bring grid electricity to these villages in the near future. Therefore only nonconventional energy sources are possible for water pumping. Biodiesel was proposed to the villagers in a meeting (Apr 2004) and the community agreed to try this option. Seed collection and plantation of niger and castor was initiated thereafter. The biodiesel reactor was installed in the village by mid-December (2004) and biodiesel water pumping began in July 2006 after construction of a water tank.

6.4. Processes followed: Actors, resources and their relationships

Even as preparations for the biodiesel installation were ongoing in 2004, the people likely to be affected by the program in the area were brought together for a series of discussions by the CNBFES project team (CTx GreEn-Gram Vikas). These meetings included issues about the technology and feedstock, the management of the unit, the long term implications on their livelihoods and the resource base. The forest department was included in the discussions from the beginning. Similar discussions were also held with the Self Help Groups and efforts to strengthen them started early.

Table 6-2 represents a rough list of initiation activities and key participants in the effort. The activities are a reflection of the ground work that was done to prepare for VLB in the village, and addressed institutional and technological issues as well as natural resources. Participants included primarily members of the two villages Kandhabanta and Talataila, but the larger community of villages in the cluster was also kept appraised of the activities being initiated in these two villages. The forest department was an ally from the inception of the project.

Table 6-2: Timeline of and participants in early discussions in KBTT

• Activity	Participants
• 3Jul04, **Cluster meeting** • To apprise the villagers/community of the biodiesel project plans at Kandhabanta-Talataila...	Members from neighboring villages: Khandisar, Kandhabanta, Talataila, Lundripadar, Saluapalli.
• 20-21-22 Jul 04**, Self help group training** • To explain the different roles of the Self Help Group. Define responsibilities of the group and of the CNBFES • Discuss mutually agreeable working plan for SHG. • Meeting held on 15th July, informal federation of 15 people formed	Two SHGs in Kandhabanta One SHG in Talataila. Facilitated by GV staff
• 15Jul04, **Joint Forest Management meeting** • To share the lessons from the natural resource monitoring program in Tumba with a larger group. • Form a subcommittee to assist with the CNBFES. The role of this committee would include but not be limited to: (1) assessment of potential trees (2) seed collection system (3) need for monitoring and method for the same.	The Van Suruksha Samiti (VSS) or the Forest Protection Committee members of Banta Cluster Attended by the Forest guard
• **Natural resources** • Discuss the possibilities of organizing a training program for natural resource assessment	VSS members, Forest guard Gram Vikas Project & Cluster coordinator, Biodiesel team
• 22-23Jul04, **Watershed assessment** • To assess the potential of integrating watershed-related activity at Kandhabanta-Talataila	Gram Vikas, Biodiesel team with villagers
• 13Oct04, **Exposure visit to Mohuda** • For the community to have an idea about biodiesel, see the machines in operation and see how biodiesel is manufactured and used.	Representatives from Kandhabanta and Talataila from Village Committee
• 29-31Oct04, **Community structures for Biodiesel** • To understand the potential of the existing SHG in KBTT. • Discuss activities of BD and RHEP and identify community organizations to carry out key tasks.	Staff of Gram Vikas, with focus on KBTT staff, facilitated by consultant from SaDhan, held at Rudhapadar Project office
• 7-8Nov04, **Energy Priorities Workshop** • Discuss energy uses (findings of the survey) • Prioritize current energy needs and present technology options • Rank options, select those suited for extended use of biodiesel	Women and men of Kandhabanta-Talataila, larger meeting with Community to present findings of workshop and invite discussion
• 26Nov04, **Natural resources** • Discuss the natural resource assessment methods and benefits of a baseline for monitoring	With Van Suraksha Samiti (VSS) members, Biodiesel team
• 31Dec04, Continued in 2005-06-07, **Biodiesel tech. training** • Discuss the biodiesel training program and identify day of the week when this can be arranged. • Identify potential barefoot technicians from village.	With the village community of KB and TT, including GV field staff and the biodiesel team.
• Dec04, **Natural Resource assessment** • Meeting to develop baseline for future monitoring and also to assess availability of trees whose feedstock can be used for production of biodiesel	With VSS, GV staff (Biodiesel team), trainer from Tumba.

6.4.1. The Forest protection committee and the energy workshop: circa 2005

The Divisional Forest Officer (equivalent of the Forest Ranger) in charge of the area was extremely receptive to the idea of biodiesel in KBTT. He was especially interested in looking at energy alternatives for villages in and near Reserve Forests, as the only way to extend the grid to these villages would be through logging the forest. Since logging was not permitted (securing permissions from the Central Government can be very tedious), electrification remained a distant dream. He was also excited by the possibility of adding value locally to forest produce, and encouraged the idea of surveying the adjacent forest for potential oil-bearing species.

The forest survey conducted in the area as a part of this research revealed that the villages KBTT had very few oil-bearing trees (~50 trees of oil-bearing species in the village's forest) although there were sufficient trees spread between other villages in the neighborhood. In the first year about 1200 kg of mohua (*Madhuca indica*) seeds were acquired by the villagers. These were actually procured from neighboring villagers by bartering oil, which was purchased for cash on behalf of the SHG by Gram Vikas. Although the barter idea was good and the SHG women participated, they did not have much stake in the purchase, not having invested any of their own money. A bad precedent had been set by the local Gram Vikas staff purchasing seeds and not encouraging the community to grow or collect and contribute oilseeds. Although the money paid remained within the cluster and there was local value addition, yet this "enthusiasm" on the part of the Gram Vikas staff to ensure there was feedstock for VLB would in the long run come back to haunt the project.

Surveying the village lands, the CNBFES team (Gram Vikas and CTx GreEn staff) found that there were large tracts of community fallows, basically deforested land where agriculture may have been practiced at one time, but which were currently lying unused. The feedstock requirement was calculated on the basis of the fuel needed for pumping. Using the data from Kinchlingi, it was inferred during an early workshop (Nov 2004) focused on energy that roughly 2 litres of fuel would be consumed per day (Figure 6-2). Based on a very rough calculation assuming 25% oil yield from the oilseeds, it was computed that about 8 kg seeds were needed per day, translating to 240 kg/month, or about 3 ton /annum. The premise of the CNBFES project was that these seeds would be a village contribution and part of the tariff structure.

Having assessed that the village would need roughly 3 tonnes of seeds for a start to comfortably use biodiesel for water pumping throughout the year, an assessment was carried out in the forest and community lands to identify the source for this amount of seeds. In the forest survey conducted[27] in December 2004 and early January 2005, 121 random plots (20x25m) were surveyed (121x500sqm=60,500 sq.m. or 6.05ha) and this was roughly 5% of the total forest area of 120 ha that belonged to the village. In the 6 ha surveyed the total number of trees with girth 10 cm or more were about 2000, of which only 49 were found to be oil-bearing trees (15 mohua, 2 karanj and 32 kusum trees), representing only 2%. Since many of the oil trees are fringe species that grows on the outskirts of the forest, another survey[28] was carried out in the government and village properties between the forest and the agricultural fields, and the inventory revealed 103 mohua trees, 12 karanj and one kusum tree.

Project overview w.r.t KB-TT
Planning with the villagers

Village Kandhabanta-Talataila

Total population of Kandhabanta + Talataills = 151
Water requirement (@ 70lt/person/day; 10,570 L or approx 1.5 hours of pumping
Biodiesel requirement at 1.4 lt/hour is about 2 liters /day
Seeds required about 8 kg / day or 240 kg/month

Biodiesel reactor installed and commissioned in village (Dec 29-30, 2004)
Temporary installation in existing cluster office-building
First 5litre batch of biodiesel produced on 31st Dec 2004
Ongoing training program every Friday includes one batch of biodeisel production
5 women, 5 men and four Gram Vikas field staff identified to receive regular training

Current status of seed collection at Kandhabanta-Talataila
Seeds = 8 quintals. 225 kg of oil extracted (about 205 litres)
(approx for 100 days, Jan – mid April)
Next collection of seeds from forest will begin in April
Castor and Niger have been planted and can be harvested April-May
Yields have to be checked and future plantation planned

Land: homestead plots, community plots and private agricultural land for planting other oil-seed crops for biodiesel has also been identified.

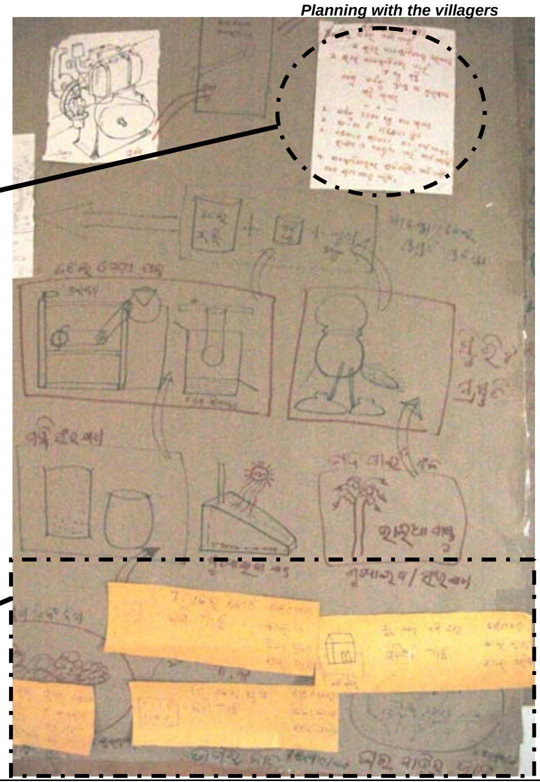


Figure 6-2: Micro energy planning workshop with KBTT community

The villagers realized that they would have to supplement forest seeds by cultivating oilseeds on community fallows. The share of forest seeds (mohua-Madhuca *indica, karanj*-Pongomia *pinnata and kusum*- Schleichera *oleosa*) was estimated to be 1500 kilogram (roughly 150 trees yielding on an average about 10 kg seeds[29]). To make up for the remaining 1500 kilogram needed it was decided that niger, an indigenous oil crop species, would be tried on community fallows. Niger, although grown in other parts of Orissa had never been grown here, and so this was a new experiment. It was estimated that cultivation of niger on community fallows would additionally contribute 700 kilograms, and homestead gardens and private plots would provide the remaining 300 kilograms (Figure 6-2). Cultivating seeds in this manner was insurance in case of failure of the forest trees to yield. Experience shows that these trees skip a season and yield good harvests only in alternate years.

Community fallows were identified through discussions with the community and 10 acres of land earmarked for cultivation. Additionally 7 acres of private fallow farmland were also identified. There was also potentially 1 acre in the form of kitchen garden plots between the two villages (Figure 6-3). At the same time an energy workshop was held in the village to understand the priorities of the villagers in terms of energy services that they needed. Domestic and livelihood activities requiring energy were listed along with the fuel currently used. Potential end-use devices for different domestic and livelihood activities were also listed. Drinking water, cooking, lighting and heating was listed as end uses that use traditional methods and sources of energy such as wood, while in the case of livelihoods, parboiling of rice, irrigation, harvesting, threshing and leaf-cup stitching were listed as the activities that could benefit from technological innovations. As a step further the community also listed some of the end-use devices that they felt could help reduce drudgery and inefficiencies. (Bio) diesel-based pumping and generation of electricity were among their choices. Irrigation through pumps and lighting through a generator were listed by men, while the women suggested rice milling and cooking with electricity. From this list the community prioritized their future energy choices.

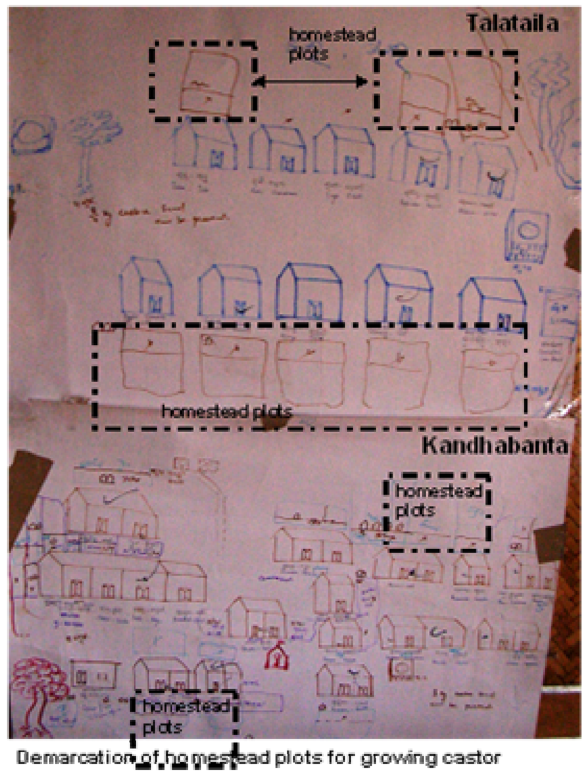


Figure 6-3: Demarcating land for growing feedstock (Energy workshop Nov04)

Lighting, cooking, drinking water and rice milling in that order were the top requirements as far as domestic energy services are concerned. But water pumping for irrigation to improve the productivity of their rice harvest topped the list (Table 6-3).

Table 6-3: Prioritizing village energy requirements

List of domestic activities Requiring energy innovations	List of Livelihood activities requiring energy innovations	Energy innovation priorities
• Rice milling, grinding	• Irrigation with pump	1. Irrigation
• Entertainment	• Ploughing with tractor	2. Lighting
• Cooking	• Check dam	3. Cooking
• Lighting	• Winnowing fan for harvesting	4. Drinking Water
• Drinking water	• Stitching machine(leaf-plate)	5. Oil Milling
	• Rice transplanting machine	
	• Vehicle for cartage	
	• Rice hulling mill	
	• Oil milling	
	• Solar drier	

Biodiesel was selected by the villagers (and Gram Vikas staff) in the workshop[30] over other renewables such as gasifiers, wind and solar, because they believed that it was less expensive, easy to maintain and would lead to conservation of the forest. Additionally they noted that the oil cake would be available as organic fertilizer. Solar panels presented the risk of theft, and of not being effective on rainy days. Lack of mobility of the fuel produced in the case of the other technologies tipped the case in favor of biodiesel. Everyone felt that there was a lot of hard work involved in biodiesel in comparison to solar, which requires no work and has no operating costs once installed. But it was recognized also that the capital cost for a solar installation was very high. *In spite of irrigation topping the list, water supply and sanitation were the final choices, since Gram Vikas' focus was on the Rural Health and Environment Program, and hence on providing running water in washrooms.*

The role of the Gram Vikas staff in motivating the community in KBTT was very important. The entire staff was very enthusiastic about the novel project and the Project Coordinator gave a sales pitch to his cluster of villages with the intention of making a case for locating the CNBFES in his jurisdiction. There was perhaps an overemphasis on the potential of the technology and not enough on the nuts and bolts of managing and maintaining the system. The community may have been convinced to some extent about the validity of a biodiesel application in their village, but reading between the lines the community had always wanted a system that would take care of itself.

Table 6-4: Proposed time schedule for RHEP construction (2004-05)

Toilet	Start date	End Date	Water tank	Start date	End Date
Foundation digging: achieved	June 30th	June 30th	Foundation	Nov 1st	Nov 20th
Stone and sand packing: achieved	June 30th	July 10th	Brick work	Nov 21st	Dec 5th
Foundation : achieved	July 11th	Aug 15th	Roof casting	Dec 10th	Dec 10th
Brick work: achieved	July 20th	Aug 30th	Water tank	Dec 11th	Dec 25th
Roof casting: achieved	Sept 1st	Sept30th	Work completion	Dec 26th	Jan 10th
Work completion: delayed	Oct 1st	Nov 15th	Pipeline	Nov 25th	Dec 30th
Incl. pipeline: delayed	Oct 1st	Nov 15th	Dug well	Mar 5th	May 5th

Dug well was never excavated and permanent water tank was not constructed until 2008

The construction of the washrooms was completed by the Gram Vikas team over an 8-month period (Table 6-4) and a temporary water tank was built on top of the community buildings in both the villages. The water tank in Kandhabanta held about 1500 L, and the one in Talataila held about 900 L. Together the two tanks had a combined capacity of less than 2500 L, barely one quarter of the capacity needed for KBTT of over 10,000 litres per day. Built in a hurry using 1m pre-cast concrete rings (to save paying money for an HDPE water tank), the water tank on top of the village community building had become dangerously slender and tall (about 5m on top of a 3m building). Additionally, the dead weight of the water tank ended up damaging an existing wooden beam that supported the reinforced concrete roof slab in the building, obviously not designed for this new load. A huge pillar (about 0.5m^2 in cross section) was constructed under the beam to save the beam and roof slab from collapsing. The tank construction was terminated at about 5 m height, and the tank remained under capacity. This was another in a series of steps taken in a hurry to “get the job finished” which put the long term sustainability of the project in jeopardy.

In the middle of July niger had to be sown but volunteer fatigue had set in due to contributions of labor by the villagers in washroom construction. The villagers also had to finish sowing brinjal and transplanting rice. Niger, which should have been sown by August 15th at the latest, was finally sown in late October and the harvest of oilseeds in January 2006 was very poor.

The sequencing of work for the biodiesel activity and the RHEP did not go as per the plans on paper (Figure 6-4), where the energy system should have been installed only after the construction of the water tank. Because of time pressures, several activities were carried out in parallel and the construction management of the RHEP hardware left much to be desired. This was primarily due to a large part of the labor inputs for the RHEP being in-kind contribution from the villagers, and two programs running at the same time made **high demands on the community**.

Water was ready to be pumped to KB in May 2005, but the half kilometre pipeline between the two villages had not yet been laid. The smaller community of TT could not get enough people together to do the job, and it was continually put off. The Gram Vikas coordinator felt that pumping water to KB should be commenced excluding TT villagers. He believed that seeing their neighbors enjoying running water would motivate them to finish digging the pipe line. This did not seem a good strategy in the long term. The biodiesel team felt that it would be contrary to the spirit of community to split up the villages in this manner and that water should be available at the same time to everyone. This delayed the start of pumping as it was decided that the diesel generator set would be moved to the village only after

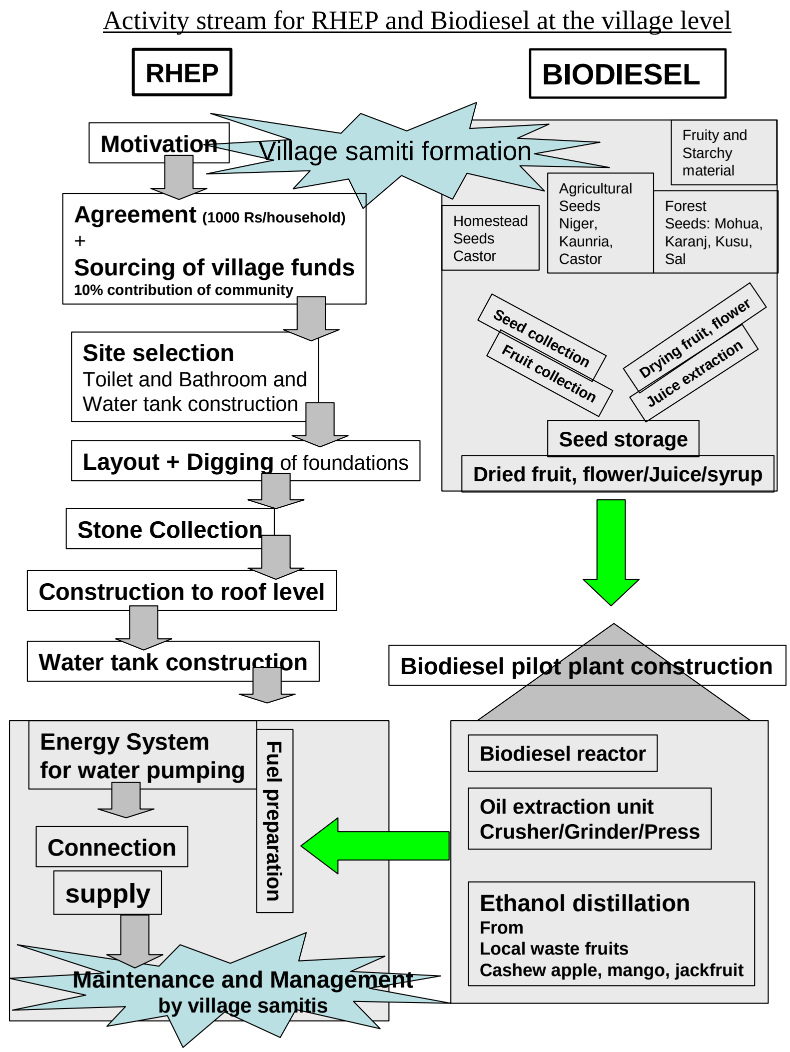


Figure 6-4: Flow sheet of RHEP & VLB activities

the pipeline was completed. Meanwhile local testing of the generator continued in the pilot plant. This was the beginning of misgivings between the local field team and the biodiesel project. This was 2005.

6.4.2. The barefoot technician and his team: circa 2006

Mandate of the Rudhapadar Project, presented during the Gram Vikas Annual Review (2006) includes KBTT

- Human and Institutional Development (including gender sensitization, strengthening Panchayati Raj Institutions (village governance structures), developing linkages with government program and capacity building activities)
- Education (including balwadis (crèches) in each village, 15 education centres and a residential school at Gyagonda)
- Community health (Sanitation and protected drinking water through the RHEP initiated in 9 villages, community management through village health committees, allopathic as well as herbal dispensary in the Rudhapadhar project office)
- Management of natural resources (Community forestry and horticulture, Micro planning for Joint Forest Management initiated in some micro-watersheds)
- Sustainable livelihoods (In 2006, 52 self help groups had a total saving of Rs. 472,000 and disbursed loans amounting to Rs.244,000. Income generation activity such as leaf plate selling and fishery were initiated. Over 1000 kilos of grain was loaned through grain banks. Livelihoods initiated in the construction sector include mason training)
- Livelihood enabling infrastructure (housing including collection of old loans and community infrastructure development)
- Technology development and demonstration (**initiation of biodiesel in Kandhabanta and Talataila and exploring potential in the other areas** through the Forest Development Agency, in at least one other cluster, agriculture development including training in animal husbandry, agriculture, beekeeping, integrated watershed development)

The villages of Kandhabanta and Talataila have a primary school between them, but only a handful of villagers are literate, and even they can barely read and write. Most can sign their names however, because of the focus of the literacy session organized in the village. Malaria is rampant here as in other tribal villages. There is a program for Joint Forest Management between KBTT and the Forest Development Agency. There are three functional Self Help Groups, mainly for small savings. No villager has taken loans for housing from Gram Vikas, although they have taken livelihood loans, and collection of dues is one of the unpleasant tasks that the Gram Vikas staff has to do. Building washrooms is, however, the star project in all the villages, KBTT being no exception.

After surveying several options, in order to avoid delays it was decided that an existing dug-well would be used for water supply. The existing village well in KB is over 12 m deep. Since TT is lower than KB, it was logical to site the water tank in KB and allow water to flow by gravity down to TT. The well in TT, where the water level was closer to the ground, could not therefore be used as this would mean pumping water over more than half a km distance and to a higher elevation in KB, which would be very inefficient. The water-cooled pump selected for Kinchlingi was working well with biodiesel but this could not be used, as a diesel pump can only pump up from a maximum depth of 8meters. To keep the running costs low, it was important to use a small pump. An electric ½ HP submersible pump powered by a small 3.5 HP biodiesel generator was the configuration for KBTT. Compared to the earlier experience with diesel pump sets in Kinchlingi this is a more sophisticated device: an alternator generates electricity and primes the electric pump in place of just an engine running the biodiesel pump in the earlier case. The generator set is also an air-cooled engine and is less forgiving than the water-cooled engine. The intricate nuances of the technology only slowly unraveled, demanding much more care to new details.

In both KB and TT (as was the case in Kinchlingi earlier) there are no villagers (men or women) who can read and write fluently, let alone log data on behalf of the biodiesel unit. Pradipta, the facilitator from the primary school being run in the village who himself had studied up to Grade IV, was selected for training as a barefoot technician to manage the biodiesel unit. The only concern was that he did not belong to either KB or TT but rather a neighboring non-tribal village. Training as the barefoot technician included basic record keeping, fuel production and generator set operations and maintenance. He was already familiar with natural resource assessment, having participated in a forest survey and had also been exposed to basic agronomy. Pradipta had the added task of training at least two men and two women from KBTT in machine operation. The barefoot technicians' training at the pilot plant was combined with comparison of the performance of the generator running on conventional fuel, diesel and with biodiesel at different lighting and pumping loads. This was important because while the diesel pump is a rugged prime-mover, the generator set is much more finicky. The suppliers of the generator (local Kirloskar dealers) also had to be convinced that the new fuel, biodiesel, was being tested for quality and the fuel specifications were comparable to that of diesel, for which the generator is designed. This was important to ensure that continued technical support was available from the machine suppliers.

The pipeline was eventually completed but the training of the technician and testing of different fuel blends was still ongoing at the pilot plant and not in the village. Restless that the generator had not yet been installed at the village, the Village Executive Committee at KBTT borrowed money from the Self-Help-Group and hired a vehicle to visit the pilot plant (140 kms and at least 4 hours one way) with an entourage of about 20 people. This was to verify if the pump had really been purchased. The unexpected visitors were given a tour of the pilot plant which included their new generator set and saw the training in progress, and returned satisfied but only after fixing a day for the eventual commissioning of the generator in the village.

The generator set was finally moved to the village in July of 2006. A water pumping routine had to be set up so that the villagers would get at least an hour supply in the morning and about half an hour in the evening, without excessive fuel consumption given the insufficient capacity of the existing water tank. This was possible with about 70 minutes of pumping per day and about half an hour of supply, alternating between the two villages when every household used and filled up water. The pump was connected to the tank at KB, which allowed water to flow by gravity to the tank at TT, about half a km away and at least 20m lower in elevation. The water supply to the villages was then shut off and both the tanks in KB and TT filled to capacity. During the evening the supply to the houses in KB was first opened, and after half an hour, closed so that the TT supply could be opened. If this was not opened alternatively, the lower elevation of TT would automatically draw out all the water from the KB tanks. These gymnastics were necessary because the tanks built by the Gram Vikas team were under-capacity, at 2,500L instead of the required 10,000 L.

Water pumping continued in this manner for about 40 days until the barefoot technician had to go away due to a personal emergency. He left instructions with the Gram Vikas supervisor on the procedure for pumping, but within a day of his absence the generator was damaged. After cranking the generator to start it, instead of loosening the air vent screw, the village crew that had volunteered to run the generator set tightened it. The vent broke and water supply stopped. When the mechanic took a look at the generator, the air vent screw was easy to replace, but there seemed to be other telltale signs on the piston. The piston had been giving trouble from the day the generator was purchased, but it was natural for the mechanic to cast aspersions on the quality of biodiesel, the alternate fuel. After all, the generator was designed for diesel, he said. His advice was to change the piston rings as he felt that although the machine was functional it could stop working at any time: now or 20 years from now. There could be no guarantee. The generator was sent for repairs. Once the piston ring set was changed, another round of tests was conducted, but this time with much cleaner fuel: biodiesel with lower residual alcohol. The specifications for the fuel thus became even more stringent, adding one more step into the production of biodiesel, that of removal of alcohol. The generator eventually moved back to the village in December 2006 but not before bringing a four-member team (two men and two women) from the village to the pilot plant for basic training and trouble-shooting about the generator. They also needed help with basic mathematics to be able to check fuel levels and calculate fuel consumption.

Biodiesel in the KBTT villages was initially used for water pumping (148 days, ~90 L of biodiesel, 130 kWh of electricity generated and 488,000 L water pumped) but on the 19th of May 2007, it was replaced by a gravity-flow water supply system. Expenses of running the unit were calculated with cost and benefits tabulated for discussion with the community (Table 6-5).

Table 6-5: Overall cost of biodiesel at KBTT (July 2006-May2007)[31]

		Quantity	unit	Debit	Credit	Balance	Rs./hh/mo
1	Biodiesel raw material cost	93	litre	5,567		5,567	
2	Cost contribution of BD project#				1,334	4,233	
3	Credit for soap and glycerin				269	3,964	
4	village contribution *cash/seeds)					3,964	
	2006	99	kg		1,584	2,380	
	2007	122	kg			2,380	
5	Amount due/hh (without subsidy)	31	hh			180	33
6	Amount due/hh (w/subsidy)@	31	hh			128	23
7	Amount due/hh (w/subsidy as in 6,credit for seed contribution)	31	hh			77	14
	Water pumped	409,514	litre				
Cost of water per litre without subsidy		Rs./L		0.01359	2.7x Mohuda water cost		
Cost of water per litre with subsidy/credit as in 6		Rs./L		0.00968	1.9x Mohuda cost		
Cost of water/litre (w/subsidy/cr + seed contrib'n.)		Rs./L		0.00581	1.18 x Mohuda cost		

*Cost of niger seeds calculated at Rs. 16/kg as this is the cost paid for seeds
Cost of chemicals like methanol, NaOH, SMS
@ w/subsidy for MeOH, NaOH, SMS; credit for soap and glycerin

While the basic cost of the fuel is no different from Kinchlingi (Rs. 45/L including credits for byproducts), the cost configuration varies because of the contribution of seeds. The cost to the village was Rs. 33/household/month. This is lower than costs in Kinchlingi mainly due to the bigger size of the community in KBTT, and also to some extent due to the marginally lower specific fuel consumption (biodiesel/litre of water pumped) of the biodiesel generator.

The cost of water per liter was calculated for three cases just as for Kinchlingi (1) No subsidies (2) Subsidies for chemicals including for alcohol (3) Subsidies and deduction for seed contribution. With subsidies for chemical and minimal seed contribution the cost per liter of water is almost comparable with the subsidized cost of water being supplied at the Gram Vikas campus (0.006 ~ 1.2 x Mohuda cost). A more detailed costing will have to be done by the CNBFES team, including maintenance, to calculate actual running costs and fully understand which of the two, the pump in Kinchlingi or the generator in KBTT is more efficient.

Technically the biodiesel generator is more sensitive to the fuel and also requires more maintenance. The electrical system is a little more complicated than the pump set, and the air-cooled engine is less rugged than the water-cooled engine in Kinchlingi. The KBTT configuration also has an electrical submersible pump set coupled to the generator and therefore the operating procedures require an additional step.

Women members of the SHG had been introduced mainly to the production of biodiesel. But they were not consistent as they always had household chores and children to attend to when not helping out at the farm. Two young girls in the village who had dropped out of school after third grade were very keen to join the team, but had not been included previously as the Gram Vikas field staff felt that girls would get married and the effort of training would be wasted. The girls were brought into the biodiesel team for KBTT and slowly learned how to run the generator and to log data. Previously women were only brought in to pedal while producing biodiesel and for drying and storing seeds or to cook for the team. Now they did all this and also learned to run the generator.

6.5. Decision making processes

6.5.1. Role of women in introduction of a new technology: Self Help Groups: circa 2004

A page from my Journal- *Five years ago in March 2004, when I sat for my first village meeting in the village of Kandhabanta, I was impressed at the turnout of both men and women. The women sat on the ground behind us, while the men sat in front of us on the cotton durries (mat). On my insistence Jayanti Jani, an older woman, moved up and then explained to me that if anyone among the men was an older brother of the husband, or the in-law, the woman (who always covers her face/head with her sari) will not share the same rug out of respect – and, since every one in the village is related in some way or the other, women end up sitting on the ground. Unless of course she is a daughter and not a daughter-in-law, in which case she does not even have to cover her head.*

The meeting being held was to introduce the idea of biodiesel to the villagers and discuss the possibility of siting a unit in either Kandhabanta (KB) or Talataila (TT). This was the third or fourth in a series of similar meetings that had been arranged for me in different villages by the staff of the local NGO, Gram Vikas. It was a very lively discussion. I explained the process of making biodiesel with local oilseeds including the fact that we hoped that alcohol, the second ingredient in biodiesel manufacturing, could eventually be locally produced from fruits that were otherwise going to waste in the forest. This they understood immediately; some men even suggested different fruits that we could use: "Anything with sugar can be brewed" they told me. I was totally engrossed in this discussion which turned out to be a *knowledge exchange that was much easier than having to explain biodiesel to the staff of Gram Vikas (GV) who, unlike these tribal communities, could not all comprehend the chemistry of alcohol! In the course of the meeting I could hear a murmur among the women in the group and even as I turned to address them Jayanti Jani burst out saying "we finally managed to get rid of alcohol in this village, and now you are talking about bringing it back!" The women had gone around the village breaking country liquor stills as part of a campaign against alcoholism. I reassured her that the alcohol would be denatured so that no one could drink it, and we could still use the unutilized fruits to generate economic activity. This she liked especially when I mentioned castor oil (often used in villages as a purgative) as a possible denaturant.*

Initial meetings were held in the spring/summer of 2004. Once the village had agreed in principle, risks were discussed. It was the first time something of this nature was being tried in villages of Orissa, and the CTx GreEn team was upfront that it would be a gamble for both the community and the Gram Vikas-CTxGreEn team. The village for their part had to construct their washrooms and water tank, and the GV-CTx GreEn team would bring the machines and train them to operate and manage the unit.

Urmila Senapati, the Manager of the ITDP project based out of the Gram Vikas' headquarters, mentioned that the women of Kandhabanta and Talataila had a track record of activism. Besides getting rid of liquor stills in the village, the women of KB and TT had come together as a group to protest against the dismal wages being paid to women for transplanting rice. Their intervention managed to raise the local daily wage fourfold from Rs. 5/- to Rs. 20/-. The prevalent government wage rate was between Rs. 35 to Rs. 40 per day. She said that 'women empowerment' as a project was started (in Gram Vikas) and individual savings initiated in 1998. This, she said, was a turning point. It was discussed in the Gram Vikas management that there should be at least one program exclusively with women. Savings and credit *a-la* Grameen Bank had been initiated for the women with the view to encourage their tendency to save.

Urmila's view was that all the machines for the biodiesel unit in KBTT should be run through the Self Help Group (SHG), and the money that the unit made should be used for community purposes. She felt that the women should be given preference for running the machines. "If we do not involve them from the beginning, then it is very difficult to get them to participate and they will ultimately be overshadowed by men."[32] Further discussion on the SHG model at KBTT was initiated based on a suggestion by the CTxGreEn team that it may be more important that the women have control over the entire enterprise, even if they employ men to run specific machines by leasing then out.

Discussions on the subject with other staff members within Gram Vikas raised skepticism about the ability of the women's group in these villages to handle entrepreneurial activities. The Manager of the Planning, Monitoring and Evaluation and Dissemination, Jaya Padma[33] gave a brief history of the savings and credit program in the organization. She said that the SHG groups were slowly becoming more and more independent from Gram Vikas. There was a time (in 1999) when the cluster coordinators would contribute to the savings of the SHGs in order to meet the target savings, and then go from door to door collecting the money. This ended up increasing the dependency of the SHGs on Gram Vikas. Many groups have subsequently broken out of this. She said that the SHGs in this particular project area had been slow in taking external loans and in forging links with the Block level savings program initiated by the Government of India, through the aanganwadi (crèche) workers. She said that the SHGs in the tribal areas are very different from the non-tribal areas where Gram Vikas is working. In tribal areas the focus has been on strengthening the group, increasing individual savings and improving utilization of money within their groups. She felt that the groups would understand the collection and transaction (of funds). She was not sure if the term federation, used by the local project coordinator when he talked about an SHG federation managing biodiesel activities, was normative, meaning an informal coming-together of SHGs, or whether his intention was to encourage them to undertake financial transactions as a single entity.

Biodiesel seemed to provide the pretext for Gram Vikas to assist the Self Help Groups (SHGs) to move away from being only savings and credit groups to cooperative ventures that would deal with financial transactions. The die for a women-based self help group biodiesel unit in KBTT was cast. By 2005 the three existing Self Help Groups in the villages of KBTT became the front for the activity of collecting seeds for biodiesel. The biodiesel project team needed to understand the roles that existing local organizations (formal and informal) played and how they supported (or did not support) each other. A workshop was conducted in November 2004 with an external facilitator from SaDhan, an organization engaged in the promotion of community level microfinance. It emerged clearly in the workshop that the decision making in the Village Executive Committee (VEC), which had equal representation of men and women, was dominated by men. Even in SHGs the male influence was apparent, as the loans being taken by women were either to assist their husbands, or consumption loans for the family.

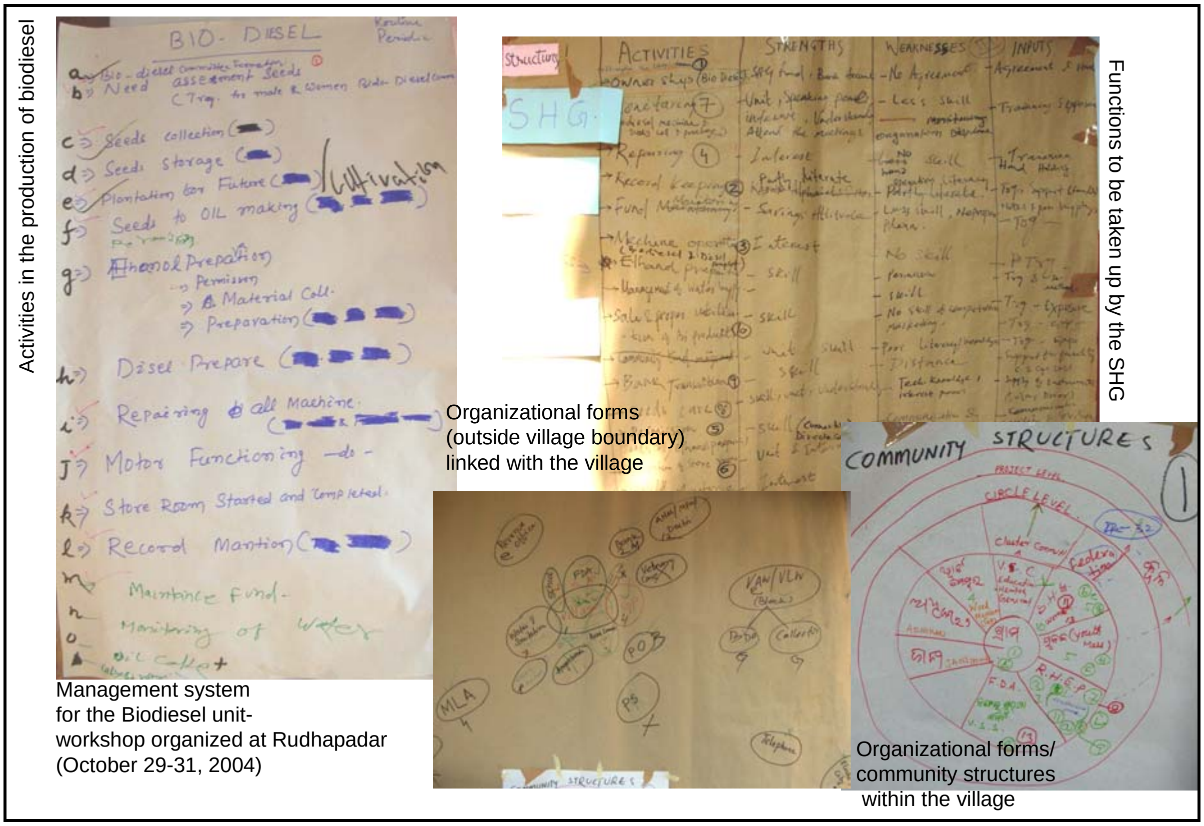


Figure 6-5: Workshop regarding community structures needed to roll out VLB[34]

This pattern of male domination continued in any new situation, and planning for biodiesel was no exception. In discussing new roles for the biodiesel project during the workshop in November 2004, all the responsibilities such as seed collection *etc*. were assigned to women's groups while managing the biodiesel machinery was assigned to the Village Executive Committee (*a.k.a* men). The overall authority on tariff fixation and collection was with the men while the women were assigned the task of checking cleanliness for newly constructed washrooms (Figure 6-5). These roles were assigned by workshop participants that were Gram Vikas staff working in these villages for over five years.

Achla Savyasachi was the external facilitator assisting CT_xGreEn in understanding the community structures that were necessary to roll out the project. In her report she summarized that the team would benefit from "*huge learning already existing in the public domain outside the four walls of Gram Vikas. SHG federations are one such example. In order to exploit the latent potential of the dedicated field staff and the existing community institutions to their fullest, strategic guidance is imperative. This would facilitate the appropriation of the existing knowledge to the benefit of the local issues*" (CTxGreEn 2004a). Although the women in the

SHGs were motivated enough to demand a higher wage for rice transplanting, they continued to be dominated by their men at home. The NGO staff was inadvertently contributing to this mindset.

6.6. Livelihood strategies: management structure to support SHG-based VLB

6.6.1. Responses to changing demands (circa 2007)

The Self Help Group model promoted for biodiesel in KBTT is different from the previous volunteer-run model in Kinchlingi. In a workshop organized in 2005 to design suitable models for each of the project locations, the Project Coordinator and his team in the Rudhapadar project area listed 19 activities necessary for sustaining VLB, along with the organizations at the local level that would take the responsibilities (Table 6-6).

Table 6-6: Activities and corresponding responsibilities for VLB

Activities	Responsibility
d. Seed collection, storage	Self Help Group SHG
e. Biodiesel production	SHG
f. Grinding	SHG
g. Oil press	SHG
h. Reactor operation	SHG
i. Seed cultivation and plantation	Village Executive Committee, VEC
j. Kitchen garden, agriculture	VEC
k. Protection and plantation of trees	Van Suraksha Samiti, VSS (forest protection committees)
l. Permits	Panchayati Raj Institution, PRI, Village level (elected) bodies
m. Seed collection from outside	Area Committee (informal group including cluster of villages)
n. Generator operation	RHEP (Rural Health and Environment Program) –through VEC
o. Pump operation	RHEP VEC
p. Monthly collection	RHEP VEC
q. Byproduct sale	SHG

In contrast to the Kinchlingi model, ownership of the machines lies with the SHG and not the Village Executive Committee (VEC). The SHG would provide the required biodiesel to the VEC after settling a price for the same. Once the tariff was set, it was anticipated that the VEC would collect the money from the villagers and pay the SHG, in either cash or seeds. Procuring the remainder seeds from the Forest Protection Committee (*i.e.* the VSS) would be the responsibility of the SHG.

The three organizational forms therefore have to work together in this model: (1) The Forest Protection Committee, VSS, to procure forest seeds (2) The Village Executive Committee, VEC to collect tariff and operate the pump and generator and (3) The SHG for supplying fuel, organizing feedstock and running the biodiesel production equipment. These assumptions are based on the premise that each of the organizational groups is independent and can operate in an autonomous manner. The fact remains however that the committee members in each of these organizations usually overlap, and the Gram Vikas staff perform the secretarial work in all three bodies. Roles and responsibilities are therefore not explicit.

In reality the tariff collection has been the most painful, with no one willing to pay either in cash or seeds for water supply. Their need for cash was so dire that they were willing to sell the forest seeds rather than exchange them for a service that they considered a luxury. The village committee president was unwilling to raise the issue of tariff collection with the villagers and wanted Gram Vikas and/or the biodiesel team to take up that role. The goal of building washrooms as an entry point for community development work entailed people coming together for a common cause. However, target-oriented development activity often leads to the mixing up of means and ends. The Gram Vikas staff is very committed, yet with no clear strategy for withdrawal they have increased the dependency of the villagers on them for the management of the community level organizations that have been created.

It is indeed surprising that after nearly two decades of work here, there are still no second line leaders who are literate enough to manage village financial transactions and maintain relevant documentation for external agencies (banks for example). The idea now is that Gram Vikas will withdraw after completing the washrooms, believing that being hands off will leap-frog the villagers' ability to negotiate development work independently. But there is not enough evidence to suggest that this will happen. Although organizational forms exist in the twin villages of KBTT for managing entrepreneurial activities such as the biodiesel, the groups have no prior experience with such operations. They have been galvanized for activist roles and have also engaged in small income generating activities, but have never engaged in any meaningful financial transaction without help from Gram Vikas staff. This is a characteristic of community development organizations across the world. According to Jim Lotz (1998, P. 174), in his book on community development in Canada, cooperatives often lay emphasis on the philosophy and goals of cooperation and not enough on the mechanics to make cooperatives operate effectively. This may be because "it is easier to impart abstract ideas than to explain organizational dynamics, financial management, or legal issues."

In discussions about tariffs, most of the men suggested cash. The concept of bartering and paying with seeds that they can grow on their own farms or collect in the forests, so that the economic transactions are really localized, does not appeal to the villagers, although they do it all the time for their own household purchases.

In 2006-07,[35] after a lot of coaxing, nine farmers planted niger in approximately 0.20 acres each, but only one of them had a meaningful harvest and contributed 17 kg to the seed store. About 2.4 acres of community fallow was planted in KB and 1.7 acres in TT from which the yield was 78 kg and 27 kg respectively. The poor yield was a result of sowing in September instead of early to mid August. Poor collection and harvesting techniques added to the losses. Although the niger crop requires very little inputs, it is extremely important that there is some moisture in the soil during sowing. Sowing should be done immediately after the first shower in August, but with the changing weather patterns, the period when this will happen cannot be predicted.

During the two years that the GV-CTxGreEn team tried sowing niger at the pilot plant in Mohuda, the ground was either too wet because of incessant rains, or too parched, causing them to always miss the window. The earliest possible sowing was the end of August. The experience with growing niger is that it is extremely sensitive to light and the yield reduces drastically with every week of delayed sowing.

The other major problem with sowing niger is that it conflicts with the time for (a) sowing brinjal (aubergine/eggplant), which has well established market linkages and (b) transplanting paddy, which is usually grown for the community's own needs (See Table 6-7: Seasonal activity men and women, village KB-TT. Combining niger sowing with black gram (Vigna *mungo*) and red gram (Cajanus *Cajan*), both of which are legumes sown for personal consumption, was discussed with the community. There is much more work needed in demonstrating this multi-cropping package and proving its success rate.

An oil press demonstration was held in the village in March 2007[36] to press the village's seeds. A total of 99 kilogram of niger seeds was pressed and about 24 kilogram raw oil and 74 kilogram of oil cake was produced. This oil converted to biodiesel produced about 30 litres which is less than two month's supply of biodiesel at current consumption levels. This is clearly not enough. The villages of KBTT at current consumption levels need at least 1.3 tons of seed, which can be easily grown on about 6-7 acres (with a productivity of 200kg/acre) provided the seeds are sown latest by mid-August. This would have to be taken up seriously by the VEC as a way of paying for the fuel.

Table 6-7: Seasonal activity men and women, village KB-TT

	Men	Women
Jan-Feb (Magha)	Black and green gram harvesting, paddy threshing, firewood and preparation for Magho-puda festival	Black gram, horse gram harvesting, decorate the gram-devati, the village goddess for Magho puda festival (2 days)
Feb-Mar (Phalguna)	House thatching, paddy processing	Collection of mohua flower, prepare silos for storing paddy
Mar-Apr (Chaitra)	Kaju (cashew) harvesting, firewood collection	Collection of tullo, mango
Apr-May (Baisakha)	Kaju harvesting, Mohua flower collection	Stitching leaf plates (sal), khajuri(palm) leaf mats, charenga collection (vegetable) for own use and sale, tullo and mango collection
May-Jun (Jesto)	Field preparation	Tullo and mango collection
Jun-Jul (Ashad)	Field preparation and paddy sowing	Sowing of brinjal (aubergine/eggplant)
Jul-Aug (Shravan)	Field preparation and transplantation of paddy	Paddy transplantation, sowing brinjal (aubergine/eggplant)
Aug-Sep (Bhadra)	Paddy transplantation, sowing brinjal	Weeding in rice and brinjal field
Sep-Oct (Aswina)	Paddy cutting (short season=70 days), castor plantation, harvesting Brinjal	Weeding in rice fields and collection of pithala, guarding brinjal fields
Oct-Nov (Kartika)	Paddy(short) threshing, cutting (long-season= 90-120 days), castor plantation, Brinjal harvest and selling	Kora seeds collection, harvesting paddy (short season) and ragi
Nov-Dec (Margo-Seero)	Paddy cutting, Brinjal harvesting, sweet potato harvesting	Paddy cutting
Dec-Jan (Pauso)	Threshing, horse gram, sesame harvesting	Harvesting black gram and horse gram

Note: The gray areas marked indicate activities that are in conflict with niger cultivation.

In Kandhabanta and Talataila the biodiesel unit was meant to be eventually owned, operated and managed by the women in the community. For the women the time saved in bringing water from the river or well (not to mention the hazards of slipping on a treacherous terrain during the monsoons) or walking to the forest to collect firewood, can be pooled to make biodiesel to meet the village requirements (See Table 6-8: Activity table men and women). However such a connection is at best tenuous as women are usually involved in some activity or the other throughout the year and if indeed time were saved they would use it to augment their income by taking up some new work.

Table 6-8: Activity table men and women

Time (Nov)	Activity: men	Activity : women
9PM to 4AM	Sleep	Sleep
5	Sleep	Cleaning the house, sweeping (bringing water)
6	Going to the field	Bathing and cooking
7	Field preparation	Taking food for men folk in the fields
8	Field preparation	Feeding children and eating
9	Field preparation	Leaf plate stitching, firewood collection
10	Field preparation	Leaf plate stitching, firewood collection
11	Field preparation	Leaf plate stitching, firewood collection
12	Bathing and lunch	Serve food to men
1	Rest	Washing dishes (bringing water)
2	Feeding cattle and other house work	Cleaning the house, sweeping
3	Collect grass for cattle	Threshing paddy
4	Collect grass for cattle, Brinjal field	Preparing to cook (fuel processing, lighting stove)
5	Preparing plough for following day	Cooking
6	Evening prayer	Rest
7	Getting together with other villagers	Feeding children and eating
8	Dinner	Dinner

The gray highlights indicate activities that were identified which could benefit from technological innovations to reduce drudgery of work

6.6.2. Energy futures

With very little energy being expended into livelihood activities, there is potential to enhance productivity in agriculture through irrigation pump sets and other small agricultural implements for tilling, threshing *etc*. Current energy usage is mainly for domestic activities (See APPENDIX VIII).

The energy use pattern in the two villages indicates that cooking is currently the most energy intensive activity, consuming over 80 tons of fuel wood annually. A substantial amount of time is invested in the collection and processing of the wood (rough calculations show about 2,500 workday equivalent annually), which could be diverted to income generating activity if an alternative were available. Kerosene, another commercial non-renewable fuel, is used for lighting. A family on average uses 3 litres /month for 3 hours of lighting; over a year the two villages together consume over 33,000 litres of kerosene, which alone could contribute to about 864 tons CO_2 emission.[37] Flashlights are used as emergency lighting and for night forays into the forest for hunting by about 9 households who spend up to Rs. 16 /month on replacement of batteries. The two villages are estimated to consume about 190 batteries annually.[38]

Lighting using LEDs (Light Emitting Diodes), with their batteries charged using a biodiesel generator, offers an avenue for offsetting not only the emissions from kerosene-based lighting but can also divert the money that is usually paid outside the community, back into the village economy. Every household today spends at least Rs. 30 per month on kerosene. The two villages together spend about Rs. 350,000 for kerosene and this is when they purchase it at a fair price shop at the subsidized cost of Rs. 10.50 per litre. This could be used as the basis for calculating utility charges for lighting that the VEC can levy on the people.

The community in KBTT wanted to use biodiesel for providing 2-3 hours of electricity for home lighting. Discussions were held with the community on how to sustain such an enterprise by having the village grow its own feedstock, resulting in minimal cash flow to the outside. At the same time alternatives were being explored for the provision of lighting through individual LED-based mobile lighting or a mini-grid supplying two fixed power points in the house.

In collaboration with Practical Action Sri Lanka and with Power Control Berhampur, CTx GreEn designed a lighting system for KBTT with the least operating cost implications. The optimum system was a “central charging system.” Not based on a mini-grid, this involved charging a “battery bank" and offline daily charging of LED lights, with the following basic electrical specifications (Table 6-9):[39]

- Two LED lights in each household and each streetlight independently powered by a battery;
- Battery bank charged centrally, daily, using a biodiesel generator set; the battery bank in turn charges the LED and street light batteries;
- Two LED lights (1 white LEDs -2power levels) per household, each with a wattage range of 0.8 to 1.2 W/light, manufactured by the company Thrive, based in the neighbouring province of Andhra Pradesh;
- Individual household batteries and streetlight batteries can be plugged into the battery bank any time of the day for charging;
- Streetlights use a 5W LED light.

With such a battery bank the fuel cost to the community would be Rs. 13 per household per family for four hours of flexible lighting (LED lights can be switched on and off as needed in comparison to the fixed time that would be supplied by the grid). As the discussions were ongoing, the community wanted electricity and gave inputs to the design of the electrical configuration in terms of number of lights, hours of lighting needed *etc*., but decided that they would not grow niger that year (2007-08) and would only contribute in terms of cash.

Table 6-9: Specifications for lighting in the Villages of KB-TT (CTxGreEn 08-09)

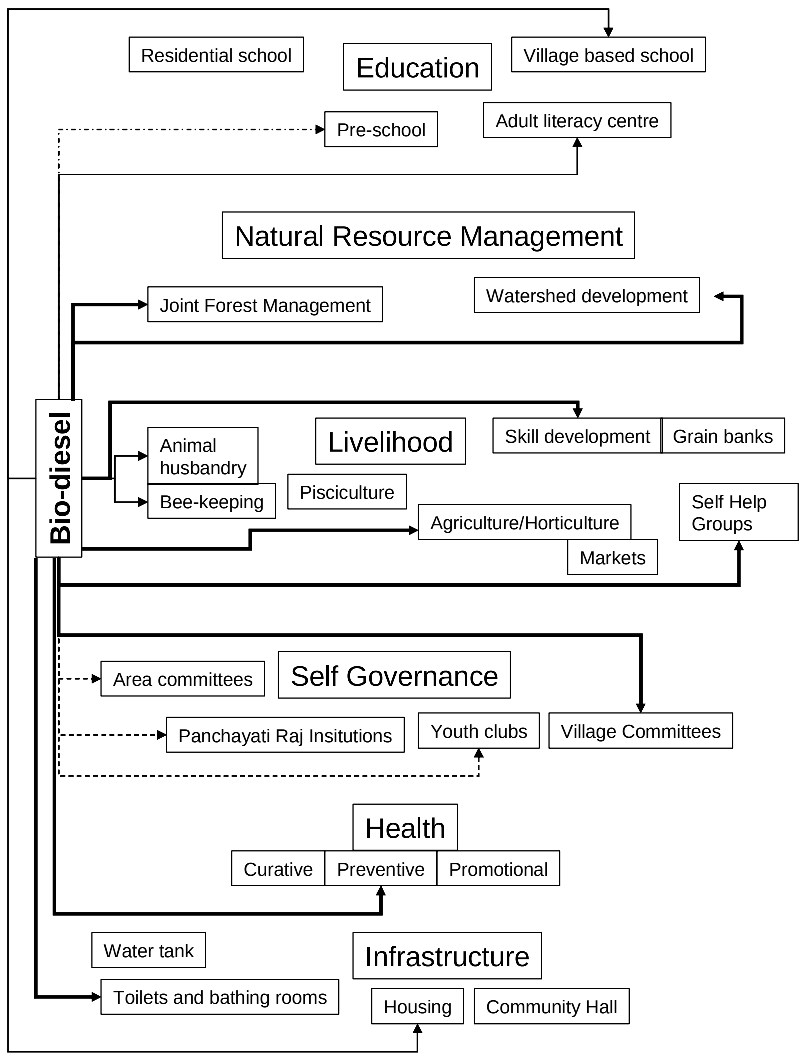
Parameters of interest	*08Apr08 calc'n*	
HOUSEHOLD LIGHTING		
No. of houses	hh	32
No. of lights (&batteries) per household	Lights/HH	2
Wattage of each HH-LED light	W/HH-LED	1.2
Operating Voltage of LED (Battery 6V)	Volts	6
Calculated Current draw/HH light	A/HH-LED	0.2000
No. of running hours per day (night)	h/day	4
STREET LIGHTING		
No. of streetlights	St LED	4
Wattage of each streetlight LED	W/St LED	3.5
Calculated Current draw/Street light	A/St LED	0.5833
No. of running hours per day (night)	h/day	4
Fuel Consumption in BD Generator	L/h	0.700
Cost of Biodiesel	Rs./L	40
Litres of Biodiesel consumed in month	L/month	10.4
Litres of Biodiesel per HH (2 LED lights)		
Cost of Biodiesel per month	Rs./month	416
Cost of lighting to family	Rs./HH/mo.	13

VLB was conceived by the CTx GreEn team as a productive livelihood model where the purpose is to reduce cash outflow and ensure that the byproducts such as oil cake can be used locally, and others such as glycerin and soap can be value added locally and then marketed outside. It is not a model that only promotes the end use energy to consumers. Therefore, after all the initial discussions with the villagers, when the system was finally ready for installation, it was moved to Kinchlingi. In contrast to KBTT, the community in Kinchlingi had decided to grow niger even after their village started getting water through a gravity flow water supply system.

While the community of KBTT was still deciding on how to proceed, people in Kinchlingi had not only voted in favor of biodiesel-based lighting, but had also sown niger to ensure that there was feedstock available to make the fuel. House wiring was completed by October 2008, and the Kinchlingi villagers were ready to commission the biodiesel-based electricity generation. The generator set from KBTT was moved temporarily to Kinchlingi in January 2009, even though the pump from the engine in Kinchlingi could easily be coupled to an alternator. The Kinchlingi engine required a system for recycling water to cool the engine, and that system had yet to be designed. Until then, or until the generator set is needed elsewhere, it is being used in Kinchlingi.

6.7. Outcomes

In a workshop in June 2005, the local Gram Vikas project team highlighted some of the linkages of VLB with the existing mandate of Gram Vikas in the village (Figure 6-4). The plan proposed by the team was premised on biodiesel-based water pumping. In contrast to Kinchlingi, where the gravity system was anticipated and the plan proposed accordingly, the KBTT design assumed 12 months of electricity and water pumping along with 5 months of income generation activities. The design also anticipated strong linkages with Self Help Groups, the Rural Health and Environment Program, Natural Resource Management and Agriculture. Indicators were listed to ascertain whether the linkage had been established.



Program areas – Rudhapadar ITDP

Figure 6-6: Gram Vikas focus areas and linkages with

On examining the proposed plan after four years, of which two years involved intense activity at the village level, only the RHEP part of the program has been well established (Table 6-10).

The gravity flow system for water supply was never anticipated here and so not integrated into the planning. The KBTT plan developed in June 2005, although theoretically much stronger than the Kinchlingi plan, seemingly based on every facet of community development that is fundamental to VLB, turned out to be a classic case of the gap between planning and implementation. The lack of success in implementation in spite of having a robust plan in place needs to be understood better by analyzing the roles anticipated for the different partners and their actual contribution in the pathway adopted at KBTT.

Table 6-10: Linkage with overall plan

Program	Sub-Program	Indicators	Achieved
SHG	Savings and credit	Ability to meet expenses at the time of need	Yes but consumption needs only
	Income generation activities	Linkage with bank	No
		Production of biodiesel as per requirement	Partly
		Record keeping	No
RHEP	Water supply and sanitation	Reduce water borne diseases	Yes
		village household cleanliness	Yes
NRM	Soil, Water Conservation measures	Increase in ground water	?
	Afforestation	Dense forest	?
		Reduced soil erosion	?
		Increase moisture conservation	?
		60% seeds available from forests	No
Agriculture	Intercropping of	More land covered under cultivation	No
	oilseeds, cereals, millets	Particularly of oilseeds	No
	Improved crop practices	Increased crop production	?
		People are able to pay electricity charges	No

Building capacity within the three village-level organizations (VEC, SHG and VSS) to organize and manage the entire system was critical: feedstock-machines-services-people. This was summed up by Achla, from SaDhan after her workshop in November 2004 with the KBTT Gram Vikas team. She said *"The (local) team also needs to strengthen their strategic and analytical capacity to think through new situations and issues arising in the course of their work that are away from the routine."* (CTxGreEn 2004)

The other important factor is the community-technology interplay. While the basic hardware can be easily installed in the village, the sustainability of operation requires rigorous operating procedure with some amount of formality. Bookkeeping is another essential element for which some degree of training is needed. These may not always be appreciated by the community, especially if they cannot see immediate individual benefits and have to bear this additional responsibility. Simultaneously implementing technology-related activity in the community, while still testing preparedness in the field, is likely to cause many unforeseen delays requiring compromises. Trade-offs and implications of the new technology should be discussed in detail with the community, and strategies modified as needed to ensure long term sustainability of the solution.

6.7.1. Role of energy innovations in reinforcing community structures

On the technical front, the issue of producing biodiesel seems to have been accepted by the women in KBTT, although the men want only biodiesel-based services and are unwilling to grow the feedstock. If the SHGs do take up biodiesel production, and offer it as a service, the end use will have to be changed to lighting, followed by fuelling pump sets for irrigation.

Possible alternatives for making cooking more efficient is another area with potential, but current cooking patterns and requirements will have to be kept in mind while developing the new specifications.

The sustainability of the biodiesel operations at KBTT seems contingent on whether the SHG, VSS and the VEC are able to take up their respective roles. The women groups (SHG) need to be supported but the risk is that the women will end up having even more work, unless some time is released from the drudgery of their housework with the help of the new technology.

Presently women spend up to 5 hours every day for fuel-wood collection, processing and cooking (see APPENDIX VIII, Table 6-8). With the fuel being used for cooking alone by the two villages, roughly the equivalent of 80 trees per year is being lost. An alternative fuel for cooking is needed in place of firewood that is more efficient, reduces the time for processing the fuel and limits deforestation.

Grain milling is another activity where women spend a substantial amount of time, which could be reduced with some innovative technology. Time made available can then be usefully channeled into activities of the SHG which can also assist the women economically.

Coupled with these innovations, a cluster approach needs to be adopted for KBTT including at least five other villages which fall in its periphery. These villages share forest and watershed boundaries and have a similar socio-economic base. With KBTT at the centre, the VLB unit could serve a bigger community. This cluster would include five villages with 80 households and a population of over 450 within a 10 km radius (Figure 6-7). At this scale the operation would function as an agro-service centre, processing local oilseeds, promoting use of oil cake as green manure and using biodiesel to fuel small farm equipments like tillers, tractors and even threshers, oil expellers and grain mills. Linkages to the government's agriculture extension programs and to those of the agricultural universities should be established to facilitate this.

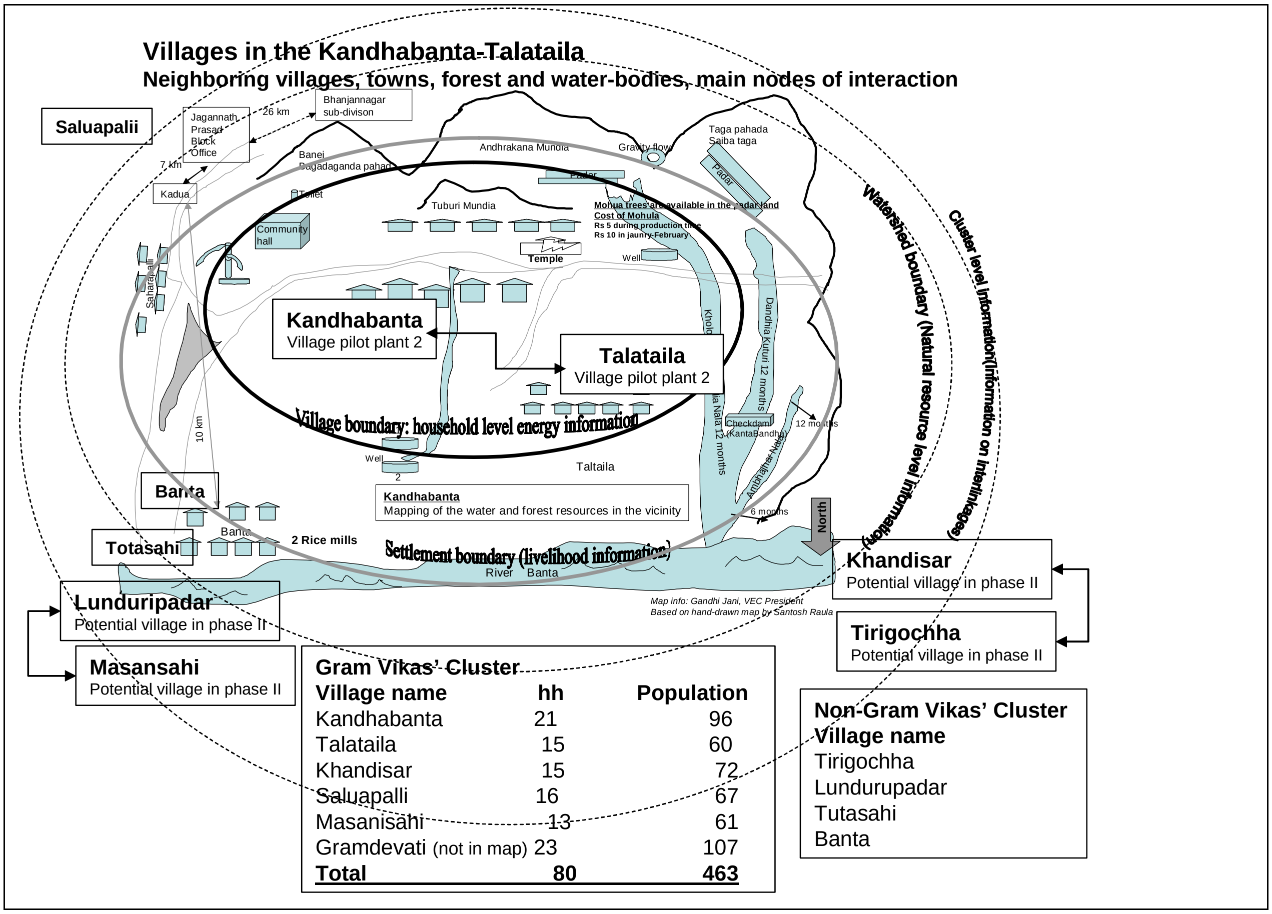


Figure 6-7: Cluster of villages around KBTT-potential reach of VLB

In moving forward with VLB in Tumba, this is a lesson that needs to be followed carefully. By including villages where Gram Vikas is working as well as others in the area, the concept of a local agro-service centre for timely inputs to the local agriculture could become the foundation of VLB.

6.8. Conclusions based on the SLF for VLB

The development of VLB in KBTT followed a different trajectory of growth compared to the Kinchlingi experience. There are several reasons that immediately come to mind: the different nature of the livelihood system in KBTT which seems less vulnerable, the lack of previous baggage from development activities, the vegetable-based cash crop economy or even the difference in the tribal population, working with Kandha tribals and not Sauras as in Kinchlingi or Tumba. The agroecosystem of the two communities appears similar, but is very different.

KBTT villagers are better off than their counterparts in Kinchlingi in terms of food security, and the village has sufficient private and community land, although a lot of it is left fallow when not leased. Their livelihood system already includes multiple strategies, such as cash cropping and selling forest produce, in addition to rice farming. The proximity to Reserve Forest, where no human intervention is allowed, is the only barrier for access to infrastructure facilities such as grid power. With respect to institutions and community arrangement for mediating access to and gaining control over resources (entitlements), these two villages, KB and TT, have a strong history of community activism. Their forest protection committee (Van Suraksha Samiti, VSS) is very active and maintains good liaison with the forest department. This can be leveraged once the knowledge of the technology (as a community tool) and its management (locally) is embedded in their thinking.

The different approach to the management system adopted for KBTT, a community enterprise instead of the volunteer model in Kinchlingi, has led to new lessons with respect to the functional composition for such a VLB. Currently VLB is being promoted as a productive livelihood model where the purpose is to reduce cash outflow and ensure that the byproducts like oil cake can be used locally, while others such as glycerin and soap be value-added locally and then marketed outside. VLB is not intended as a model that only promotes the end-use energy to consumers. This view is also supported by the Gram Vikas management who believe that VLB can be a vehicle to strengthen the SHGs and that the SHGs in turn can generate funds to support their community. The combination of the SHGs, VSS and VEC is a very good institutional arrangement, viable especially if different roles are assigned to each of the entities and when it is composed of different members of the community. However, in the absence of these (SHGs, VSS, VEC) being mature organizations, as was the case with KBTT, it is the NGO nurturing these organizations that assumes the main role. There is then no clear demarcation of roles or of authority between the three entities. The strengthening of the VSS, VEC and the SHGs to assume their separate roles is therefore very important for the smooth functioning of VLB as a community enterprise. This may require training in technical and management aspects and a degree of responsibility beyond informal volunteerism.

There are also important lessons from KBTT with respect to the technology-community interface. With this degree of sophistication in the technology, a more involved process of demystification and simplification is necessary to enable the community to fully engage in its operation. This process is essential, but is likely to lead to unforeseen delays as technology is a means and not just a “water pumping or lighting alternative.” The role of the community in the technology development process needs to be clarified upfront to avoid frustrations at a later stage. Reflecting on the framework ‘SLF for VLB’, it appears that we should prioritize the five components based on the prevailing context and the innovation system being proposed. When, as in the case of KBTT, innovations are involved in both the technology system and the management system, a better understanding is needed of the ability of mediating institutions and community organizations to facilitate local integration of VLB. The community organizations need to have an identity distinct from the NGO. Recognizing this at the outset and engaging with the community accordingly could make the technology adoption process easier.

The project in KBTT itself appears on the face to have stagnated, but there are indications that the project can be revived and VLB replicated here on a very different scale. The initial experience with VLB in KBTT indicates a very receptive agroecosytem and a resilient community with clear signs of diverse livelihood potentials, as was voiced by the villagers early in 2004 during the energy workshop. Functioning at a cluster scale including at least 5 villages located at its periphery, VLB at KBTT could cater to the economic needs of a larger community, through an agro-service centre that processes local oilseeds, promotes use of oil cake as organic fertilizer and uses biodiesel to fuel small farm equipments like tillers, tractors and even threshers, oil expellers and grain mills.

In the following chapter, this cluster approach of VLB, accompanied by the idea of provision of services through a nodal agro-service centre for multiple livelihood strategies, will be further explored.

7. Designing a strategy with the SLF for VLB: Integrating VLB with livelihoods in Tumba

7.1. Feedback from experience- VLB in a modified context

The greatest practical challenge for VLB is in trying to work on five dimensions all at once: (1) scaling to agroecosystem (2) integration into the existing livelihood system (3) demystification for local adoption of appropriate technology (4) enabling entitlements by linking micro level organizations with macro level institutions (5) leveraging policies for legislating grassroot changes. The technology's intrinsic link with the land makes it necessary to have an agricultural package in place along with the practice of the technology. This package of practices has to include local agro-practices, the correct use of oil cake as green manure, and oilseed cultivation practices including intercropping with nitrogen-fixing legumes. Most of these were traditional practices that the local farmer has slowly traded for quick fixes such as high-yielding variety seeds, chemical fertilizers and cash crops. VLB, while bringing with it a futuristic view of a high quality renewable fuel, also carries a paradoxical message to the farmers to go back to their past to traditional practices. In the village of KBTT, the practice of sowing niger was seen only from the point of view of a feedstock for biodiesel and the farmers felt it conflicted with current farming practices. If it were integrated as an oilseed intercrop instead while sowing red and black gram (during rice transplanting), it would not be seen as an additional burden. This will have to be done through intense agronomic field implementations and VLB requires the support structure to implement it.

The strengthening of community organizations to manage VLB is critical. Since VLB is implemented in tandem with the RHEP, it assumes that the organizations are capable of taking up this additional responsibility. The evidence in KBTT is that this is not so. There is some tension in the VLB-RHEP combination because Gram Vikas sees RHEP as the pen-ultimate activity in their withdrawal scheme, but it is also clear that much more strengthening is needed before the community can effectively manage programs such as VLB without external support. Based on early learning from Kinchlingi and KBTT (2004-05), VLB has been recast by CTx GreEn as a livelihood model instead of a renewable energy system for Gram Vikas' RHEP (CNBFES for water supply and sanitation was the original title of the proposal to the WBDM2003).

The agroecosystem of Tumba, with its forest oilseeds, traditional slash-and-burn form of agriculture and remote location, is ideal for VLB. The livelihood strategy adopted here to site a "local production for local use" VLB is cognizant of traditional livelihoods and the natural resource base. Another important step in the Tumba livelihood strategy has been unraveling the linkages to the external policy context. The grassroot model for local self reliance requires links to the legal and policy regime to nurture sustain and replicate it. In the following sections of this chapter, formal and informal organizations that mediate resources (people and natural resources) essential for the sustainability of VLB have been identified in the Tumba context (applicable to Orissa), and their responsibilities and roles in strengthening the local economy have been defined.

A more comprehensive livelihood-based strategy has been developed for Tumba by the CNBFES team in conjunction with the community. To date VLB in Tumba has only been done as a demonstration while the search for a local green entrepreneur continues (as of June 2009). The obstacles faced in the implementation of VLB as an integrated grassroot strategy for catalyzing livelihoods in Tumba have been identified by CTxGreEn. Taking this a step further, a workshop was organized as a part of this research in February 2008 with an extended group of like-minded organizations working in Orissa, to brainstorm on strategies to overcome these obstacles. The next step of linking with stakeholders at the government level was established through another workshop held in March 2009. This workshop discussed both the practical and legal challenges to replication of VLB, and the forum provided avenues for synergies with the state government programs. Details are discussed in the following chapters.

The current research has anchored the work of developing a livelihood plan for Tumba, incorporating lessons from the first two villages using the 'SLF for VLB' as a guiding framework. The process of collaboratively developing the plan with the community in Tumba was iterative and reflective and involved instances of irritations and jubilation, many of which have been included as a process document in the course of this research. The attempt is to include as many viewpoints as possible and capture the voice of the community, the point of reference in understanding the validity of VLB as a catalyst for sustainable livelihoods in Tumba.

The narration that follows regarding Tumba deviates from the sequence followed in Kinchlingi and KBTT. In the first two case studies, the Chronology of events (Sec x.2) is followed by a description of the Context (Sec x.3), discussion of the Processes (Actors, resources and their relationships, Sec x.4), Decision making processes involved (Section x.5), Livelihood strategies adopted (Sec x.6) and Outcomes (Sec x.7). In the case of Tumba, where implementation has been restricted to demonstrations of the technology, the emphasis has been in developing livelihood strategies that incorporate multiple perspectives. The section on Livelihood strategies therefore precedes the section on Decision making processes.

7.2. Chronology of Events in Tumba

Feb – 2004	Quick trek through villages to survey (from base camp to +900msl) Forest oilseed purchase initiated
Jun – 2004	Training on natural resource survey
Jul-Nov 2004	Natural resource survey
Jul 2004	Rapid survey of livelihood and the agricultural system
Aug 2004	Workshop with farmer families
Nov 2004	Counting trees in non-forested areas/village community land
Sep-Mar 2005	Land use mapping and understanding the slash-and-burn agro-system Clusters for biodiesel implementation identified integrated with traditional livelihoods
Mar 2005	Workshop on biodiesel-based livelihood system with Gram Vikas field staff Forest oilseeds purchased
Apr –Nov 2005	Surveying agricultural fields for understanding niger availability Completing tree counting
Dec 05 – Apr 06	Assessing yields of forest tree-oil species Case study of niger fields of farmers
Jan-Feb 2006	Youth from Tumba undergo preliminary orientation
Mar-May 06	Field visits to select area for biodiesel implementation Selecting cluster for implementation and preparation for workshop
Jun 2006	Workshop with community to link watershed with biodiesel activities Prioritizing watershed for immediate implementation Orientation to training for future barefoot technicians
Jul 2006	Estimate prepared for watershed work Work begins on soil and moisture conservation
Aug-Dec 2006	Training of two potential barefoot technician Watershed development work in progress in Tumba Exposure visit to other watersheds Base plan for implementation prepared (supply and demand centres)
Dec 2006	Farmers growing niger identified
Jan 2007	Demonstration of biodiesel technologies in Tumba

	Oil pressing and water pumping demonstration
May07	Meetings held in Tumba to discuss roles and responsibilities *w.r.t* operation and management of biodiesel systems
Jun – Jul 07	Training of 2 new youth as potential barefoot technicians Visit by Practical Action Team from Sri Lanka, followed up with discussion on potential for collaboration
Jul –Aug07	Niger sowing initiated in the watershed. Approximately 1.5 acres of land sown
Nov-Dec07	Niger collection and harvest plans discussed with the community. Orientation workshop to the business aspects of biodiesel technology planned for the month of December. Target of 500kgs of seeds earmarked for collection and eventual pressing and conversion to biodiesel. Oil pressing demonstration proposed for January 2008. Assessment of potential micro-finance linkages
Jan08-May08	Initiated training of two women (Grade 7 dropouts) as potential barefoot technicians, including 'back-to-school' refresher courses. 90 kg niger seed harvested from the 1.5 acre community plot (after cleaning and drying the harvest reduced to 76.5 kg). Oil press training organized for three interested entrepreneurs at Mohuda. The team of three from Raikhal also assisted with disassembling and packing up the oil press and filter for transportation to the foothill village of Tadakasahi. A team of villagers then carried the machines up to Raikhal (675 m above mean sea level). After reassembly of the press and filter at Raikhal, the Maa Dwaarashuni oil mill opened for business on Jan. 25th for a two month "profitability" demonstration. 543 kg of seeds were pressed including 292 kg of niger seeds from Kinchlingi, Kandhabanta-Talataila and Mohuda biodiesel projects. Farmers growing niger were identified in the neighboring village of Ankuli and exposure visits organized. The quality of oil and powdery oil-cake which could be used directly in the fields as a fertilizer, greatly appreciated by local community. Discussion ongoing with the community on linking with MFIs, banks, *etc*., for purchase of a new oil press and filter for setting up a permanent business.
Jun08-Jan09	Train in niger sowing, of young girls from Tumba at Mohuda continues Tiller demonstration held in Kinchlingi and in Mohuda, Niger sown in both places and the young girls from Tumba trained. Oil cake demonstrations in Tumba and Tamana a village 5km from the pilot plant Exposure visit of Tumba SHG women to Vasundhara's area in Ranpur to meet other SHG members. Self help group strengthening through initial meetings Training in soap making initiated at Mohuda, to be taken forward in Tumba eventually.
Feb09-	Refocusing of work area in the Tumba project of Gram Vikas, from working in the hills to the plains. Skeletal staff left at the Raikhal cluster. Work at Tumba has currently slowed down, while work is ongoing in Kinchlingi

7.3. The context

The Tumba cluster of villages is located at altitudes ranging from elevations of 200 metres to over 1000 metres, spread over ll km radius. Settlements in the hills are nestled within the Singharaj and Bengasahi Reserve Forests[40] and the communities are forest-dwellers of the

Saura tribal community, relying on these reserves for sustenance. These hills form the catchments for the river Baghalati, and are even today a rich biodiversity reserve. The river Baghalati, dammed[41] for irrigation purposes, has submerged at least 10 villages and presently earth embankments of the dam are being raised again. Perhaps silting has decreased the water-holding capacity of the reservoir, as deforestation in the surrounding hills is washing away valuable topsoil into the river during every monsoon.

Almost all the households in Tumba face a deficit of food grains ranging from 25 to even 50% in some cases which is compensated partially though sale of forest produce. Community grain banks are in place to tide over a bad harvest but often men migrate to cities to supplement their income.[42] The 21 Gram Vikas-adopted villages have a total population of 2900 (Male: Female ratio 1:1.02). The Infant Mortality Rate for the period April 06 to March 2007 was lower than the previous year but yet high: one for every six babies born alive.[43] Malaria (*Plasmodium falciparum*, the strain that causes cerebral malaria) is rampant and the usual cause of the high mortality. With the assistance of Gram Vikas the Under Five Mortality rate for the same period was reduced, and ante-natal and post-natal support extended to the women. Very little support is available from the government in the form of healthcare. The closest Government Primary Health Centre is about 20 kms away in the town of Surangi, at the foothills (an average climb down of about 300 metres over 6-7 kms and then a walk at the foothills of about 13 kms). Road construction activity is ongoing on the Tumba hills at the cost of the forest, but may at least allow movement of private vehicles. No public transport is available even from the foothill at Tadakasahi village to the closest town of Surangi. Grid electricity is therefore a distant dream, although with the cellular phone, connectivity is getting better in some of the villages.

The Saura women are the mainstay of the community, involved in almost all the activities of farming and gathering forest produce, while also cooking (fetching firewood and water) and rearing children. More responsibility falls on their shoulders when the men migrate to cities to supplement cash income. Older members, unable to participate actively in the farming, help out with the children and guard the farmstead from grazing animals. Women have an informal system of peer support and work on each other's farms: daughters, mothers, mother-in-laws, aunts and nieces working together during the sowing period when seeds have to be broadcast and tilled within a very small window. Women give birth to 4-5 children but often only 2-3 survive. A form of matriarchal society exists in that future grooms (and newly married ones) have to work in the field of their in-laws in return for the hand of their daughter.

Activity in the *bogodo* (the slash-and-burn farmstead) starts slowly around March-April when much of the slashing is done. Work peaks around May-June with the burn followed by sowing after the first rains. After this, work such as weeding and guarding continues until harvest in January. Most families shift from their houses in the village to their farmsteads, where they continue to live until January. Crops are harvested continuously from September-October, and no new harvest is eaten without a *nuakahyi*[44] – an invocation to the gods with a ceremonial offering of the fresh harvest. The harvest festival peaks by the middle of January with different villages celebrating *nuakhayi* on different days. A ceremony for the Gods is followed by a week of festivities involving eating, drinking and dancing together. This is also the season for weddings, which in themselves involve 3-4 days of eating and drinking communally under blaring music from speakers, both at the groom's and the bride's houses (invitations are extended to surrounding villages and attendance ranges from 200-500). By the time the celebrations start tapering out it is March and work begins again of preparing for the *bogodo* and collecting forest produce like mahua flowers and seeds.

7.3.1. Bogodo and women- the backbone of the Tumba economy

27th May 2006*. The first rains had just arrived and everyone in the villages of Tumba was busy. Sowing had to be completed. Pandu and his daughter were also sowing. She showed me her seed basket: kangu, suan, jhudungu, dungarani,*[45] *all mixed together. There was a metal object at the bottom of the basket to ensure fertility of the seeds. They sprinkled the seeds and then covered the seeds with soil using a simple tool – a metal blade 3-4" wide at the end of a wooden handle. Pandu told us that it is important that metal touches the seed once it is sown, as that alone assures them of a good harvest. At Bhima's field Suni his wife showed me her seed basket. They had already sown 4 kilogram and about 2 kilogram remained. About 6 kilo of mixed seeds are scattered over the entire field - about an acre it appears, although it is difficult to judge as there are lots of Mohua trees standing in the field. Stacks of wood have been collected after the burn. Three women and two men were tilling the soil, pulling out weeds and sometimes displacing stones. They have a bamboo basket with jhudungo, dungarani, janna, kangu, sua and, ghantia seeds. Kandulo was sown earlier in the month using a rod to dig a hole and sow the seeds as the roots need to go deeper. Kandulo has already germinated. The soil cover in the field is only about 18 inches. I tried the gobudu- it is a very light implement and turns the soil over easily. They use it to hack branches of some of the shrubs. This is a real low-input form of agriculture- even soil turned over is minimal, although there is a lot of slashing and burning of trees. The bogodo farm gives them their food, firewood and protein as animals that stray into their farms from the nearby forest are hunted, and eaten. Bhima is ready to call it a day but not his wife Sunni. She feels there is still enough light to sow. Her sisters are helping her and after they finish this field she will help them sow theirs. They go back home everyday and will move into their farmstead shack after germination when watch and ward will begin. So much of hard work is involved living in dispersed settlements in this manner-what is the driving force I wonder?*

Journal extract, Geeta Vaidyanathan

Note: Underlines indicate agroecosystem characteristics

Livelihoods of the indigenous "*Saura*" community in the hills of Orissa, India are connected intrinsically to the forest around them. **The forests are a storehouse of biomass serving food, fodder, fuel and habitat requirements, medicinal plants and land to practice a form of "shifting" agriculture locally known as bogodo.** Work on the *bogodo* is almost an extension of the house, with activities being equally shared by all members of the family. Although *bogodo* occupies the major share of the activities within these communities, it does not always adequately satisfy their food requirement. Sale of forest produce supplements their output from subsistence agriculture but is hampered as the collection period for non-timber forest produce such as oilseeds overlaps with activity in the *bogodo*. The community ultimately has to resort to wage labour, causing seasonal migration of men to cities, and breaking up families.

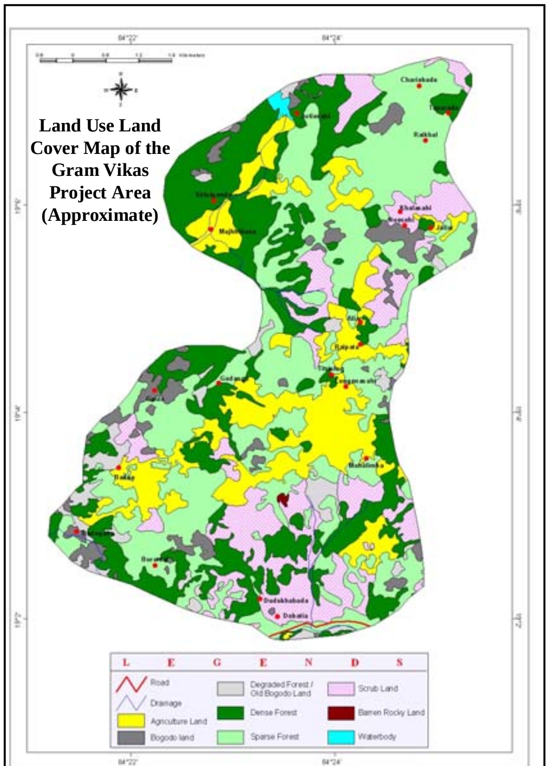
7.4. Processes followed: Actors, resources and their relationship

7.4.1. Agroecosystem land use plan: bird's eye view

VLB in the Tumba region of Orissa, India has followed a slow but steady process of orienting the community to the technology while understanding the local forest and agricultural base and the community's energy priorities. A detailed natural resource assessment was initiated in the summer of 2004 by CT_xGreEn in collaboration with the University of Berhampur's Botany and Marine Science Department (Mishra, 2005). The aim was to assess the quality of the forest, prepare a land use plan and identify forest trees that are oil bearing.

Over 300 plots were laid[46] off 37 transects, covering a total area of 152,500 m^2 (each plot was 20m x 25m) in 7 forest patches and represented between 0.5 to 1.9% of the forest. There were only about 11 plots where *bogodo* was practiced although about 36 plots showed evidence of past *bogodo* activity. The forest also showed evidence of hunting, collection of timber and forest produce and grazing.[47] Using the data, a land use plan was developed for the area with the assistance of the remote sensing department at Berhampur University. A LISS IV image from the Indian Remote Sensing Satellite IRS P6 with a resolution of 5.8 m was used with the date of pass 8th of April 2004 (Mishra, 2005). The land use plan from the remote-sensed image Figure 7-1) is the base map for planning for biodiesel and additionally provides a baseline for monitoring the impact of any work being done in the area.[48] The landform in Tumba is classified into 8 categories and the percentage distribution of each land use was calculated within the roughly demarcated Gram Vikas work area. The total Gram Vikas area of work is about 4,500 ha and the distribution includes (1) Agricultural land 17% (2) Bogodo land 5% (3)

Old bogodo/degraded forest land 3%, (4) Dense forest 21% (5) Sparse forest 41 % (6) Scrub land 13%, (7) Barren rocky area less than 1% and (8) Water bodies 1% (Mishra, 2005). What becomes obvious is that **although bogodo or slash-and-burn agriculture is blamed for deforestation, it contributes to less than 10% of the total land use**. The sparse forests and scrub land (about 54%) are slowly edging out the dense forest which is presently over one fifth of the land cover here (Figure 7-5). Although illegal, wood from Tumba Reserve Forest is logged by people in the plains. This will become even easier with the completion of the ongoing hillroad.



Sl. No	Categories	Area in Ha.
1.	Agricultural Land	754.23
2.	Bogodo Land	222.37
3.	Degraded Forest/Old Bogodo Land	129.67
4.	Forest (Dense)	954.14
5.	Forest (Sparse)	1852.47
6.	Scrub Land	569.03
7.	Barren Rocky Area	6.61
8.	Water Body	25.27

Figure 7-1: Land use land cover map Tumba

7.4.2. Rural livelihood mapping: farmer's view

The study of the local livelihood system conducted with the assistance of farmer families made it clear that the community has very strong attachment to *bogodo*, and although settled farming is slowly coming to Tumba, the existing form of low-input agriculture is preferred for their staple food crops. There is diversity of crops within a single field: at times over 20 varieties including cereals, pulses and vegetables are grown on the same plot. The productivity of crops is high: about 350 kg/acre of grains and over 70 kg/acre of pulses, in addition to vegetables, all within the same plot, as compared to what they harvest on middle or lowlands (200 to 400 kilogram/acre of paddy). Almost a third of the entire agricultural cycle of 300 days is spent in preparations: cutting, clearing, burning and wood collection occupying over 90 days. **Bogodo occupies more than two thirds of their lifestyle (on an annual basis) but in most cases satisfies only 75% and sometimes just 50% of the food needs of the family** (CTxGreEn, 2004). The nutrition gained from the coarse cereals and pulses grown in the bogodo is far superior to that from rice.

Individual orientation: Visions and aspirations Farmers vision and aspirations for himself and for his children ***Can continue Bogodo but not without ignoring own aspirations- Gram Vikas staff*** "Adivasi culture" so we will do bogodo, if our children choose to study they will go elsewhere for work perhaps. Parents (Srikar) wants his son to study, but son is not interested. Farmers view	**Family Orientation:** Ancestors, caste, social status Land inheritance, ancestral practice vis-à-vis today's practice, difference in practice between families/sub-castes, food habits. ***Cannot ignore family's orientation /aspiration.-Gram Vikas staff*** Issues resolved in the "Kula": Marriage issues- Jikka System stopped, serving Non-veg in weddings no longer compulsory	**Collective orientation**: Religious tradition, world views and education Cultural connotations, past trends in bogodo, present status and future visions of bogodo *Bogodo is sustained through collective/solidarity among villagers. Gram Vikas staff* Area committee organizes people's movements. Kula: 48 villages with one member from each village.Meetings held twice a year Kula president in Gaurango village Villagers prefer taking conflicts to "Kula" than to the police.
Inner Human Space: Integrity, identity, selfishness, compassion Individual farmers association with his Bogodo land *Discipline and responsibility essential for the practice of Bogodo. Gram Vikas staff*	**Family Space:** Gender relations, solidarity: Work sharing, role of the women and children. Migrants returning for Bogodo *Good health, Family peace and solidarity important for Bogodo. Gram Vikas staff*	**Socio-Economic space:** Community organization for Land distribution, Other (seeds, tools) *Land and labor essential for continuing Bogodo.Gram Vikas staff* **Raikhal**: Community arrangement only for Bogodo: Produce not shared only labor shared. MFPs would need collective arrangement for longer period. The community share of 26 trees are leased out. Lessee gives half of what they collect to the village community fund. **Jalior:** collective integral part of community livelihood (MFPs). **Khalasahi:** Limited number of community trees (MFPs) **Teparda:** People come back home to village during Bogodo (since fields are nearby). Have individual; trees + community trees
Emotional base: memories and attachments Traditional values associated with Bogodo *Boredom, lack of enthusiasm and emotional attachment cannot sustain Bogodo. Gram Vikas staff* Raikhal: "Whatever happens we will not leave Bogodo- It is important for our food." "For food we will be happy in the village, doing Bogodo." Jalior: "We get 22 varieties; we can't leave/will not give up Bogodo	**Knowledge and activity base:** Technology, experience skill Bogodo:Tools, equipment, method, skills *Knowledge essential for practice of livelihoods, including Bogodo. Gram Vikas staff* Raikhal: Horticulture is an innovation expanding to Billa-Padra land with Ragi and Rice in the vicinity of Bogodo. Jalior: Forefathers did only Bogodo, now we are doing horticulture+Padra. Bullock has been introduced in Padar land where Ragi is grown, Since the last 7 years (GV influence) we are growing turmeric.	**Physical Base:** natural resources, assets: Resource input, crop diversity, productivity, land *Topography essential for Bogodo. Gram Vikas staff* Raikhal: resource base sufficient for Bogodo. Minor Forest Produce also sufficient but no arrangement for harvesting full potential. Jalior: Resource base insufficient for Bogodo. Minor Forest Produce insufficient.

RURAL LIVELIHOOD FRAMEWORK: Hogger, 2004

Farmer's feedback and Gram Vikas staff voices

The text inside the box are the views of farmers who participated in the workshop held in August 2004.
The shadowed text, in italics is the summary of the views of the Gram Vikas supervisors, working in these villages.

Figure 7-2: Rural livelihood framework (Hogger 2000)

A workshop was organized by CTxGreEn in August 2004[49] to understand the local livelihood system so that VLB could be established in a symbiotic relationship with it. In addition to the quantitative information on food productivity, techniques and input of labor, the cultural aspect of the bogodo livelihood system- were discussed with the farmer families. This information was collected using the Rural Livelihood Framework (Figure 7-2) (Hogger, 2000; 2004), discussed in Chapter 3: Methods. The tool was first introduced to the farmers and to participating Gram Vikas staff members during the August 2004 workshop.

The community has a collective called "kula" where there have been several radical decisions of moving away from traditions that were seen to be repressive such as "jikka" or bride-kidnapping. **The community has also been able to hold on to the tradition of slash-and-burn with respect to diversity of crops, traditional seeds, no chemical fertilizers, while at the same time moving towards stable agricultural practices through horticulture. There are community forests**

and community assets in terms of oil-bearing forest trees, which the community is not able to leverage fully. While parents are attached to the bogodo, they would like their children to be educated. But the youth are themselves unable to go through the formal education, and with a few exceptions often return to continue the bogodo. Many of these elements such as value adding to the seeds, providing training to absorb the youth in local work opportunities meaningfully *etc.*, can be positively reinforced by VLB.

When talking about the changes in the livelihood base in Tumba there appears to be a progression towards more settled agriculture. Earlier the farmers only practiced *bogodo*, whereas now the farmers are also practicing horticulture in middle lands and rice cultivation in lowlands. This indicates their openness to change. Interestingly **the women are more involved in bogodo, a low-input agriculture, than in the resource-intensive middle and low land cultivation. Here again VLB could facilitate the trend towards stable agriculture with the locally pressed oil cake replenishing the soil nutrient without recourse to chemical fertilizers**.

> ***28th May 2006:*** *I wake up in Chakrapani's house. It is barely 5 in the morning. His wife has already had a bath and her daughters have rinsed yesterday's utensils, fetched water and lighted the hearth. I can hear the dhenki in the kitchen: this is the grain milling device- a big log of polished wood with a 4" wooden cylinder at one end that goes up and down in a hole filled with grains. Operated by the foot, there is a rhythmic up, down motion while another person pushes the grain into the hole. The grain is soaked in water before being fed into the hole. One person pounds the dhenki while directing the other person, who pushes grain into the hole and intermittently winnows it. Water is boiling on the stove with pulses and cereals-usually the freshly chaffed grains. The women cook and then go to their bogodos. It is the woman and her relationship to the land that feeds these people. There is so much work for the women that I will have to understand better what will make life easier for them.*

Note: Underlines emphasize the role of women in and outside the house in Tumba

Large sections of the population, usually men, seasonally migrate to big cities for work for a period from June to November. All of them do so only after completing the sowing in the bogodo, and most of them return during the main harvest. The *bogodo* agricultural system depends on a lot of physical factors such as land, topography, health of family members and knowledge. But most of all it is sustained through the collective and the anchor provided by the active female population.

Each village receives substantial revenue from the sale of flowers of the mahua trees, which is also value added locally to brew alcohol. They are unable to leverage the same level of income from other forest produce. The percentage share of income from the sale of mahua flowers alone when compared to the rest of the forest produce is over 70% in the village of Raikhal.

For other villages in the cluster it ranges from 30-60% (CTxGreEn, 2004). Most of these trees are owned communally although in some of the villages the trees are divided among the households. The seeds from most of these trees are not even picked, leaving them to the people from the plains to collect and sell. (CTxGreEn, 2004, CTxGreEn-GV Proceedings 16-17Oct07).

7.4.3. Livelihoods Integrating biodiesel and bogodo -the field staff's view

A livelihood plan was developed with the Gram Vikas field supervisors in the Tumba project for the villages in their area in March 2005 during a workshop organized as a part of this study. All 21 villages in the Tumba region (out of a total of 48) that Gram Vikas works in fall within two distinct watersheds: one in the Raikhal cluster of villages sloping north, with all the streams falling into the *Bahuda-nala* and eventually into the river Bagalati, and the other in the Burataal cluster of villages sloping south, with streams flowing into the *Maadhaala-nala* which flows into the river Mahindra-Tanaya (See Figure 7-3).

Livelihood plans were developed for both these clusters based on biodiesel providing additional opportunities for the community, while linking the forest and existing livelihoods. Most of the participants had taken part in earlier workshops of natural resource monitoring and livelihood assessments, and had an understanding of the working principles of VLB. In the Raikhal cluster, following the August 2004 livelihood workshop, land development activities had already been initiated and discussions were ongoing on how to integrate VLB into the local livelihood activities. The proposal for the Burataal cluster covers 16 villages, with 538 households, population of 2289 and an area for watershed development of about 800 ha. The proposal for the Raikhal cluster is smaller in scale and has 8 villages, 187 households and a population of 1046. The area earmarked for watershed planning in Raikhal is 638 ha (Figure 7-4). Both the Burataal and the Raikhal cluster have good forest resources and so offer equal opportunity for initiating VLB. However, according to the Gram Vikas staff the communities in the Raikhal cluster are more responsive. The recommendation from the field team was to initiate work in this cluster of villages. Although detailed livelihood plans were developed for both the clusters during the March 2005 workshop (APPENDIX X), only the Raikhal cluster is discussed in the sections that follow, as it was decided that the initial focus of the CNBFES and VLB would be in Raikhal.

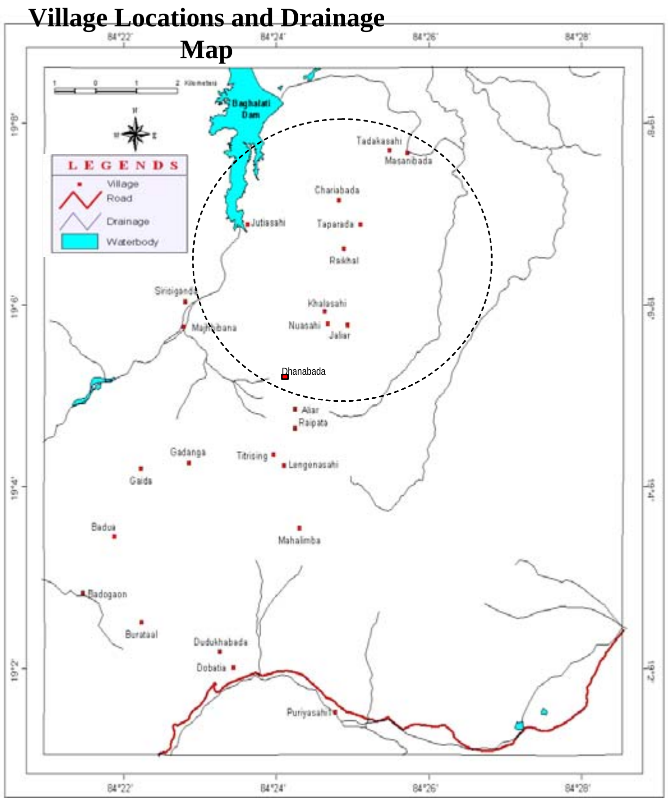


Figure 7-3: Villages and main drainage lines, Raikhal cluster (ORSAC 2004)
The Raikhal micro-watershed does not appear on the map

Table 7-1: Demographics and landholding patterns in the villages in the Raikhal cluster

	Households (brick houses)	Men: women	Total Population	Land holding acre			Community land
				Up	mid	low	
Dhanabada	50 (GI roof 13)	146: 141	287	No info			60 acres community Forest
Jalior	34* 17)	104: 108	212	78	11.3	0.25	20 acres Reserve. Forest
Khalasahi#	16 (13)	61: 51	112				15 acres community. Forest
Masanibada	16 (2)	37: 38	75				
Raghuballab	12 (1)	21: 24	45				
Raikhal	**31 (19)**	**87: 72**	**159**	**50**	**5**	**2.5**	Village is in Reserve Forest
Teparda	17 (06)	44: 40	84	75	17		
Tadakasahi	9 (3)	28: 21	49	27	22	15	
TOTAL	**185 (74)**	**528: 495**	**1023**				

- **3 households have permanently migrated out of the village # Badanala is where the village moves to do Bogoda**
- **Data based on Gram Vikas' household census 2003 and verified during the 2005 workshop**

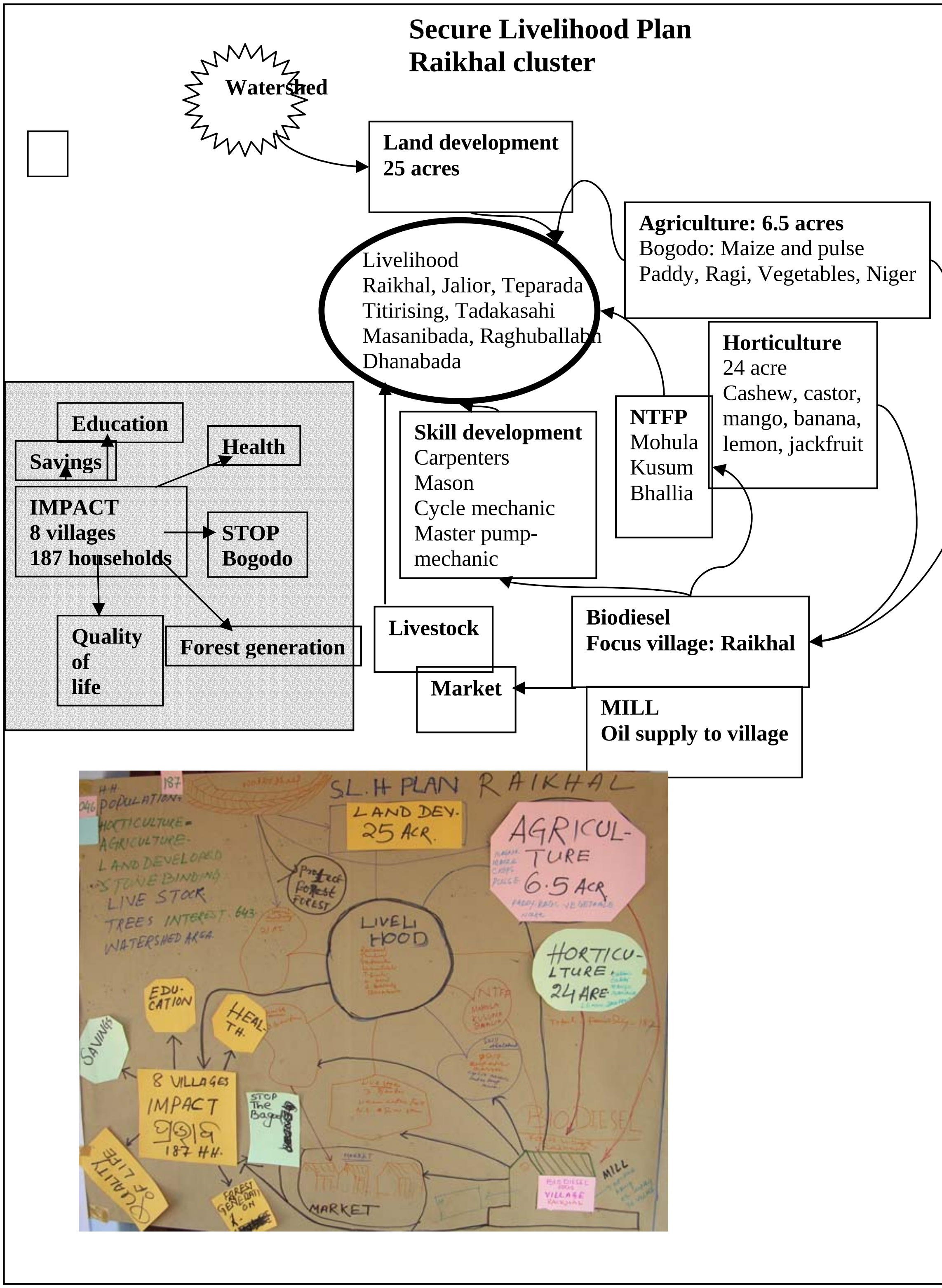


Figure 7-4: Livelihood plan proposed for Raikhal

The plan was developed by Gram Vikas Tumba project staff (March 2005). The lower image is the proposal as presented and the top is a representation of the same idea

This plan for VLB includes eight Gram Vikas focus villages, *viz.*, Dhanabada, Jaliar (and its hamlet Taramunda), Khalashi, Masanibada, Raghuballab, Tadakasahi, Teparda in addition to Raikhal and five other non-Gram Vikas villages in the periphery, *viz.*, Guruding, Jibasahi, Kumardoly, Luhasing and Tasarang (Figure 7-3). An overview of the demographics and land holding details of the eight villages in the Raikhal cluster is presented in Table 7-1. Dhanabada is the biggest among all the villages with 50 households, while the village of Tadakasahi at the foothills with 9 households is the smallest. A mix of Reserve Forests and community forests exist, and upland agriculture appears to dominate, at least in the case of villages where data is available.

The March 2005 workshop helped to define the cluster approach for implementing VLB and to identify villages in the clusters along with the nodal village where work would be initiated. It became clear that forests and water bodies defied conventional boundaries and so watershed boundaries were chosen as the most suitable. Dhanabada in the Raikhal cluster is on the ridge of the watershed in this cluster, and defines the uppermost boundary of the Raikhal cluster, while Tadakasahi at the bottom defines the lower extent. The watershed approach as an entry point for biodiesel activity was also suggested during this workshop. It was decided as early as 2005 that the focus in Tumba would not be water supply and sanitation, but livelihoods. For water, the Gram Vikas staff was tapping hill streams for a gravity-based supply. The livelihood plan provided strong linkages with agriculture and land development activities, focusing on introducing stable agriculture practices anchored in biodiesel. It was proposed that biodiesel in these clusters would assist irrigation, grinding and oil milling, the residual oil cake from oil milling being used as an organic fertilizer (Figure 7-4).

In a follow up workshop “Biodiesel in Gram Vikas-reflections and future directions, 6th June to 9th June 2005.” a more detailed plan for implementation was developed for Tumba, just as it had been done for Kinchlingi and KBTT. In the case of Tumba, the field team led by the Project Coordinator based their proposal on the Raikhal plan developed in March 2005. A phased approach spread over a five year period was suggested (Table 7-2). Phase one was the land regeneration phase and focused on agriculture and natural resource management through watershed activities, and on strengthening the local organizations. External linkages were also proposed in the form of marketing channels for future products. In the second phase, value addition activities were to be seeded, and lighting was proposed in villages using biodiesel.

Marketing of byproducts such as oil cake, and income generation activities such as grain and oil milling also formed a part of the second phase. The third phase was the technology phase and proposed integrating biodiesel with the existing water supply and sanitation program while also establishing stable agriculture practices.

Table 7-2: Phased plan for biodiesel

End use	Proposed	Actual
Agriculture	**First Phase**	
NRM through watershed	one year	2004-2007
Strengthening of SHG, VEC		Three years
Develop marketing channels		
Lighting	**Second Phase**	
Marketing (byproduct)	Year 2+3	2008-2009
Income Generation Activity (Rice milling, use of byproduct), ragi milling		Year 4 +5
Development of Management system		
Implementation of RHEP	**Third Phase**	**NA**
Transfer from shifting to settled agriculture	Year 4+5	

The bulk of the responsibility in the model proposed was anticipated to lie with the Village Executive Committee (VEC), supported by Gram Vikas and the biodiesel team. Responsibility for getting permission from relevant authorities (forest department in this case) for (1) collecting seeds, (2) sale and use of seeds, (3) biodiesel production, (4) storage and sale of products, as well as for (5) ethanol production, (6) ethanol storage and (7) ethanol sales to the biodiesel production unit, was expected to be with the Village Executive Committee, supported by Gram Vikas and the CNBFES team.

Raikhal was identified as the node for biodiesel activities serving a cluster of 8 villages (Table 7-1). Raikhal was chosen because 37% of the mohua trees surveyed in the cluster Raikhal-Jalior-Khalasahi-Teparda are on Raikhal land, and Mohua is a potential oilseed for use in biodiesel production. The tree counting survey indicated a total of 2273 mohua trees, 420 karanj trees and 151 kusum trees on the northern slope (Table 7-3).[50]

Watershed management was reinforced as the entry point activity for biodiesel, and it was decided that a more detailed livelihood strategy would be worked out with the communities from the villages that were included in the Raikhal cluster.

Table 7-3: Seed available in the Raikhal Cluster (CTxGreEn 2007)
Presentation in the GV Annual review

	Village	Mohua	Karanja	Kusum	
1	**Raikhal**	856	71	87	
2	**Taparada**	278	59	0	
3	**Jalior**	712	239	17	
4	**Khalasahi**	427	51	47	
	Grand Total	**2,273**	**420**	**151**	**2,844**
Rough estimates	Seeds	45,000 kg	8,400 kg	3,000 kg	56,400 kg
	Oil	*18,000 kg*	2,100 kg	*750 kg*	*20,850 kg*
	Biodiesel	Edible oil & for soap	2,000 kg	700 kg	2,700 kg
3,950	*Hours of running*		*11*	*Hours per day*	

It was decided that there would be a brief watershed workshop in Tumba (end of June06) inviting potential trainees, during which the selected candidates would be asked to begin the training in Mohuda from the month of July 2006. For the workshop cum training in Jalior in Tumba (26-30 June), Kumud invited 9 boys from different villages. The attendance kept dropping from day two onwards and finally only 4 boys continued throughout the training: Damodar, Kalia from Raikhal, Nando from Jalior, and Ghanshyam from Dhanabada. Santosh was identified as a candidate for training based on his visit to Mohuda. A second candidate had to be selected from the four boys who remained throughout the training. Based on the performance during the workshop and written reports submitted by the four boys Damodar was identified as a possible candidate. Damodar, who has earlier worked as a para-taxonomist and even trained villagers in KBTT on the natural resource survey, is the only person who willingly expressed his desire to work with the project.

(Excerpt: Minutes of the meeting4Jul06 GV-CTxGreEn Biodiesel project)

7.4.4. Watershed-integrating the different views

In keeping with the recommendations, a workshop was held with the community in the summer of 2006 (26-30Jun2006, facilitated by this research). Nineteen selected members from five of the eight villages participated in a planning workshop, in addition to three Gram Vikas field staff, a Gram Vikas watershed engineer, and a CTxGreEn staff member. There were many onlookers from the villages represented who also passively participated. The purpose of this workshop was to understand the land topography and the watershed and prioritize where work for phase I could be initiated. One of the outcomes of the workshop, other than the land use and watershed development plan, was a short orientation for the youth in Tumba about the linkages between biodiesel, agriculture and forests through a hands-on training on land and water conservation techniques (Minutes 16Sep06). The main contour bunding (stone embankment) activity for safeguarding against erosion in the Raikhal watershed was also initiated during this workshop.

At the end of the workshop two young boys from the Raikhal cluster were identified for an extended training program to be conducted at the pilot plant in Mohuda. The purpose of the training was to learn more about the biodiesel technology, and assist in preparation of the base map indicating supply nodes and demand centers in the Raikhal cluster, an input into the feasibility analysis for VLB in their community. This training was intended to lay the ground for sharing of information with the community about VLB, and was the first baby step towards setting up a biodiesel enterprise in Tumba.

Tumba Diary 2006: the Watershed workshop and mapping exercise

Jun 23: *I have been trying to figure out how to explain contours, levels and slopes to the villagers. I am quite fascinated by maps and their features but have not been able to use the information completely to navigate my way around this area myself. But I am learning…*
Jun 25*: I spent the morning drawing out a grid on a brown paper and blowing up the contour map. The idea is to translate the grid on the ground and build a scaled model. Since we are interested in a small area it seems needless to blow up the entire map. It is clear that we will be doing catchment protection of the water source identified to supply water to the village of Raikhal even though biodiesel is not going to be used as a fuel for (household) water pumping here. Using the water source as the centre I have demarcated roughly 1.5km radius as the watershed of immediate interest.*
Jun 26*: I am considering using watershed to define the boundaries of the micro-region in my exercise on planning for biodiesel. In order to be prepared for the workshop with the villagers I explored the lay of the land in the area that I had earlier demarcated- the route from the base house (where I am camped and where we will hold the discussions with the community) to the water source. I like this route- we pass a sacred grove, some bogodos (sloped land where shifting/slash-and-burn agriculture is practiced), some padar land (middle level lands that are relatively less sloping) and mohua trees (Madhuca indica) with markings from our previous counting exercise. It is a nice compact watershed. I am considering doing a transect walk with the boys who will participate in the survey after we have made a scaled model of the area on the ground. (It will be a nice way to discuss land-use and classification).*
Jun 27*: The workshop got started and after a brief introduction we got busy in groups drawing the water sources. While most of these boys have by now made myriads of maps working with the local NGO, where RRA and PRA are buzzwords, their maps seldom reflect scale or indicate directions. Initiating the construction of the scaled model was a challenge. When the groups of villagers were asked to translate their map into a three dimensional model on the ground, they understood the importance of scale in defining spatial relationships between two villages. The topography and its implication on the catchments and water flows also became apparent.*
The Raikhal team quickly built up the hills around their village and marked out the streams. As soon as the next team started working on the model they realized that their core village Badanala was below Raikhal. Raikhal had to be elevated and so they had to remodel it by filling soil to elevate it and redoing the contours. A large quantity of soil was needed as Badanala is at least 200 m below Raikhal. It also

became clear that the groups needed to coordinate with each other- higher elevation villages being located first followed by the others. Once hills and valleys were in place we used wood-ash to indicate streams.

After all the streams were drawn we realized that there were at least three distinct micro-watersheds and the challenge would be for the teams to prioritize, keeping in mind that we wanted to have maximum impact in terms of soil and moisture conservation and benefits to a large section of the community…

Figure 7-5: Land-use watershed map of Raikhal developed by the youth in Tumba

Within the Bahuda watershed centered on Raikhal, three micro-watersheds were identified around the villages of (1) Raikhal and Jalior (2) Badanala (3) Dhanabada. Dhanabada is at the ridge, the highest point on the Bahuda watershed, and is the biggest, with three big streams and at least 5 smaller ones (Figure 7-3). The impact of work carried out here would be on the village of Dhanabada alone (pop. 287), although it would also check erosion downstream. Badanala village is the lowest in the watershed and work carried out here would benefit only that particular village (pop. 112). The Raikhal-Jalior watershed (Figure 7-5) has one large stream and two smaller ones and forms the catchment's basin to the well, supplying water to the village of Raikhal (pop. 176), which in future would also be linked to Teparda (pop. 84). Farmers from the village of Jalior (212 pop.) have their lands within this watershed basin and would benefit from work carried out, as would the villages like Badanala and Khalasahi downstream. A vote was taken and Raikhal-Jalior emerged as the favourite, getting 19 out of a total of 30 votes. It is advisable to begin checking soil erosion at the top, and so logically Dhanabada at the ridge would have been the correct place to begin. However, there seemed some merit in starting work on the Raikhal-Jalior watershed, as it is smaller than the Dhanabada watershed, has multiple communities that would be positively affected, and ultimately would benefit a larger population (over 400 people).

The workshop was followed up with a smaller training program for six of the youth who had participated, on soil and moisture conservation. The watershed identified in the workshop was physically demarcated and surveyed. The Raikhal-Jalior watershed covers an area of about 40 ha and lies between two hillocks. Random plots in these areas were surveyed to assess the state of the forest and to obtain transects of the area and a broad baseline (Table 7-4).

Table 7-4: Monitoring and assessment of plots in the Raikhal watershed

	M1	M2	M3	M4	M6	M5
Grades assigned based on scoring by Tumba trainees	B	D	C	C	A	C
Latitude	19.107°	19.107°	19.102°	19.103°	19.106°	19.107°
Longitude	84.419°	84.419°	84.417°	84.419°	84.415°	84.416°
Altitude (meters)	756.2	720.4	632.2	726.8	613.1	602
Humidity (%)	57	14	56	77	81	78
Trees with girth > 30 cm (no.)	55	24	11	16	22	24
Type of trees with girth >30 cm (no.)	4	10	7	4	8	7
Trees with girth < 30 cm (no.)	35	140	27	145	35	41
Saplings (no.)	47	20	Not countable	30	50	31
Canopy cover (%)	30	0	50	20	40	10
Litter cover (%)	20	0	60	60	70	30
Dominant species (no.)	50	11	3	11	8	7
Dominant species, %	91%	46%	27%	69%	36%	29%
Dominant species, name	Sal	Sarupatri	Kusum	Sal	Keruan, Kusum	Kusum
Soil condition	Wet black. Sloping land	wet, sandy	Wet black, marshy (water stagnant)	Wet black, rich in organic content (*khatua*)	Black, organic	Wet black (*doroso*)
Duration of survey hrs:min	1:45	0:45	0:30	0:40	0:45	1:50
Location	Madhuca bada, pahada, Saragi bana, Raikhal	Madhuca bada Pahada, Banko's bogodo, Raikhal	Bada Jharana, Raikhal	En-route to Bada Jharana to Narsingh's kudia, Raikhal	Raikhal Dhenku di	Kalising Pahadi, Raikhal Bana

It appears from the table that sections of the forest deemed as sacred groves (*dhenkudi*), (M6) have higher species diversity, and trees that have a good canopy cover (40%). A healthy Sal (Shorea *robusta*) forest with several tree girths exceeding 30 cm (M4) also exists within the watershed, but this patch of forest planted by the Forest Department has less diversity of local species. The survey and the preliminary analysis were done with the workshop participants, and the state of Plot M6, which was protected due to religious reasons, was compared with Plot 2, where bogodo was practiced. Plot M1 was also discussed as the afforested patch without diversity, not the best form of afforestation. Plots M1, M2 and M5 are areas that have potential for regeneration, where species diversity could be revived and tree cover enhanced. Kusum, whose seeds are presently not being collected, grows as a dominant species in the watershed area. This is one of the potential tree-oil species suitable for use in producing biodiesel.

A land use plan of the watershed was drawn up identifying community (Raikhal land) as well as private lands (14 farmers from Raikhal, Jalior, Banabandha and Teparda) that require soil and moisture conservation measures, in addition to treatment needed on the two hillocks. The land use in this micro-watershed was assessed and indicates 60% old *bogodos* (2-5 years old) and about 20% new *bogodos*, 15% dense forest and 5% other land uses. Over 80% of the area was being used for bogodo (slash-and-burn) over different times.[51] The incidence of bogodo within this micro-watershed of 40ha (less than 0.1% of the total area of the Tumba agroecosystem where Gram Vikas is working) is very high and close to the water body. This is much more than the average for the area: remote-sensed data analysis had indicated only about 8%, including old and new bogodo, in the entire 4500 ha. This indicates that in most cases the choice of bogodo may be dictated by proximity to water sources and settlements. It seemed logical therefore to start land regeneration and reclamation activity here.

Figure 7-6: Land use map of the watershed further developed with the youth
(Map credit: Parameswar Gauda, CTx GreEn 2007)

The ridge, streams and the outlets that would be part of the watershed management plan were identified. The main aim of the watershed treatment plan would be to reduce soil erosion and augment water conservation. The ridge and the slopes of the two hills were measured, and stone rubble walls 2 feet wide, 1.5 feet high and about 2 feet long were constructed along the contours as markers. When the work of watershed protection began in May07, these markers were extended as continuous bunds at 50-60 feet intervals along the contour lines of both slopes in order to check the flow of water, and thus soil erosion. In the process of slowing down the flow of water, local water conservation would also be achieved. This would charge local aquifers and allow the forest in these pockets to regenerate, provided they were protected from grazing animals and humans chopping wood.

A proposal was put forward through Gram Vikas to the Orissa Development and Action Forum in Jul-Aug06. The budget approved for the watershed treatment was Rs 530,055 of which 10% was to be paid into a village fund[52] and 20% was to be sweat equity contributed by the community. The rest of the money was paid as wages. The work included drainage line treatment of two hillocks, starting plantations with local forest species, social forestry and horticulture. The main work of treatment to the hillocks was completed by the summer of 2007, and provided a local means of cash income to the villagers, an alternative to migration. A preliminary survey of the farmers who have their fields within the watershed was also conducted (Figure 7-6). The challenge would be to convince them to undertake soil and moisture conservation measures in their fields.

The next step in regenerating the land was identifying the community fallow land in the watershed for sowing niger. About 1.5 acres of land was taken up and local niger seeds sown. The harvest of about 80 kg seeds yielded about 20 kg of oil, which was pressed at the village using the hand press during the business demonstration at Raikhal in January 2008 (more details in the next section). Villagers were impressed by the quality of the oil and were interested in having an oil mill in their area. They realized that they pay much more when they purchase adulterated oil (~ Rs. 80 per litre or Rs. 88/kg of oil) at the market in the foothills after selling seeds very cheaply. Niger seeds were sold that year for up to Rs. 18/kg. At 25% yield, 20 kg of seeds would give about 5 kg oil and 15 kg oil cake, which could potentially generate an income of Rs. 440 from oil + Rs. 90 from oil cake – Rs. 40 oil milling charges = Rs. 490 in revenue instead of Rs. 18 x 20kg= Rs. 360. This quick calculation shows that a larger net income could be made by selling oil instead of seeds, even at the current oilseed price of Rs. 18/kg, which is at least 15% higher than in 2007. But more importantly, good quality unadulterated oil and oil cake would be locally available.

Use of oil cake was demonstrated by the CNBFES during the Apr/Jul-Oct 2008 (called kharif season in India) in the fields of two farmers in Tumba using niger oil cake and one in the village of Tamana near the pilot plant using karanj oil cake. The demonstration itself resulted in a local demand for oil cake, as other farmers saw the paddy thriving in these farmers' fields. Calculation of yields was carried out for the farmer's field at Tamana. Comparison was made between two plots, one where conventional urea (chemical fertilizer) was used, and the second plot where oil cake was used. The paddy yield from both plots is comparable. The quantity of immature seedless hulls was higher for urea in comparison to the harvest in which karanj oil cake was used. The overall paddy yield was therefore slightly higher in the case of karanj oil cake. The straw yield was higher when oil cake (karanj in this case) was used. The overall yield of paddy was about 2600 kg/acre in both plots, substantially higher than the national average of ~800 kg/acre (R. Sankaranarayanan, personal Communication, and Sept 18, 2009). There were also fewer pests in the fields, and the farmer did not have to spray pesticides as he would have normally done (R. Mallick, Personal Communication, Jan 29, 2009).[53] Oil cakes such as karanj and neem act as biopesticides as well as fertilizers. Altogether the use of oil cake is likely to be the best choice in the long run.

An important qualifier is that the amount of oil cake that needs to be applied for equivalence of performance is almost 10 times the quantity of urea. Chemical fertilizer is concentrated and has a much higher percentage of NPK (Nitrogen, Phosphorus, and Potassium) compared to oil cake.[54] Thus the requirement of oil cake needed to displace urea is huge. Local demand can only be satisfied if all the oilseed in the Tumba area (Table 7-3) is locally pressed in the hills, instead of selling oilseeds to the traders in the plain and purchasing chemical fertilizers.

7.5. Livelihood strategies: Alternative energy and biodiesel enterprise, nuts and bolts

***June 2005**. I begin climbing up to Raikhal (elevation: 572msl) from Tadaksahi (elevation 27 msl), with Kumud who has come to the foothills to pick up supplies. Two boys from Raikhal are trying to arrange for kerosene. The kerosene is to run a generator set so that they can watch movies on a CD player! The generator and the CD player have been rented from the foothills. At Raikhal as I walk in to the village and head for the Gram Vikas base house I am joined by three to four boys from the village. They instantly associate me with biodiesel and the work of the forest assessment that was carried out earlier. Debraj one of the farmers who participated in the agricultural study also joins me. Some of the boys have even visited the other biodiesel project sites to train the local villagers there on conducting natural resource surveys. One of them asks me when we were going to <u>bring the biodiesel cycle machine</u> to their villages. He says he wants to <u>make biodiesel and sell it in Tadakasahi at the foothills</u>. When asked if he would be interested in coming to the pilot plant for 6 month training he thinks that is too long: 3-4 months is possible, <u>but 6 month seems too long</u>!*

When I reach the village Jalior (elevation, 702 msl) I hear blaring music. There is a wedding in the hamlet. They have rented a 60 Volt battery to run a music system. The battery belongs to Kabiraj who purchased it 8 months ago from Hanuman Mandir in Berhampur and even has a 5 year guarantee on it. There is <u>a solar panel, a control panel and some light fittings, all of which together cost him Rs. 10,000. He uses the light fixtures in his own house, but rents the battery</u> to run a music system on special occasions like weddings.

***May 2006.** No one in Raikhal has slept all night. The wedding in Raikhal was grand as the boy's family had rented a music system, a CD player with a TV and additionally the single central village street was illuminated with florescent lights. The person renting it out, a former government school teacher Apna Pradhan from Jalior, <u>has given up a "secure" job for the sake of his enterprise. He has invested Rs. 40,000 for a 5400 watt system he says and purchased second-hand a microphone, a generator, a television, sound boxes and CD player. He charges Rs. 2000 per night, plus food and hospitality, and will set up the system in the evening and dismantle it in the morning</u>. Transportation to and from the village (on foot as there are no roads) of the equipment is the responsibility of the client, as is the provision of fuel for the generator (about 3 litres of kerosene lasts 3 hrs) and the movie CDs.*

Journal Entry, Geeta Vaidyanathan

Table 7-5: Seeds their sources and seasonality

Seeds	Sources	Time
Tullo, mahua	Forest and village land	May –June
Karanj	Forest and village land	May-June
Kusum	Forest and village land	June
Castor (kala)	Upland (bogodo)	March
Jatropha (Bada kala)		May-June
Niger	Upland and middle land	December-January

It appears that the spirit of enterprise exists in Tumba. Raw material in the form of feedstock for making biodiesel is also plentiful here: forest seeds as well as agroseeds are available for almost 6 months of the year (Table 7-5). The VLB machine configuration for Tumba includes oil milling and biodiesel production, in addition to a generator or/and pump set. This is four sets of machines on which people will have to be trained. The area is difficult to reach so the turnaround time for servicing any machine that needs it would result in significant downtime. Hence there is need for locally-trained people.

In January 2007, a demonstration of the oil press and biodiesel pump was organized at the foothills on Sunday, the day of the market, when people from the villages on the hills come down to buy and sell wares at the village in Tadakasahi. Three or four farmers that grow niger oilseeds were informed earlier and brought their seeds for pressing. The demonstration proved to be very successful, with over 24 people from 8 villages actively participating. About 27 kg of seeds were pressed and filtered over 4 hours. In addition there was a water pumping demonstration using biodiesel, during which some farmers requested an additional one hour of pumping, and channeled water into their fields. A feedback session was arranged after the demonstration in which the villagers from the Raikhal cluster expressed interest in seeing all the machines established in the hills, closer to their villages. Villagers from both Dhanabada and Raikhal wanted the machines to be placed in their respective villages. Community members from Dhanabada felt that they would be able to service villages both on the north and the south slope, and that the machines could be kept running year round as there were both forest as well as agricultural seeds available. Raikhal villagers felt that their village was more central as it is enroute to the market in the foothills. They also felt that there were many villagers in and around Raikhal who had low lands where irrigation was needed and who could pay for the service.

7.5.1. The Barefoot technician's proposal (Jan07)

A first level plan was developed by the boys from Tumba undergoing training at the pilot plant in Mohuda. The plan examines the possibility of a cluster approach, linking 6-8 villages through the supply of feedstock for biodiesel, and providing services based on the locally-produced fuel. The suggestion is that the oil press and the biodiesel reactor be located in the village of Dhanabada (see Figure 7-3 for location of village), with a mobile pump in the village of Badanala or Khalasahi. Seeds would be sourced from at least 6 villages within a 4 km range. The oil press would function not only to produce oil for biodiesel but also to provide edible oil. The mobile pump could initially service at least 50 acres owned by about 20 farmers in 5 villages, all within a 3 km radius. (Saranga & Santosh, Personal Communication, 2007) This plan needed to be developed further by mapping out the routes and exploring the practicality of moving a pump over the rough terrain. A visit to the villages by Practical Action, Sri Lanka in July 2007 opened the possibility of low cost, low maintenance, all weather roads as an immediate action to be undertaken while the biodiesel enterprise is being set up.

Individual initiative already exists among the local people, who have invested personal money in alternative systems like solar and a kerosene generator. This seems to suggest that a green enterprise based on biodiesel could be a success here. However it also seems that people are willing to spend the extra money on consumption /recreation, but when it comes to subsistence they continue to rely on age-old practices. In addition, most of the expenditure currently being made is during festivities, all of which are concentrated between the months of January to June. After that, people get busy on their farms. This is also the period when most of the migrant population returns to the village with savings from their city jobs. Any option for lighting should consider the fact that the villagers spend 4 months in their village homes and the rest in their farmsteads. Will the villagers have the ability to pay a regular tariff for lighting? Will they be willing to pay for irrigation as an insurance against droughts, given that irrigated, settled agriculture is only slowly making its way into the area? These questions can only be discussed after some pilot demonstrations are done in the area and the actual cost of the service worked out. Although enhanced livelihood options seem to be attractive to the community, especially to the older people, commitment is needed from the youth to be trained in the new technology. Whether the youth would be willing to give up their forays into the city with the excuse of earning the extra income, and put in that same hard work close to their homes, is not certain.

Experience from other villages makes it clear that the only way to find out is to start the operation there.

7.5.2. Proposal by the Tumba residents

After the watershed workshop, and following the recruitment of two boys from Tumba to be trained as barefoot technicians at the pilot plant in Mohuda, an exposure trip was organized in October 2007 for key community members (and potential entrepreneurs) from four of the villages in the Raikhal cluster of Tumba.

The purpose was to see VLB functioning at the pilot plant in Mohuda and then to further develop the preliminary plan proposed by the barefoot technicians, the youth from Tumba. This proposal was a preliminary feasibility assessment prior to installation of VLB in their community. Nine members visited the unit. After a detailed tour of the biodiesel facility they divided into groups to first understand the history of VLB-related activities in their area, and then prepare a preliminary feasibility plan for biodiesel. Five out of eight villages from the Raikhal cluster were represented during the workshop (Khalasahi, Teparda, Raikhal, Dhanabada and Jalior). An excerpt of the proposal made at the workshop[55] is presented in Table 7-6. The villagers identified multiple uses for biodiesel ranging from pumping, lighting, oil pressing and even production of biodiesel for sale.

Three hours of LED-based lighting were proposed for all the villages in the cluster, using a biodiesel generator charging a battery bank. This was the same system proposed for KBTT. In addition they suggested irrigation through a biodiesel mobile pump to enable the production of a second crop between October and March, when there is no rain and agriculture is not possible unless assisted in this manner. Irrigation would facilitate growing of vegetables, finger millet /ragi (Eleasine *coracona*) and paddy. They expected at least 4.5 acres between four farmers in four villages with water sources, where water would be needed almost every alternate day during the critical growing period. Based on their experience with kerosene based pump sets, about 1 hour of pumping was needed for a fifth of an acre. If pump sets with higher flow rates were used, the time and therefore the fuel consumption could be halved.

Table 7-6: VLB proposal for Tumba

Which machines are required?
Biodiesel reactor, oil press, oil filtration, pump, generator, grinder
Which villages do we install the machines in?
Titirising, Majhibana, Jaliar, Phulasahi
Proposal for pumping prepared by Purna, Hari, Dhanu of Tumba
Villages : Teparda, Raikhal, Dhanabada, Khalasahi, Jalior
When is water needed? October to March, everyday
What crops require water? Vegetables (cauliflower, brinjal, cabbage, tomato, chilly), Ragi, Paddy
How many times /hours of pumping? Every alternate day; 1 hour for 20 cent land
The school-teacher in Ankuli had rented his pump (without fuel): Rs. 200 was paid upfront and the pump was left in the renter-farmer's field for two months. The farmer: Sahib of Dhanabada said he has used 2 litres of kerosene purchased at Rs. 11 / litre.
Proposal for lighting: Sarathi Karjee, Saheba Bisoyi, Dasarathi
Villages: Khalasahi (16 hh) + Teparda (17 hh) + Raikhal 31 hh+ Dhanabada 50 hh + Jalior 34 hh
Hours of lighting: 3 hrs in the evening (6 to 9 pm) + 1 hr in the morning (4 to 5 am)
Lighting through battery based system
Quantity of oil/oilseed used for personal consumption
For food: 8 litres per household per year
For body: 2 litres per household per year

In this manner the community had established the need for roughly over 450 litres of biodiesel[56] for the year, just between the five villages. This would require at least 2 tons of seeds. Although a detailed inventory of trees existed for the region (Table 7-3), the villagers did their own estimate of the amount of seeds being currently collected. They calculated that there was about 600 kg mohua, 550 kg of karanj, 175 kg of castor and 170 kg of niger between the five villages. This adds up to about 1.5 tons (roughly the amount they needed), although based on actual tree count the estimate of seeds available is much higher: a best case estimate would yield 56 tons of seeds, and a conservative estimate about 38 tons.[57]

Seeds from all the trees are never collected, yet the villagers had grossly underestimated the seeds available in their area to less than 5%. Based on rough estimates of what they actually collect and sell, seed collection is about 40% of the yield (Mishra, *et al.*, 2008). It is likely that the villagers estimate, although on the low side, may have made allowance for some seeds being kept aside for selling for immediate cash, just as some of the grains from every harvest are kept aside for sowing and serve as insurance for hard times. **A major attraction of setting up the biodiesel unit in the region would be the accompanying oil pressing unit, for which the villagers felt there was sufficient local demand.** Currently every household consumes between 18-20 kg of oil (or~20litres) per annum (Survey May08,[58] Mishra *et al.*, 2008). In Raikhal alone the 31 families would consume over 600 litres of edible oil. This purchase could be offset if edible oilseeds were pressed for local consumption, in addition to inedible oilseeds for biodiesel. A more detailed analysis has established that there is locally a very high demand for edible oil in the cluster, and that the communities in Railkhal can absorb both the edible oil and oil cake, if seeds are locally pressed (Mishra *et al.*, 2008).

The configuration of the machines that were proposed by the Raikhal community members (October 2007) included the (1) biodiesel reactor (2) oil press with the filtration units (3) pump and (4) generator. Although there were suggestions of possible entrepreneurs in the community, it was considered important to conduct a profitability demonstration in Tumba, so that those interested could understand the implications of running a business. This workshop, proposed for November 2007, was finally held in January 2008. It was also decided to phase in the machines, first establishing the oil press so that the outflow of seeds is stemmed, local edible oil security is guaranteed and oil cake utilization is established in Tumba. Once the oil pressing enterprise is well established, the biodiesel reactor, the pump and generator could follow.

7.5.3. Business demonstration- Testing waters, from the drawing board to the ground.

Three of the participants of the earlier October 07 workshop, all from Raikhal village, returned to the pilot plant in Mohuda for a week's training on the business aspects of the oil press. The objective of the training was: (1) to understand how to calculate profit and loss and the running costs of the oil press, (2) prepare publicity material announcing the opening of the oil mill in Raikhal (3) pack the oil press and transport it first to the base village Tadakasahi (elevation ~200m) and (4) organize people to move it to the village of Raikhal.

Several scenarios of conducting the oil pressing business in Raikhal were discussed, including systems of barter as well as cash payment to facilitate the village customer. Finally a rate structure was agreed on (Table 7-7). It was a useful preamble to the operation of the oil mill as a business in their villages. The concept of assigning costs for milling, oil cake and labor, deciding working hours and productivity, and keeping money aside for maintenance and wear and tear of the machine, were all new concepts for the young men from Tumba. This was perhaps the first training where there was so much emphasis on the details of running an operation and on bookkeeping. The villagers quickly realized the difference between being a laborer working on a machine, and a business person running an enterprise. A simple profit loss statement was worked out with the villagers, with different oil press productivities demonstrating how the profit increased: four fold if they increased their productivity even by a factor of 1.5 (Table 7-7).

Table 7-7: Transcript of poster of business workshop for oil milling as a component of VLB

Cash payment		
Milling charge at Mandarda com. oil mill	Rs. 12/nauti	Rs. 12/8kg=Rs1.50/kg
Milling charge at Raikhal oil mill	Rs12/8kg seeds	Rs. 1.50/kg
Barter: niger exchange rate		
Selling rate at Tadakasahi market	15	Rs./kg
Buying rate at Raikhal oil milling station	12	Rs./kg
If cake and oil are taken back by farmer	2 kg seeds/nauti pressed	2 kg niger seeds/ 8 kg niger pressed
	0.5 L oil /nauti seed pressed	0.5 L oil / 8 kg niger seed pressed
If cake and oil are taken back by farmer	0.450 kg oil/nauti of seed pressed	0.450 kg oil / 8 kg niger pressed
Oil milling if cake is left behind	1 kg niger seed/nauti pressed	1 kg niger seed/8 kg seed pressed
Business case	Scenario 1, 5hrday	Scenario 2, 8hrday
Niger pressed kg per day	50	80
Milling cost	75	120
Cake cost	130	208
Income	205	328
Labor	140	140
Income-labor	**65**	**188**
Machine cost	12.5	20
Additional cost for a new machine	12.5	20
Total machine cost	**25**	**40**
Maintenance cost	**10**	**16**
Profit = Income (labor + machine + maintenance)	30	132
Assumptions		
1. Seed pressing rate on the K1OP oil press	10	kg/hr
2. Milling charge = Rs12/8kg niger seeds	1.5	Rs./kg
3. Labor rate Rs. 70 /day: rate paid in by Govt.	70	Rs./day
4. Cake cost (Rs. 4-5 /kg at Mandarda)	4	Rs./kg
5. Machine cost = Rs. 30,000 /1,20,000 kg seeds	0.25	Re/kg seed pressed
6. Maintenance cost	0.2	Re/kg seed pressed
7. Amount of cake/10kg seeds: 6.5 -7 kg cake, 3 kg oil	6.7	kg cake/kg seed

Nauti is a local volume measure, 8kg/nauti. , (BIZTRG_Tumba.xls)

One of the villagers headed back early to distribute the publicity material and make arrangements to transport the machines to Raikhal. The machine was disassembled and packed, no part weighing more than 15kg, and each of the parts was transported manually from Tadakasahi at the foothills to Raikhal, which is at 580m.

7.5.4. Local oil milling, focus of local-production-for-local-use model

The mill arrived in the village on the 21st of January 2008 and the first customer was served on the 25th of January. The mill ran in the village from the 25th of January until the 20th of March under the name of Maa Dwarshunni Oil Mill, named after the village goddess. During this period about 540 kg of seeds were pressed, of which about 450 kg was niger, 60kg was sesame and 30 kg was mustard. The last customer was served on the 20th of March 2008, after which the machine was packed up and brought back to the pilot plant.

The oil press was rated to press 10kg of seeds per hour. As is clear from Table 7-8, which is an excerpt from the books of the oil mill, even while pressing just 36 kg/day, the business could break even and the workers would be able to comfortably earn a living running their own business instead of looking for labor work. If the team could press 62 kg per day, they would be able to make a profit of Rs. 145 after deducting their wages and costs for machine maintenance.

Revenue/Expense	Rate	Break-even (Sesame) 36.5 kg/d	Best case (Niger) 62 kg/day
Daily Revenue (incl.deferred revenue)			
Milling Charge	Rs.1.90/kg	69.35	117.80
Cake sale @cake yield of 75%	Rs.4/kg	109.50	186.00
Oil sale @5%DO as FO margin & 25% oil yield	Rs.60/kg	27.38	46.50
Sub-total Revenues		**206.23**	**350.30**
Daily Expenses (including reserve/allocations)			
Labour	Rs.50/d x 3	150.00	150.00
Old m/c cost	Rs.20/d	20.00	20.00
New m/c cost	Rs.20/d	20.00	20.00
Operating/Maint Cost	Rs.15/d	15.00	15.00
Sub-total Expenses		**205.00**	**205.00**
Profit/Loss = Revenues - Expenses		**1.22**	**145.30**

Table 7-8: Excerpt of profitability analysis of oil-mill a component of VLB

Maa Dwaarashuni Oil Mill Profitability Demonstration, 24Jan08-20Mar08:
Operating structure for the mill (3 laborers, wage rates, rate schedule for milling charge, cake sale, money kept aside to repay purchase cost of current machine, reserve for future purchase of replacement machine, allocation for maintenance costs, *etc.*). Reasonable profitability can be achieved by operating the mill on a regular basis (break-even point is 36.3 kg/day; max. capacity = 80kg/day @ 10 kg seeds/hour). Mishra *et al.*, 2008

The competition from commercial mills was studied, and the advantages of the Raikhal mill compiled in order to prepare a marketing strategy. There is sufficient supply of oilseeds in the Tumba hills to cater to the local demand for edible oil. No external marketing linkage is necessary at this point (Mishra *et al.*, 2008). Just catering to the local demand would itself ensure the business profitability of the machine. Using the data collected from running the mill, a sensitivity analysis was carried out (for different productivity levels and seed mixes) and a bankable business plan developed for the machine (Mishra *et al.*, 2008). If the mill were operated for at least 182 days every year at a minimum capacity of 60kg seeds /day (~11tons of seeds/year) it would be possible to repay the loan on the machine (Rs. 20,000 loan out of a total cost of Rs. 30,000 for machine and accessories) within one year.[59] Based on the availability of feedstock, it is estimated that there is potential for at least three machines in the region.[60] The catch however, is that no financial institution is willing to lend directly to the entrepreneurs, as the terrain where the village is located makes it difficult to follow up on loan repayments.

Village Meeting in Raikhal, 27Mar08
Maa Dwaarashuni Oil Mill Profitability
MDOM Oil Seed Pressing Statistics

Sl#	Period	Seed	Qty.Pressed	Oper.'s	Remarks
1	25Jan08 – 05Feb08	Niger	46.25 kg		**Just two customers**
2	08Feb08 – 09Feb08	Niger	35.00 kg		**1 niger customer; rest of Ankuli cluster seeds gone! S*old-off*!**
3	10Feb08 – 17Feb08		0 kg		Transport niger from BD projects
4	18Feb08 – 19Feb08	Sesame	60.20 kg		18thFeb:24.7kg; 19thFeb:36.5kg*
5	20Feb08 – 01Mar08				NGO Forum @Mohuda; drying and cleaning of seeds in Raikhal.
6	02Mar08 – 09Mar08	Niger	35.20 kg		Seed cleaning continues.
7	11Mar08 – 18Mar08	Niger			2days: >60kg*** 5days: >48kg** ?days: >36.3kg
8	19Mar08 – 20Mar08	Mustard	31.9 kg		
Grand Total RKL08-MD (Niger+Sesame+Mustard)			**562.9 kg**		

*** Break-even operation ** Profitable Operation *** Max. Profit Operation**

Table 7-9: Business demonstration: seeds pressed locally

The experience of the Maa Dwaarashuni oil mill was shared at a meeting in the village (Table 7-9). As noted above, even at the base level of 36 kg /day, the mill can break even. There were days when up to 48 kg was pressed, and some days as much as 60 kg. This would proportionately increase the profits to the enterprise.

7.6. Decision making processes

The biggest challenge has been to convince the communities <u>not</u> to sell the seeds to traders, but to get together and sell oil instead. **After years of doing business with the traders, there is a circle of trust that is difficult to break into.** The traders deal with each villager individually and often buy the seeds on the paths, before they even reach the market. Often cash advances are paid as distress loans, and the farmer becomes bonded to the trader. Whatever the reason, it has become clear that **the community has to be brought together to be able to first negotiate better prices (by**

weight instead of by volume) and then to be able to make the switch to selling value-added products instead of the raw resource. Reflecting on the experience of oil pressing at Raikhal, it is clear that the Self Help Groups in the area were not leveraging their full potential. Even as seeds were being sold to traders by individual households that needed cash, seven of the Self Help Groups in the Raikhal cluster had over Rs. 85,000 in the bank (Table 7-10) and could potentially buy the seeds themselves. Three of these self help groups are from Raikhal and between them had more than Rs. 27,000. But the money could not be accessed to buy seeds, as the paper work necessary to withdraw money from the bank was usually carried out by a Gram Vikas staff, and at that time there was no one available to assist the groups. Training on banking transactions is needed for the groups. Another obstacle for the groups is that their money is currently deposited in a bank which is about 20 kms away and there is no public transport available to reach the bank, even from the village at the foothills.

Table 7-10: Self Help Groups: record of savings (workshop notes)

SHG groups name	village	date of inception	monthly collection	Saving to date
Bijaylakshmi	Ankuli		30	15,500
Maa Dwarashunni	Raikhal	Mar-06	30	11,516
Maa Ghata Taarini	Raikhal	Apr-06	30	8,668
Maa Maha Taarini	Raikhal	Apr-06	30	8,738
Maa Sarala	Teparda	2005	30	18,347
Maa Kureisunni	Masanibada	2004	30	14,850
Padmabati	Raghuballav	2003	30	7,606
As reported in the meeting at Mohuda, 24Sep 2008				85,225

Survey-tumba.xls

7.6.1. Sell in the mart not in the path

Three young girls in their late teens, inspired by Maa Suliya Self Help Group in Haripur, near Ranpur in the neighboring district about 250 kms from their village, cajoled members of their own Self Help Group - Bijaylakshmi, to collectively invest in a business instead of working individually. Until now, although the group leveraged loans from the bank as a group, they had always given the money as consumption loans or to do business individually. After visiting the poultry farm at Haripur and hearing the trajectory of growth of the Maa Suliya Self Help group, they also decided to try their hands at a group business. Since it was the season of citrus fruits, they purchased these in bulk from different households in their village and collectively sold the fruits at the haat (local market). Through this small business venture they have managed to earn wages for selling the fruits and additionally make a profit of Rs.1000/- What the group learnt was that the collective business had the ability to enhance their income by about 7 times. More importantly by working collectively they were able to negotiate prices with the traders. As a next step the women have resolved to protect all their forest produce and are discussing ways to emulate the Gundribadi Forest Protection Committee and undertake guarding their own forest. If this example of one community inspiring another sister community is nurtured, there could be a tidal wave of change beginning at the grassroot. Excerpt from tour report, Geeta Vaidyanathan, 25Sep08

"Sell in the mart, not in the path" is the new slogan of the women of Raikhal, who in September 2008 visited a successfully-functioning SHG in the neighboring district. The women realized that the collective had better negotiating power, and that by selling only in the market they could regulate prices, with everyone in the villages benefiting. Some of the groups from Tumba have started working collectively in small ways. No one has yet leveraged loans from the bank. They have, however, set up norms for a collective and have decided on ways to ensure full participation, sharing the work as well as the profits.

The women from the eight villages also started meeting together. These meetings were a forum for discussion and several promises were made: to not allow any oilseed to leave their villages, to sell oil instead of oilseeds, and to retain oil cake for their fields. The women from Raikhal promised to start guarding their forest. Women in Ankuli village were even contemplating buying the oil press, but they were quickly dissuaded by their husbands. Although the women were enthusiastic enough to arrange the meetings and even took part in the discussions, an external person is needed to facilitate the discussions. The Gram Vikas staff and the village facilitator appointed by Gram Vikas have until now been taking up this role. **With Gram Vikas shifting focus away from these villages and towards villages in the plains, this kind of support has not been forthcoming, and there is as yet no one among the community who is able to take up this role. Political and religious leadership, as well as resolution of internal disputes, are dealt with by the villagers without external support, but development has not yet been internalized as a mandate for the same leadership**. This may be changing with several of the government's infrastructure programs like the National Rural Employment Guarantee Act, stipulating local contracting and supervision of village development work.

A very important step for the success of VLB-based livelihood plan is to galvanize the SHG to act together and leverage benefits for themselves and for the region. **The SHG could be the marketing and financial support to local entrepreneurs, thereby decreasing the need for working capital loans and reducing the burden of repayment. SHGs could also be the moral conscience of the enterprise, ensuring that there is equitable sharing of resources.**

7.6.2. Individual level decision making

Decentralized renewable energy systems are a transparent technological system existing in the village. Knowing what it takes to run such a system in comparison to the convenience of grid electricity, available at the flick of a switch as long as you can pay the price (or have the ability to illegally hook onto the transmission line) can sometimes deter participation of the community. It is not surprising that community members seem happier to have the facility of running water or lighting through the least cost/least effort option. It is surprising however that they are willing to go back to their old fashioned familiar ways of hauling water from a well or using an oil lamp rather than mobilize the community in these matters. **In spite of being articulate about their priorities during initial planning processes, the women often step back during implementation of decisions and allow male-oriented solutions to take over, even if it has negative implications for them.** On the technology front, biodiesel, if implemented in a sustainable manner, requires an integration of land-based activities with the production of energy. The complexity of the process can be simplified if there is sufficient capacity in the organization (SHGs) to barter seeds for the services. However, the cash income from the sale of seeds to middlemen (often a distress sale) is more tangible than bartering it for the provision of water or electricity in the homes. Unless an equivalent economic benefit is derived it is very difficult to establish the exchange (**seeds for energy): these indigenous communities rely on the cash to supplement their income, being able to only fulfill 60-70% of their needs through subsistence farming** (CTxGreEn, 2004b). Electricity and running water continue to be luxuries that they do not necessarily think they can afford. In many of these villages water is brought to homes from hillside steams at higher elevations through gravity. After the initial effort of mobilizing capital cost subsidies, running water is available at zero operating costs. Whether this a sustainable practice, and whether such a diversion of an aquifer can truly justify zero operating costs, are debatable issues. In the short term gravity flow is more attractive than having one's own self reliant system of producing biodiesel from home-grown, self-collected seeds.

7.7. Outcomes

The CNBFES project has developed VLB into a full-scale livelihood model during the five years of its evolution from pumping water in Kinchlingi to oil milling and tilling. The commitment of VLB to food security is evidenced, in the promotion of local use of oil cake, edible oil security, by emphasizing the establishment of an oil pressing operation ahead of the biodiesel services. The biodiesel services are also strongly linked to providing timely input to agriculture in the form of irrigation, ploughing, threshing *etc*. Watershed development activity has been established as an entry point activity for VLB. The watershed activity in turn leads to assessment of natural resources (including oil bearing trees) and community fallows for initiating indigenous short rotation oilseed crops. The agroecosystem in Tumba is similar to many subsistence communities in India and even in other parts of the world. The lack of infrastructure support has been a big setback to these communities, but in a way has also been the reason that much of their forests are still intact. The communities which are dependent on their forests for their subsistence have cultural systems that ensure protection of the resources to some degree. The main stressors are those that come from the outside. Construction of roads is leading to an onslaught on the forest. Demand for tree oilseeds from the forest has hiked the price of seeds by over 50% and more of it has begun to leave the local resource base. Influx of chemical fertilizers and promotion of rice through the public distribution system are displacing indigenous crops like millets. But millets have more nutritive value and are more suitable for the agroecological base than rice, which in the present form is intensive in water and chemical input. Integration of VLB into the local livelihood system has the advantage of reinforcing all the good values of the indigenous system, while allowing it to enhance productivity of resources. Having assessed the forests and the livelihoods with the community, the CNBFES project has a clear idea about the available resources and skills (assets) in Tumba.

The discussion with the community and the development of a livelihood plan were based on the available information. The land use plan of the region indicated that bogodo (slash-and-burn) was a small proportion (less than10%) compared to the degraded forests (54%). (See Figure 7-1: Land use land cover map Tumba). Bogodo is a low-input agriculture with high biodiversity and no chemical inputs, but it satisfied only 50-75% of their needs. The involvement of the people in this activity occupies over two thirds of their time annually, primarily because the Sauras do not like to use chemical fertilizers and prefer the slash-and-burn approach instead, using the ash as the organic input to the thin soil cover. VLB in Tumba addresses this need for organic fertilizer in the form of oil cake, while also ensuring that the oil is locally used: the edible oil displaces the current practice of purchasing cheap, often adulterated oil, while the nonedible oil is value added and made into biodiesel for local use, and soap that can be marketed externally (Table 7-3 page159)

The research resulted in a series of plans that were developed in sequence. The 2004-05 remote-sensed image and land use plan was the first overlay, which was used to develop the livelihood plan (Mar 2005) with the supervisors (Figure 7-4). Discussion of the rural livelihood system of the Sauras in August 2004 with the farmer families (Figure 7-3) made it clear that the bogodo had values which should be reinforced, such as low-input agriculture, biodiversity, and diversity of high nutrition crops. It became clear that water and sanitation needs for the houses would not be the focus for VLB in Tumba. In Tumba, VLB was a means to fuel the values of the bogodo approach, while releasing the stress on the environment caused by slash-and-burn. . The idea of a cluster of villages with one nodal village crystallized here. Watershed boundaries as a way of assigning clusters also emerged in these discussions. This plan was further developed by the Gram Vikas senior staff members (in early 2005), who suggested a three-phase plan over a five-year period, beginning first with watershed and land based activities, followed by strengthening of the Self Help Groups, and finally leading to income generation activities that would be locally managed. The Raikhal cluster consisting of eight Gram Vikas focus villages was identified as the starting point.

In keeping with these ideas, a watershed planning exercise was carried out with members from villages in the Raikhal cluster (2006). A topographical map was used as a base, recreated to scale on the ground, and micro-watersheds were identified. Work was prioritized based on maximizing positive impact. The Raikhal micro-watershed emerged as the place to start. This provided an entry point for VLB (and the CNBFES), which had until then been involved only in feasibility studies conducted by village boys and local farmers. The watershed activity led to identification of community fallows, and niger was grown communally for VLB in 2007. While local demonstrations of the oil press and biodiesel pumping were ongoing, local boys were being trained at the pilot plant in Mohuda. As a follow-up to the training, the barefoot technicians belonging to the Raikhal cluster developed a plan for VLB based on supply and demand patterns in their cluster of villages. This plan was validated by older members of the community and a more detailed discussion was held on the configuration of VLB in Raikhal in October 2007. Multiple uses were suggested, including oil expelling, biodiesel production and water pumping as separate livelihood activities. Before finding a local entrepreneur to manage these units, establishing the oil expelling activity was seen to be the crucial first step. This would stem the outflow of seeds, and ensure local oil cake availability, besides making oil available for conversion to biodiesel. In January 2008, three villagers from Raikhal were given an initial orientation to business aspects. After the training, the oil press was transported to Raikhal (600m elevation), and a business demonstration established the feasibility of the business. It also made it clear that it was important to strengthen the SHGs to support the local oil pressing enterprise. SHGs with access to finance could purchase the oilseed, have it milled at the local enterprise, and sell oil cake and the oil. The mill owner would then offer a service without the burden of arranging working capital, and could easily return the investment in a maximum of two years. The assessment of the SHGs also indicated that they were the weak link in setting up VLB in Tumba.

VLB in Tumba while focusing on understanding the context (Rural livelihoods and legal and policy regime) includes agroecosystem components to scale the technology to the needs of the community. Institutions and organizations to support VLB locally are also being simultaneously developed. VLB in its present form has the potential to catalyze multiple livelihoods and create small economic synergies locally. It therefore satisfies the conditions of generating livelihood diversity and livelihood intensity, while nurturing the environment. The VLB approach also engages with local community structures such as the SHG in fostering local enterprise. This opens up access to finance and provides the entrepreneur with much needed insurance against risks. The SHGs become the medium to displace the 'middle-men' from outside, by being the interface between banks and between markets. This form of enterprise with SHG-entrepreneur symbiosis ensures much more equitable distribution of wealth, guarding against monopolies of private enterprise at least to some extent. SHGs thus become mediums to ensure connectedness between the village and the external context.

7.8. Conclusion

The SLF for VLB was used to develop the livelihood proposal for Tumba (see Table 3-1: Research proposal and APPENDIX IV: Detailed description of Project). The proposals offered a checklist for activities in the field and guided the design process. VLB in Tumba, which is a culmination of the Kinchlingi and KBTT experience, shows potential to catalyze sustainable livelihoods. It can therefore be concluded that a grassroot biofuel-based strategy such as VLB has the ability to facilitate sustainable livelihoods. A more detailed discussion on sustainable livelihood opportunities catalyzed by VLB follows in the next chapter. The relevance of the framework SLF for VLB in assessing the ability of VLB to facilitate sustainable livelihoods is also discussed.

The question of how to energize VLB so that it can move beyond the realm of pilot projects is important. In its cluster approach in Tumba, CTxGreEn is moving into the next level of replication. Strategies to overcome challenges currently faced by VLB are discussed in the following chapters.

SECTION III

Sustainable Livelihoods
and the challenges of implementation

I would categorically state my conviction that the mania for mass-production is responsible for the world-crisis. Granting for the moment that machinery may supply all the needs of humanity, still, it would concentrate production in particular areas, so that you would have to go about in a round about way to regulate distribution, whereas, if there is production and distribution both in the respective areas where things are required, it is automatically regulated, and there is less chance for fraud, none for speculation.

Mahatma Gandhi (n.d), on Village Development.

8. Conclusions of the study

Chapter Summary: This chapter concludes that VLB as a biofuel-based livelihood strategy can lead to sustainable livelihood opportunities. The main rationale leading to these conclusions is discussed, followed by an entitlements analysis.

Resilient livelihoods and natural resource sustainability are the main outcomes considered for assessment of Village Level Biodiesel. The case studies illustrate steps taken to ensure natural resource sustainability (use of oil cake for stabilizing soil nutrients, and watershed activities for forest regeneration, soil and moisture conservation). Ensuring natural resource sustainability is also a pre-requisite of the technology development process for the VLB, which has been considered in Kinchlingi, KBTT and in the proposal for Tumba. Land use, land cover assessments are tools to monitor the sustainability of the resource base. A baseline map is available for Tumba (Figure 3-6, Figure 7-1), which can be used to monitor the natural resource base of that area, over time. For the purposes of this research, we acknowledge the importance of assessing this outcome, but have not included a detailed discussion on sustainability of the natural resource base in relation to livelihoods catalyzed by VLB.

The framework, SLF for VLB (Figure 2-5: Structure of the SLF for VLB, page 29) was used in each of the case studies to identify if the VLB can catalyze sustainable livelihoods. Context specific conclusions have been included at the end of the respective Chapter. The design of the VLB in each of the villages has taken into consideration the building blocks and incorporated key elements identified in Table 2-2. However, each of the building blocks in the SLF for VLB is part of a dynamic process and decisions taken in any one building block affects the others (see Figure 2-6 page29). Overarching outcome indicators are therefore necessary for assessing trends towards sustainability. Resilience of the livelihood system has been identified as an important parameter for ensuring sustainable livelihood opportunities. Three main considerations used by this research in assessing resilience of the livelihood outcome are: (1) livelihood diversity and intensity as characterized by VLB's three-pronged approach (CTxGreEn, 2009) (2) connectedness among institutions assessed using Leach's *methodology for analysis of environmental entitlements* (Leach, *et al*, 1997) and (3) adaptation to climate change assessed using McGray's adaptation continuum (McGray, 2007). It is useful to include all these ideas into one integrated framework, combining earlier SLF for VLB frameworks (Figures 2-4, 2-5, 2-6 and 2-7). This integrated framework is presented in (Figure 8-1).

As depicted in Figure 8-1, the five building blocks fall under the three main SLF elements: (I) Rural Livelihood System and Legal and Policy regime fall under **Context**, (II) Environmental Entitlements falls under **Institutions and organizations** and (III) Agroecosystem and Appropriate technology fall under **Livelihood strategies**. Each of the building blocks is characterized in Table 2-1, page 17. Resilient livelihoods and natural resource sustainability define the sustainability of the **livelihood outcomes** catalyzed by VLB. Three parameters are used to define the resilience of the livelihood system and hence the sustainability of the livelihoods *viz*., (1) livelihood diversity and intensity, (2) better connectedness and (3) adaptation to climate change. The three-pronged approach characterizes livelihood diversity and intensity, Entitlement analysis reveals the degree of connectedness between organizations and the Adaptation Continuum assesses the climate resilience of the livelihoods.

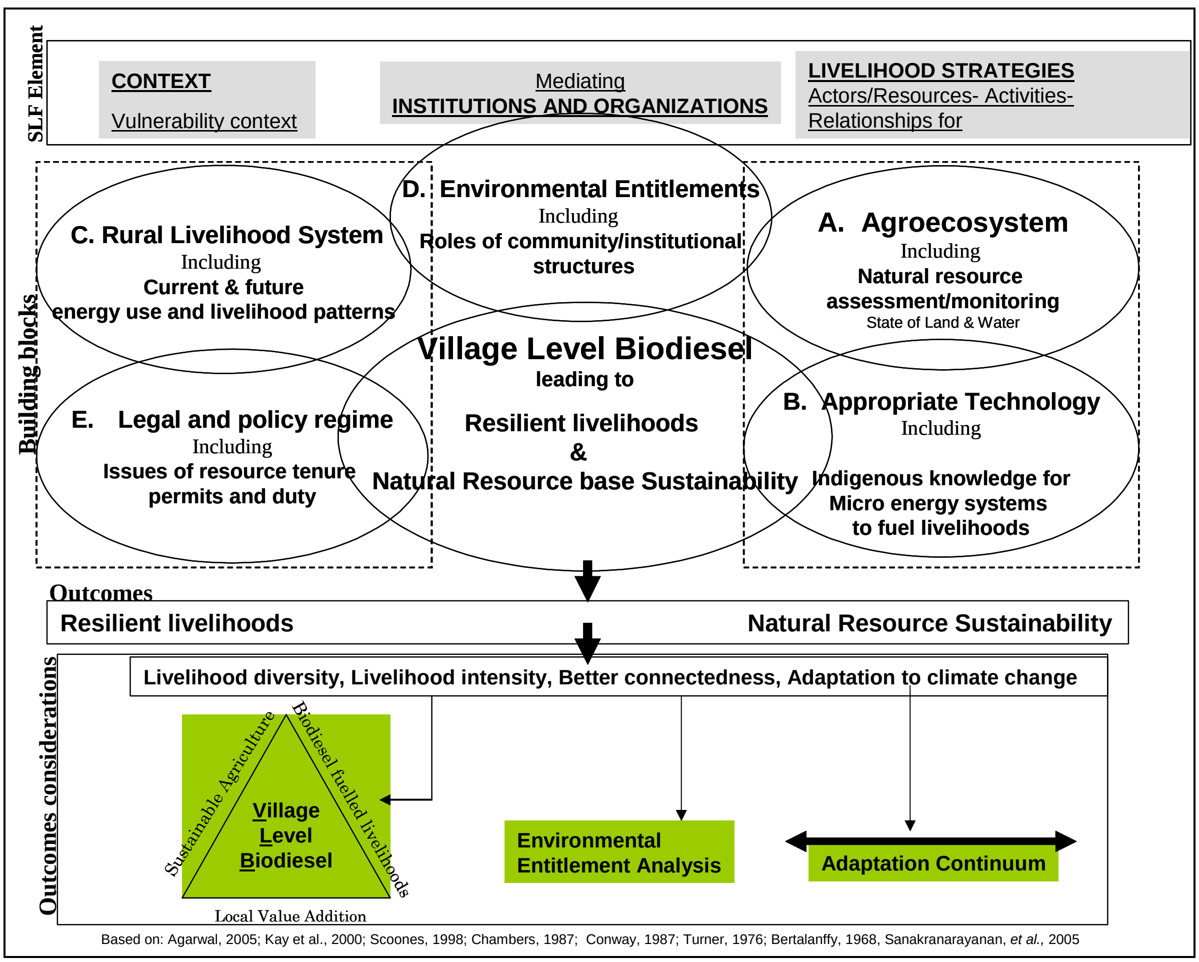


Figure 8-1: SLF for VLB reformulated to assess outcomes

Conclusions from the case studies in Kinchlingi (Sections 5.8) and Tumba (Sections 7.7, 7.8) of the case studies indicate that VLB has potential to reduce vulnerability and enhance the resilience of the livelihood system. Conclusions from the case study on KBTT (Section 6.8) highlight the challenges of implementation. In spite of having a very good plan, the implementation in KBTT was less than satisfactory. One of the conclusions from the KBTT is that the SLF for VLB could be used to prioritize action when anything new is proposed in more than one of the building blocks. For example in KBTT both the technology and the institutional system for managing the VLB being proposed were new. The focus of all the action in the field was, however, only on integration of the technology, and there was no emphasis on reinforcing the management structure. This caused a lot of setbacks leading to delays in the project.

Another important conclusion is that a rigorous assessment of community level organizations and mediating institutions is necessary to facilitate the local integration of the VLB.

In the following sections of this chapter we elaborate on some of the above conclusions. We then assess the VLBs ability to catalyze livelihoods that are resilient, defined by the three outcome considerations: (1) Livelihood diversity and intensity (2) Connectedness between organizations and (3) Adaptation to Climate Change. These are discussed in sections 8.3.1, 8.3.2 and 8.3.3 respectively.

8.1. Consolidation of lessons from the case studies

Evidence from the case studies indicates that the technology for VLB is robust and the technology development process itself enhances resilience within the community. In the case of Kinchlingi, where the agroecosystem was more vulnerable, the community was also more open to taking risks as a group than in KBTT, where availability of land and some linkages with external agencies indicated that the community was seemingly less vulnerable.

Community organizations were assumed to be strong due to the field presence of the local NGO (Gram Vikas), but this turned out to be an incorrect assumption. Still burdened with collecting the left-over loans from housing, the Gram Vikas supervisors were not interested in motivating the SHGs to take up a loan from the bank. SHGs remain the weakest link in the implementation of VLB in Orissa. The volunteer model in Kinchlingi appears to be the community's innovative way to share risks. In the case of KBTT, where the SHG-based approach was being promoted, the configuration of shared responsibility between the Self Help Groups, Village Executive

Committee and the Van Suraksha Samiti (Forest protection committees) appeared to be the more viable option. However, at this point these organizations in KBTT are not mature enough and need to be strengthened. **An important lesson has also been that when technology is a means rather than the end, it is all the more important to engage the community in the technology development process.** Such a process, especially when the level of preparedness in the community is low, can cause delays in the implementation process. It is therefore important to acknowledge this in the beginning and make the community a willing ally in the entire journey. When both the technology and management system being proposed are untested, as it was in the case of KBTT, understanding the capacity of the local institutions is useful to facilitate integration of the innovation. The SLF for VLB is a useful tool that can be used to prioritize action on the ground.

The Tumba experience lays the road map for the adoption of VLB in an agroecosystem and establishes the usefulness of the framework 'SLF for VLB' as a guiding tool in the design of a livelihood strategy. Following an assessment of the context that included the rural livelihood system and the legal and policy regime, an involved process with the different stakeholders in and outside the immediate 'community of interest' led to the development of a livelihood strategy. Combining agroecosystem and institutional aspects, a cluster approach was proposed with Raikhal as a nodal village (an agro-service centre in the making). The watershed was proposed as the basis for defining boundaries, and land and water conservation measures were taken up as the entry point. A phased implementation, starting with livelihood planning, was followed up with reinforcing the agroecosystem through watershed management activities, including planting niger on community fallows, which eventually led to the introduction of the technology. The process of technology introduction in the case of VLB in Tumba included long term training for barefoot technicians to become ambassadors of the technology.

In order to ensure food security, the first step while introducing the technology in Tumba has been to try to establish a local oil press for edible and non-edible oil. Concurrently, the use of oil cake as an organic fertilizer was also demonstrated. The process is now underway to identify a private entrepreneur to run the oil mill. The proposal for the enterprise includes a symbiotic relationship between the SHGs and the private entrepreneur, with the SHGs being responsible for buying oilseeds for milling, paying for the service at the local oil mill, and then marketing both the oil and the oil cake. The process in Tumba, which benefited from the field experience of the

Gram Vikas and CTxGreEn project staff, offers the ground rules for planning similar livelihood strategies, especially those related to small scale biofuels.

It is clear from the experience of CNBFES that this phased implementation is an iterative and complex process. It is best to focus on the building blocks individually (agroecosystem, institutions and related entitlements, appropriate technology), while tying them all together at every step of the implementation process. For example, in the case of the CNBFES experience, the inability of the SHGs to leverage financing from the bank to buy seeds almost jeopardized the oil press demonstration process in Raikhal. The business training conducted in January 2008 for community members from Tumba at the pilot plant (focusing on appropriate technology), should have included SHG members (and focused on local level institutions also). Concurrent training should have been conducted for the SHG members, leading up to the women accessing money from the bank even as the technology demonstration was being planned with the potential entrepreneurs.

We have established that the SLF for VLB is a useful tool both in planning livelihood strategies and for their implementation. In the following section, we further consolidate lessons learned by focusing on the three building blocks of VLB *viz*., Entitlements, Agroecosystem and Appropriate technology. The building blocks that have not been discussed are those defining the context, *viz*., Rural Livelihood System and Legal and Policy regime. These two blocks therefore inform the other three and are ubiquitous.

8.2. Discussion of 'SLF for VLB' building blocks

The three building blocks are discussed in the **Context** of the Rural Livelihood System of indigenous communities in the sub-humid agroecological zone of Orissa, and within the Legal and Policy Regime defined by the political economy of the State of Orissa, in India. These conclusions are therefore largely context specific, although some generic conclusions have been inferred in Section 8.2.4.

8.2.1. Entitlements converting resources to capabilities mediated by institutions

Concepts	Key components used in developing framework
Institutional mechanisms, role of stakeholders, power relationships governing access and control	
Environnmental Entitlements[61] (Leach, *et al.*, 1997, Agarwal, B., 2000) Environmentality (Agarwal, 2005) Structures/processes (Farrington *et al.*,1997; Hobley *et al.*,2000, Almas *et al.*,2003) Participatory processes (Johnson *et al.*, 2003; Classen, *et al.*, 2008) Civic driven change (Fowler, 2008; Context International, 2008)	Resources are converted to endowments when people acquire rights over them. Endowments are converted to entitlements 'through legitimate and effective command over resources,' resulting in enhanced capabilities and well-being. Meso, micro and macro level institutions moderate access to and control over resources Role of women and other marginalized groups

The Gram Vikas-CT$_x$GreEn biodiesel project has field-tested three management models for village-level production and use of biodiesel: (1) volunteer-driven (or sweat-equity), (2) SHG-driven, and (3) entrepreneurial models, respectively. It has become quite clear that longer-term sustainability and equitable sharing of benefits across the widest-possible spectrum of stake-holders are achievable only with the entrepreneurial model, even within the development-centric approach taken to-date. (The volunteer driven and SHG driven management models may yet be viable in other locations where ground realities and SHG capabilities are stronger than in the villages where these models have been tested to-date.) CTx GreEn 2008

Legal provisions and enabling policies

For effective micro-management of VLB, significant participation is needed from an informed community with a knowledgeable tier of politically active (and conscious) representatives.

The national policy for biofuels, passed in 2008, has set out an indicative target of 20% for blending of fuels (PMCCC, 2008). There is emphasis on use of non-edible oils. The suggested minimum support price for biodiesel has been set at Rs. 25/litre and includes raw material costs as well as production, testing and transportation cost to the purchase centre. Based on the cost calculation carried out for Kinchlingi and KBTT, the proposal by the government does not seem viable. The cost of biodiesel without credits for byproducts was calculated to be Rs. 57/liter, even without excise duty levied on alcohol, and without including the sweat equity component contributed by the community. With credits for soap and glycerin, this cost was reduced to about Rs. 45/ litre (Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2: Overall cost of biodiesel at Kinchlingi (June 2005 **to March 2008)**, page 81). Increased reduction in the cost is possible, if the duty on alcohol used for biodiesel production is waived. However, Rs. 25/litre does not seem feasible. The present policy clearly has a focus only on import substitution for fossil diesel, and the role of the farmer is restricted to developing plantations for energy crops such as jatropha. Even then, at Rs. 25//litre it is difficult to imagine that the farmer is able to get a fair price for the oilseeds. Leveraging the Gram Panchayat

(Village Council), which technically has the power to pass resolutions, is essential to (1) enable waivers of duty and permits for models like VLB, and to prove their validity and importance, (2) ensure that policies promoted at the top represent the interest of community organizations like the VSS, VECs, SHGs, private rural entrepreneurs and the farmers at the grassroot.

Farmers are part of both sides of the equation: supply (oilseeds) and demand (using biodiesel services for water pumping, tilling, threshing). They are key stakeholders in promoting VLB as an agro booster with the potential to fuel an evergreen revolution. VLB without doubt locates itself in the community, relying on volunteers, Self Help Groups, first generation tribal entrepreneurs and members of the community. Three approaches have so far been attempted in the promotion of VLB as a community enterprise: volunteer, Self Help Group and the enterprise-based.

The biodiesel technology has been functioning as a volunteer-driven enterprise in the village of Kinchlingi in Orissa since November 2004. Maintaining the spirit of volunteerism has not been very easy. The community now functions through a committee that is supported by young village boys who provide the technical anchor. At the community level, the youth, the Committee (a part of the larger VEC) and the SHG are the main stakeholders. There are a few prime-movers in the community, but considerable amount of mobilization is done by the NGOs.

In the second set of villages, Kandhabanta and Talataila, also in Orissa, it was anticipated that VLB enterprise would be owned, operated and managed by the women-based SHGs in the community. The success of this model will depend on the women assuming a more pro-active role in this village. A more plausible alternative is a configuration that has been suggested by the CNBFES team for the community enterprise in KBTT, which includes SHGs, VSS and VEC. The success of such a combination depends on each of the groups having differentiated responsibilities, and being composed of distinct members. This is not the case now, as the executive members of all the organizations (President. Secretary, Treasurer) are often the same people, with the NGO as the lynchpin.

In the villages of Tumba where forest seeds are in plenty, an enterprise-based approach is envisaged. This green enterprise operated by a private entrepreneur would be supported by the SHGs. SHGs play an important role by mediating purchase of seeds and the sale of finished products like oil, oil cake, soap (and perhaps even biodiesel). In this way they cushion the oil-milling enterprise. Not burdened with the working capital requirements, the mill can function solely as a service provider. With an assured quantum of work and minimal capital investment, the entrepreneur would be able to pay back his investment much faster.

Based on the analysis of the case studies in Orissa, three different institutional arrangements have emerged: (1) Volunteer based model (2) SHG-VEC-VSS combined community model (3) SHG-private entrepreneur enterprise model. The role of the SHGs in Tumba requires that they negotiate with the market and the state on behalf of the enterprise. **It may be concluded that the success of VLB as a civic-driven approach depends on going beyond links with community organizations to establish necessary linkages with the State and the Market as well**.

8.2.2. Agroecosystem producer driven process

Concepts	**Key components used in framework**
Resource base characterization of the agroecosystem	
Agro ecosystems (Conway, 1987; Altieri, 2002) Self Organizing Holarchic Open System (Kay, *et al*.,1999; Holling, *et al*., 2002; Waltner-Toews, 2004) Hierarchy (Giampietro, 1994; Tognetti, 1999) Open Systems (Von Bertalanffy, 1972; Brodt, 2001) Community tools, local agriculture (Illich, 1973; Berry, 1993) Sustainability (Gibson, *et al*., 2005; Hunsberger *et al*., 2005)	Social system and ecological systems co-exist as open systems Consist of nested structures and processes Include feedbacks resulting in constant self organization Are unpredictable and uncertain Patterns of space, time and flow define ecological systems Decision flows reflect human management processes Multiple perspectives required to understand complex systems

With biodiesel it is possible to run a power tiller, pump, thresher and winnowing fan. Biodiesel can be produced by growing oilseed. Biodiesel can be produced and oil cake is also available. The oil cake can be used in the fields (as fertilizer) for growing vegetables. This year I used karanj oil cake in my land (for my paddy crop). (As an experiment) I used urea in half the plot (as I would normally have done) and karanj in the other half of the plot. I used 30 kg urea twice, but karanj was used only once. Karanj oil cake is better than urea. There were no pests either. To buy diesel we need money, this (biodiesel) we can make ourselves. Rabi Mallick, Farmer from the Village Tamana

In another district of Orissa, cases are being taken up as “human rights violation” (FIAN, 2008) where land was leased from food growing farmers for planting jatropha *curcas* for the sole purpose of converting the seed oil to fuel. This has resulted in a shortfall in the food grain even as the farmers are waiting for the promised yield from jatropha. FAO’s voluntary guideline on “right to food for agro-fuel expansion monitoring” (FIAN, 2008) is being invoked in India to protect the livelihoods of the farmers. In addition to these reactive measures, guidelines for Strategic Environment Assessments (SEA) are being suggested as a way of informing stakeholders of possible impacts, in parallel or prior to implementation (IC, 2008; Sankaranarayanan, May, 2008[62]).

In India, the first large-scale thrust to biofuel came from an alliance between the Central Soil and Marine Research Institute (CSMRI) and Daimler Chrysler (FIAN, 2008; CSMCRI, 2005). A close look at the promoters of agro-fuels nationally and internationally is revealing: corporate alliances of multinational agri-businesses, biotech companies, oil companies (including British Petroleum BP, Exxon Mobil, Chevron-Texaco, Royal Dutch Shell), groups representing large land owners and plantation companies in the global South, new agro-fuel companies, car manufacturers, forestry companies, corporate funders including carbon trading firms and the Anglo-American military-industrial complex (FIAN, 2008).

Village Level Biodiesel is a local-production-for-local-use model, where the fuel is not being produced to feed consumptive transport, but for productive livelihoods. **The scale of the technology in this case is "tied to the carrying capacity of the land, and to the community's needs and ability to adapt to mechanization, rather than being driven by technological requirements alone"** (Vaidyanathan *et al*., 2009).

When biodiesel is used as a community tool (Illich, 1973) to produce for one's own need, using unutilized or under-utilized oilseeds and replenishing the soil with the oil cake byproduct, there is no danger of diversion of agricultural land to produce energy crops, and hence no food-fuel crisis. While economic benefit exists for the oil cake, sustainable benefits are tied in with encouraging farmers to use it locally rather than sell it. Since the knowledge of using oil cake has been displaced by the use of chemical fertilizers such as urea, VLB includes agronomic practices for oil cake application.

It is only large-scale schemes with industrial operators aiming at economies of scale that ignite the food crisis, and leave everyone poorer except the refiners and retailers of the fuel. In contrast to the agro-fuel transport model all the proponents of VLB have a direct stake in the well-being of the local ecosystem and the community. All the activities, ranging from growing the seeds, producing the fuel, selling the fuel and byproduct, and using the fuel for a range of services are all entrenched within the community and are with the men, women and youth in their roles either as SHG, VSS, VEC members or as citizens of the village. Emphasis is always on reducing cash and resource outflows from the region.

There are several challenges to this, including adequately equipping the community to handle the technology. Yet in the long run this is more sustainable.

8.2.3. Appropriate technology

Concepts	Key components used in framework
Appropriate technology inclusive of indigenous knowledge	
Intermediate Technology (Schumacher, 1979; 1999) Ecological Economics (Cleveland, *et al.*,1997) Industrial Ecology (Ayres, 1996; Allenby, 1999) Participatory technology development (Reijntjes, *et al.*,1992; Lie, *et al.*,1996; Mackay, *et al.*,1992; Scholt, 2001; Shove, 1999; 2003; Ornetzeder, 2006; St.Denis, *et al., 2008*.)	Small is beautiful Soft energy paths, Closed loop system Regenerative technology design Transformative learning (Vernooy and McDougall, 2003)

Much of (the work) centers on capacity building, the learning curve appears to be dauntingly steep given the relatively low level of literacy in the community, and the need to raise awareness and support hesitant first steps to take up new initiatives and so on. An additional threat to these efforts is the dependence of the tribals on the traders (who double in times of need as saukars or money-lenders), which skews the success of local value addition." (CTx GreEn, 2008b)

Technology

VLB is set in the context of resource-base dependent communities in the sub-humid agroecosystem of Orissa, India. The technology is scaled to the needs of the community and to the resource base, designed as a closed loop model. Unutilized and under-utilized seeds from local plant and tree species are pressed to make oil, which is converted to biodiesel that is used to fuel small farm implements to increase the productivity of resources. At the same time the oil cake, an organic fertilizer, which is a byproduct of the oil, stays within the local nutrient cycle and replenishes it (see Figure 4-1: Flow chart of the Village level Biodiesel (VLB)). **Thus the dual objective of value-adding locally and closing the resource loops is achieved through the principle of byproduct synergy. The advantage is that in the process there is minimization of waste, as the end-product of one stream becomes the raw material for another product loop.** Principles of Green Chemistry (Anastas and Warner, 1998) and green process design are incorporated. Additionally, byproduct synergies reduce the burden of costs on the community.

The importance of scale cannot be emphasized enough. The maxim that is followed is, "To maximize the efficiency of human effort, while optimizing the amount of mechanization needed" (Vaidyanathan, et al., 2009). Based on principles of Schumacher and Gandhi (Schumacher, 1979, 1995), the technology is designed to cater to the needs of the people and not *vice-versa*. Pedal power is currently used to produce biodiesel in 5 litre batches, which can be scaled up as needed. In Kinchlingi the requirement of biodiesel meant production only two or three times a month. If needed, 8-10 batches can be produced in a week (40-50 litres per week) using the same equipment. There is even a step-down motor-drive which, if needed, can be coupled to a biodiesel generator to run on electricity, if very large quantities need to be produced.

The technology itself is a complex package including (a) handling and storage of oilseeds (b) oil expelling (c) oil refining (d) biodiesel production (different for different seed-oils) (e) biodiesel refining (f) soap-making from glycerin and (g) oil cake utilization. The design process includes scaling each of the processes to a village level and setting up operating procedures to maintain quality, while keeping costs to a minimum. This has been the challenge of the technology development process. The package is unique and addresses a gap in human scale production systems. While up-scaling of technological processes is widely discussed, there is very little in the literature on down-sizing to the village level. There is also very little literature on demystification of technical training to suit the local vernacular, and on the challenges of collaborative and participatory technology design with respect to projects like VLB. VLB addresses these gaps and considers both scaling and demystification important because it is not enough that people have access to technologies, they should be able to have control over both the existing technologies and over the development of new ones (Wakeford, 2004).

Training

Training is one way of reducing risks for everyone: the community, the technology developers, the suppliers and the banks. Training is an integral part of the technology development process of VLB and is one way of handing controls to the community in a manner that ensures that the technology is an asset and not a liability. The training package includes technical and business skills. It also includes basic mathematics as well as technical hands-on and record-keeping training. Learning the business aspects, as well as understanding the social and environmental implication of the technology, is built into the package for the barefoot technicians. The training for VLB in a remote place like Tumba would be diverse, including calculating inputs for agriculture, troubleshooting generator and pump sets, and ensuring quality of fuel. This would enable the community to trouble shoot independently if required. The focus of the demonstration in Tumba in January 2008 was to establish the business profitability of the unit, but at the same time bare foot technicians were being trained in the operation of the oil press and its accessories, maintenance, log-keeping, book-keeping and assessing profit and loss. Training carried out in Raikhal village (572 m elevation) in January 2008 included young boys and girls, potential entrepreneurs, most of whom are school dropouts, with an average Grade VI education. Training the youth ensures intergenerational commitment and additionally leads to an exchange of skills and eventually to new economic opportunities. This has been demonstrated in the case of the barefoot technician from Kinchlingi, who ultimately set up his own rice-hulling enterprise, catering to his community.

Finance

In sourcing finance for local VLB enterprises, three possible options are envisaged by CTx GreEn: (1) micro finance loans, (2) bank loans, (3) grants from external agencies for the initial capital investment that will become a revolving fund. There is a certain minimum investment foreseen from the entrepreneurs, indicating their buy-in. SHGs and farmers' cooperatives can anchor the enterprise by procuring seeds and selling the finished product. Suitable microfinance organizations have to be contacted, but there is also some work to be done in helping the community understand the implications of such a loan. Currently, the villagers hesitate in taking loans, and the local rural banks are also not in favor of lending to these groups whom they deem to be loan defaulters. The profitability demonstration of the oil press in Tumba is one way of orienting these "zero-generation" entrepreneurs[22] into small business practices.

Another difficult task is to convince the SHGs to leverage their group savings from the bank to purchase seeds, to counter traders who are siphoning away all the seeds to the cities. The SHGs need to be motivated to purchase all the locally grown oilseed, press it at their village oil mill (thus supporting their local enterprise) and sell both the oil cake and the oil instead of the oilseeds. Currently each villager is individually indebted to the traders and middlemen whom they patronize and trust implicitly. Breaking out of this vicious cycle continues to be a big challenge, even for Gram Vikas, the NGO which has been working with the communities for over two decades. Developing and demonstrating the SHG-private enterprise model as well as the SHG-VEC-VSS model will be an important step in the replication of VLB.

Marketing

The three-pronged approach of VLB, which includes: (1) local value addition (2) biodiesel-fuelled livelihoods and (3) sustainable agriculture (Figure 8-2 page197), promotes livelihood diversity. In the present form, VLB has the ability to span various positions in the utilization (market) chain (Practical Action Consulting, 2009), thereby promoting multiple livelihood strategies, making it more robust as an innovation. Examples of this ability of VLB to span various positions in the utilization chain are listed below:

In Kinchlingi and KBTT, biodiesel is the main output of the utilization chain, used directly in generators and pumps and now in tillers (small walking tractors);

With the introduction of lighting in Kinchlingi, biodiesel is a productive input into another utilization chain. It is used to run a generator, which in turn charges batteries for lighting through LEDs. Biodiesel will similarly be used to fuel an oil-expeller, for pressing out oils from edible and non-edible seeds;

In Tumba, biodiesel is designed to be a byproduct of another chain. Large quantities of oilseeds are available and there is potential to use oil cake locally as an organic fertilizer in agricultural fields. This will require a focus on using biodiesel for oil expelling, to cater to local requirements of edible oil and oil cake. Biodiesel production then becomes an accompanying activity to the oil expelling operation.

Most of the products such as edible oil, oil cake and biodiesel are products that will be consumed locally, and for which there is an established market. For higher value products like soap from glycerin, marketing linkages will have to be established in future. The bigger challenge is, however, dealing with the competition. Small oil mill operators have developed a nexus with the farmers where they give them incentives and draw them to use their oil mills. The oil milling service is offered free in lieu of the oil cake, which the farmers think is a very fair deal. The farmers do not realize that the mill earns most of its revenue from resale of this valuable organic fertilizer and is shortchanging them.[63]

8.2.4. Lessons from the case studies related to the framework building blocks

The main considerations in the design of VLB as a catalyst for sustainable livelihood opportunities, inferred from the case studies, are summarized below.

- The success of VLB as a civic-driven approach depends on going beyond links with community organizations, to establish necessary linkages with the State and the Market
- The scale of the technology is tied to the carrying capacity of the land, and to the community's needs and ability to adapt to mechanization, rather than being driven by technological requirements alone

- Criteria for development of the technology are maximizing the efficiency of human effort while optimizing the amount of mechanization needed; value-adding locally and closing the resource loops through byproduct synergy.

A summary of other conclusions from the preceding discussion in Section 8.1 and 8.2 are:

1. When technology is a means, a community tool rather than the end, it is all the more important to engage the community in the technology development process. The technology and the technology development process itself can enhance resilience within the community.
2. In order to ensure food security, the first step while introducing the biodiesel technology is to try to establish local oil presses for edible and non-edible oil and concurrently enable the use of oil cake as an organic fertilizer.
3. During implementation, after defining the context (rural livelihoods and legal and policy regime), it is best to focus on the building blocks individually (agroecosystem, institutions and related entitlements, appropriate technology). It is however important to tie them all together at every step of the implementation process. A detailed analysis of institutions and organizations that mediate access to and control over resources is very critical prior to implementation.
4. The SLF for VLB is a useful tool both in planning livelihood strategies and for their implementation. The framework can also be used to assess the situation, classify information under one of the five building blocks and accordingly prioritize action on the ground.

The discussion indicates that VLB in Kinchlingi and KBTT has been designed keeping in mind all the building blocks of the framework, SLF for VLB, (Agroecosystem and Appropriate technology, through Entitlements, in the context of Rural livelihoods and the Legal and policy regime), and has also attempted to include the components defined in Table 2-2. While the strength of the VLB has been the integration of technology with agroecosystem components, its weakness has been on leveraging local institutions to anchor the VLB. The SLF for VLB has however helped to identify the weak links and the strategic remedial action (see also Chapter 9). In the following section we use outcome considerations and Figure 8-1 to ascertain whether VLB designed in this manner has the potential to catalyze livelihoods that are sustainable.

8.3. Assessing resilience of VLB

The main considerations for assessing sustainability and resilience of livelihoods, as defined by this research are reviewed here:

- **Potential for livelihood diversity and intensity catalyzed by VLB**. Livelihood diversity is defined as a single source of income being replaced with multiple livelihood strategies. Enhanced livelihood intensity enables communities in different agroecosystems and socio-cultural milieu, with differing degrees of access to resources to generate (i) their own mix of solutions and (ii) small scale economic synergy (Chambers, 1992).
- **Connectedness of the institutions involved in the decision making process,** Connectedness is assessed using the IDS methodology for analyzing environmental entitlements (Leach *et al*., 1997). More connectedness between the micro, meso and macro level is indicative of more of the environmental goods being converted to capabilities for the community. Better connectedness is also an indicator of more resilience in the system (Holling, *et al*., 2002).
- **Adaptation to Climate Change**. Adaptation to Climate Change is defined as the potential of the livelihood to address drivers of vulnerability at one end while confronting impacts of climate change at the other. Resilience of livelihoods is defined in terms of this capacity to span the entire continuum of adaptation approaches as framed by McGray (2007).

In the following section we examine the resilience of the VLB for each of the three outcome measures mentioned above, and draw some generic conclusions.

8.3.1. Livelihood diversity and intensity

CTx GreEn (2009) consciously distinguishes the Village Level Biodiesel as a 'no-conflict' model[64] fuelling an evergreen revolution through a three-pronged vision (Figure 8-2).

The three-pronged livelihood strategy, which is a culmination of lessons learned in Kinchlingi, KBTT, and Tumba, includes:

1. **Local value addition,** through manual pressing and sale of edible oil instead of sale of oilseeds, oil cake as fertilizer and animal feed and production and sale of glycerine soap, contributes to livelihood diversity
2. **Biodiesel-fuelled livelihoods**, consisting of biodiesel production and use, oil expelling, multipurpose tiller, generator set, battery banks and battery powered LED lighting, provide avenues for small scale economic synergies
3. **Sustainable agriculture**, leading to second crop irrigation and cultivation, improved soil fertility, watershed development, soil and water conservation, forest regeneration and re-plantation of native species, enhancing the basket of options, leading to livelihood intensity

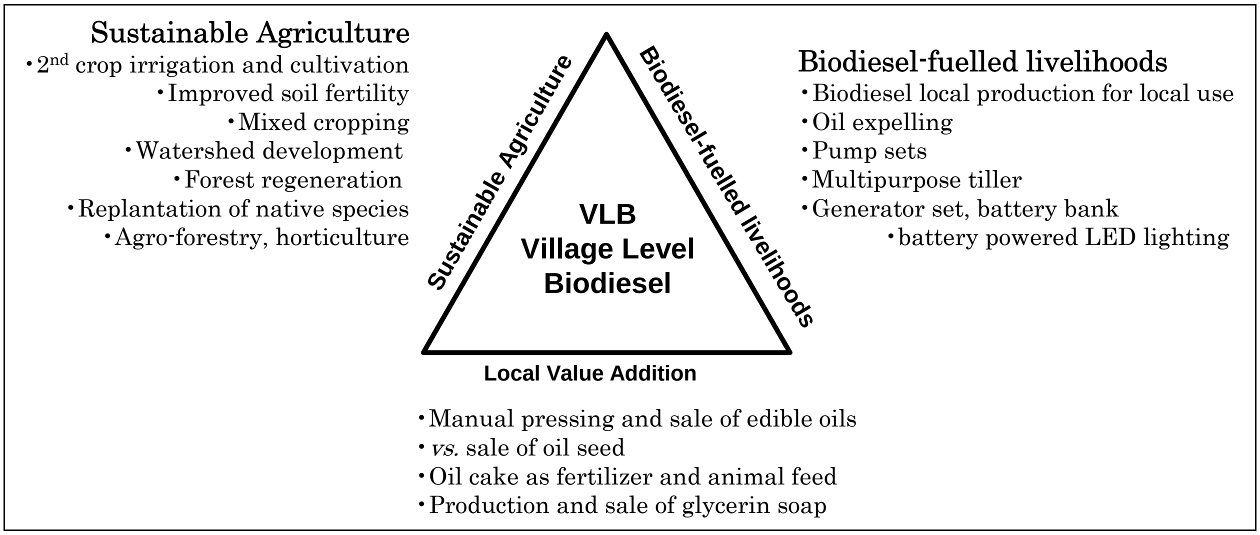


Figure 8-2: Three-pronged livelihood strategy of VLB (CTxGreEn 2009)

Activities listed under each of the three heads are indicative and based on the lessons learned in the villages of Orissa, India. They may be extended, depending on the local context, to other agroecosystems (CTxGreEn, 2009). Conceptually, local value addition contributes to byproduct synergies and provides an important input to sustainable agriculture and biodiesel-fuelled livelihoods. Examples of such synergies are (1) use of oil cake locally in agriculture, thus closing the nutrient loop, (2) edible oil self-sufficiency and (3) production and sale of soap made from glycerin, reducing the outflow of finances. The advantage with local value addition as is reflected from the discussion on the costing of services provided in Kinchlingi and KBTT (Ref. BD cost_04_08-GV-RS-rev3.xls

Table 5-2, page 81 and Table 6-5 page 126) is that it reduces the cost of biodiesel. Thus, while there is more money being retained in the economy, this also subsidizes the cost of fuel for local services.

The new definition of VLB as a three-pronged approach ensures local economic development with minimal damage to the environment. The VLB contributes locally by regenerating the soil and forests, and globally by offering low emission alternatives. VLB is a workable, replicable livelihood strategy that promotes livelihood diversity, livelihood intensity and small scale economic synergies. The three-pronged approach directly addresses three out of five of the building blocks of the SLF for VLB: agroecosystem, and appropriate technology in the context of rural livelihoods.

Irrespective of whether sustainable agriculture, biodiesel-fuelled livelihoods or local value addition is the starting point, it is important that the three-pronged approach of the Village Level Biodiesel is taken forward as a package. It is clear from KBTT that without activities for sustainable agriculture and value addition, biodiesel-fuelled livelihoods are less likely to result in sustainable livelihood opportunities. As was shown in Kinchlingi, byproduct synergies reduce the burden of the technology, and good feedstock yields reduce cash outflow. These are factors which ultimately contribute to the sustainability of the livelihood within the forest-agroecosystem.

While appropriate technology can assist in maximizing local use of agroecosystem resources for food and energy security, the issue of access and control of the resources is mediated through institutions and organizations. Environmental entitlements analysis therefore is important.

When the preferred mechanism for change is civic driven, community arrangements are necessary, which may include more than one community level organization that has the ability to mediate between the State, the Market and the formal and informal structures in civil society. Several such community arrangements are possible, some of which have been identified by this research. Those identified by this research are:

1. Volunteer driven approach as in Kinchlingi but with a strong prime mover (preferably outside of the facilitating NGO)
2. Community enterprise as in KBTT consisting of the Self Help Groups-Village Executive Committee-Van Suraksha Samiti, (SHG-VEC-VSS) combination and
3. Symbiotic relationship between a private enterprise and the SHG as proposed for Tumba. Each of these community arrangements are dictated by their own unique way of sharing the risks involved. They also have the institutional structure necessary to mediate micro-macro relationships.

In the next section we examine the nature of decision making, and linkages between organizations at the micro, meso and macro levels, necessary to make VLB a viable community enterprise**.** The analysis is preliminary in nature and a work-in-progress. Early findings have been presented to emphasize that **beyond identifying community arrangements needed to drive the civic-process, an analysis of entitlements is necessary for the success of any community enterprise.** The analysis that follows, identifies informal arrangements and linkages beyond the 'narrow emphasis on community-level organizations,' increasing the possibilities of external support

(Leach *et al.*, 1997, p.29). Enhanced linkages also imply better connectedness between organizations mediating livelihood-resources, and make the livelihoods catalyzed by VLB more resilient (Holling *et al.*, 2002).

8.3.2. Decision making and Environmental Entitlements

The analysis of decision making was a three step process.

The first step was to list all the relevant VLB actors and locate them on a two dimensional matrix (based on Uphoff, 1992). The matrix locates the actors according to the levels at which decision making is currently taking place (government, NGO, collective and private) and the level where administrative action takes place (macro = international, national, micro = state, district, block, meso = gram panchayat, village, groups, household).

This matrix identifies the level at which most of the decision making for VLB is concentrated. Three very detailed matrices were developed in this manner (see APPENDIX XII).

As a second step, key actors were short listed from the detailed matrices and compiled into a table containing all the three levels: micro, meso and macro (see Table 8-1).

The third step was to use Table 8-1 and select actors that facilitated two of the activities that are critical for the replication of VLB:

1. Exemptions under the excise law (alcohol use for biodiesel) and
2. Access to forest produce (seeds for biodiesel)

The selected actors were then mapped on the environmental entitlements framework to understand the linkages between VLB and organizations above and below it that mediate access to resources with respect to alcohol and to forest produce, both of which are ingredients used in production of biodiesel.

Based on the detailed matrices developed in Step 1 (see APPENDIX XII), the following section discusses the next two steps in the analysis:

Step 2 Decision making matrix (Table 8-1) and

Step 3 Environmental Entitlements analyses (Figure 8-3).

__Step 2 in the analysis: Decision making matrix (based on Uphoff, 1992)__

Table 8-1: Selected units indicating levels of decision making for VLB

	Levels	Governmental/ Quasi-Governmental	NGO / NGO-organized	Participatory /Collective	Private/Quasi-Private
	International	CBD	FAO, ENERGIA	Volunteers	CTxGreEn
MACRO	National	Nat Action Plan o Climate Chang New&Ren Energy Min Nat BiofuelCoordComm Nat Policy on biofuel	Gram Vikas		Enviro Legal Defence Fund
MESO	Regional /State	Panchayati Raj, Excise, DST, Forest&Env Khadi Vill Ind Comm., Nat Bank for Agri.& Rura Dev, Banks, Micro Fin Instit.	ODAF, Gram Vikas	VLB Working Group	Machine Suppliers: Kirloskar generators Usha Kiran tillers Jagannathprasad Inst Tech Mgmnt.
	District	Micro Fin Inst –BASIX *etc.* Dist Rural Dev Agency, Dept. Sc.& Tech. Prin.Chief Cons. Forest Oriss Forestry Sec.Dev. Pr	JICA		Retailers SME oil mill owners
	Block	BDO, Police, DFO Lead banks	VLB units RHEP team		Local markets, Traders Local oil mill owners
MICRO	Locality/ Gram Panchayat	Gram Sabhas Community Police Forest ranger	Area committees VSS	SHG Federation Forest Federation	Weekly-Markets, Tribal brewers Money lenders
	Villages	Ward member *Agriculture extension worker* *Forest Guard*	Gram Vikas VEC, SHGs Barefoot technician		Ago-service centres Rice-huller (ex –VLB technician)
	Groups	Govt. Health Worker	SHG run VLB	Volunteer run VLB	Oil expelling VLB BD services
	Households	Voters	SHG members	Youth, Women, Men	Farmer MFP seed collectors

Government Linkages

Civic driven change

Civic driven change

BDO=Block Development Officer CSMRI=Central Salt and Marine Research Institute, JICA=Japan International Cooperation Agency, JITM=Jagannathprasad Institute of Technology and Management, MFI=Micro Finance Institution, MFP=Minor Forest Produce, NABARD=National Bank for Agriculture and Rural Development, NBCC=National Biofuels Coordination Committee, NREM=New and Renewable Energy Ministry , ODAF=Orissa Development Action Forum, Panchayati Raj= Local Decentralization, OFSDP= Orissa Forestry Sector Development Project, PCCF = Principal Chief Conservator of Forest, RGVEP=Rajiv Gandhi Village Electrification Program, SME= Small and Medium Enterprises, VSS=Van Suraksha Samiti, Forest Protection Committee

Most of the decision making for VLB is currently concentrated at the lower half of the Table 8-1 and along civil society organizations. Decision making being concentrated at that level indicates a grassroots process. The strength of a civic or grassroot process depends on a strong foundation at the micro-level, and adequate nurturing from an umbrella of regional, national and perhaps even international bodies (nested support). Strong connections are needed between the Market on the right and the State on the left. From the case studies it appears that some effort is being made to bridge over to include the Market at least at the Block level (competition with oil mills is acknowledged and a strategy is accordingly being suggested in the CNBFES. Similarly the middle men as an obstacle are also acknowledged). However, these elements of the Market have to be positively linked to VLB. More connections are also needed with actors in the government, located on the right side in the table.

The Panchayati Raj (Local Governance) Ministry and the Ministry of Forest and Environment along with the National Bank for Agriculture and Rural Development can reinforce the SHGs, VSS and VECs for VLB through existing programs. In the process they can also assist individual farmers and private entrepreneurs. It is not only financial support that is required for these green grassroot enterprises. Training supports are also needed to direct their skills towards business development. The Panchayati Raj Ministry and the Ministry of Rural Development in Orissa have several schemes,[65] which can be creatively channeled to develop VLB into a full-blown civic-driven process. Currently, while VLB has the making of a strong civic-driven process, it needs to be adequately bolstered through State Government and Central Government support**. At the micro level VLB needs to draw synergies from government bodies like the Gram Sabha (Village Council) to be able to negate competition from private operators that are a conduit to resources from the region.** These linkages are indicated by the block arrows in Table 8-1.

In addition to **creating convergence with the government program,** policies and acts that are in place can be leveraged to assist in the replication effort for VLB. At the national level, the National Action Plan for Climate Change 2008 (PMCCC, 2008) addresses climate change through eight core national missions, and biofuels has been obscurely included under the solar mission. There is a National Biofuel Policy (MNRE, 2008) but it is not relevant to VLB as a local-production-for-local-use model. However, with devolution of power to the village council (Gram Panchayat) through the 73rd amendment, there are several policy and legal provisions that can be leveraged to assist local economic development. Of relevance to VLB are (1) Forest laws in operation in Orissa (2) Orissa Excise rules 1976, (3) Policy Guidelines for Raising of Energy Plantations and Biodiesel Production (Govt. of Orissa, 2007), and two specific acts with special provisions for indigenous communities: (4) Panchayats Extension to Scheduled Areas act 1996 (PESA) and (5) The Scheduled Tribes and Other Traditional Forest Dwellers (recognition of forest rights) Bill 2006. In light of several existing enabling policies and associated actors at the macro, meso and micro levels (macro = International, national, micro = state, district, block, meso = gram panchayat, village, groups, household) it would be useful to map them on Figure-3-3: Environmental Entitlements to understand how they enable access (Endowments: Stage 1) and control (Entitlements: Stage 2) over environmental goods and services and facilitate their conversion into capabilities (and in turn into sustainable livelihood opportunities: Stage 3, Figure 8-3).

Step 3 in the analysis: Environmental Entitlements Framework (Leach et al., 1997)

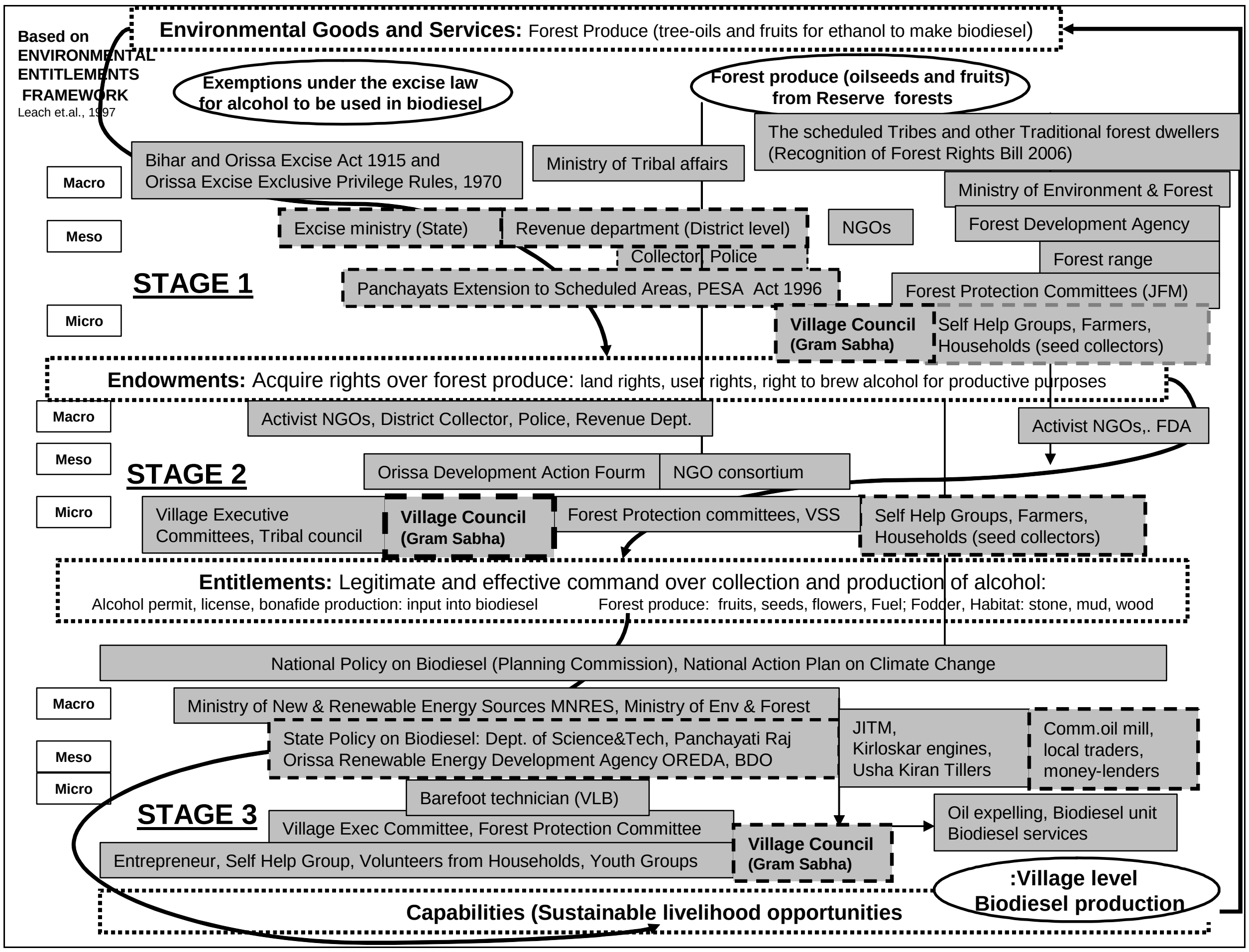


Figure 8-3: Environmental Entitlements analysis of VLB

Organizations mediating transformation of environmental goods into sustainable livelihood opportunities

The methodology for Environmental Entitlements, EE analysis is used to facilitate understanding of how resources can be accessed and converted into opportunities for livelihoods. Two of the main input materials for producing biodiesel are oilseeds and alcohol. Seeds can be from agricultural or forest sources. For the present, in this research, we are analyzing only the issue of access to resources from the forest, and agricultural seeds have been left out of this analysis. The second input, alcohol, is currently being purchased, but will be produced from waste fruits locally in future. CTxGreEn is making a case for duty waiver on alcohol used for biodiesel, both for procuring alcohol and for producing it locally. As already mentioned, EE analysis has been carried out for two key issues surrounding these inputs into VLB. These are:

- Exemptions under the excise law and
- Access to forest produce.

The map developed for the EE is only indicative at this point, but it can be used to make some inferences about reinforcing VLB in Orissa. The dotted boxes denote linkages that are currently being developed. The CNBFES project is struggling at Stage 1 with respect to leveraging excise exemptions. In the case of forest produce, linkages have been only informally forged. If we examine how the communities can access resources for their own well being, we can locate organizations and provisions under the law, which will mediate their access. These institutions, organizations or provisions are listed below:

- Endowments: The Forest Rights Bill (Gazette of India 2007) enables the communities to acquire rights over forest produce. Similarly the PESA (Ministry of Panchayati Raj, 1996), which has allowances for tribals to brew alcohol for their own consumption, enables them to acquire the right to locally produce alcohol.
- Entitlements: The regulatory authority for both these issues is the Gram Sabha, which can pass a resolution waiving the duty for alcohol. The communities are, however, not aware of the provisions under the new Acts and a process of awareness generation leading up to passing of the resolution can open up the bottleneck. The CNBFES is working with organizations like the Orissa Development Action Forum (ODAF) to enable this.
- Capabilities: Current policies do not favor VLB. The role played by commercial oil mills and the money lenders also needs to be converted into a positive feedback for VLB. These are two obstacles to the replication of VLB. The Gram Sabha can to some extent negate the effect of both these factors as it is responsible for village development activities. The Gram Sabha could also be the medium to negotiate for inclusion of the principle of ‘local-production-for-local-use’ and VLB into the State government policy for biofuels.

Currently CTxGreEn and Gram Vikas are working towards that end, but it would be of advantage to include Gram Sabha members formally in the discussion with the state government officials. If we look at Figure 8-3 we see that the Gram Sabha (Village Council) occupies the liminal space between State bodies and the Market structure. This position is probably representative of other civil society organizations also. What is unique about the Gram Sabha however is that it is empowered to act on behalf of the State (due to devolution of power) and can in this role also regulate the market to suit the needs of the village. The Gram Sabha could facilitate the exchange of technology and knowledge and be the prime-mover for VLB and other such opportunities for sustainable rural livelihoods. The role of the Gram Sabha is similar to institutions that govern access to common property resources. The above argument is supported by inferences about institutions associated with common property resources, where Anderies (Anderies, Janssen and Ostram, 2004) argues that the link between resource users and public infrastructure providers determines the robustness of a socio-ecological system.

To deal with the legal and policy issues it is the Gram Sabha as a part of the Gram Panchayat[66] that needs to be empowered. Demystification of the existing policies dealing with excise and forest produce is necessary, especially those pertaining to biodiesel, and their ramifications need to be explained to the Gram Sabha members. An empowered Gram Sabha can then contribute to increasing the power of the VSS, VEC and the SHGs. This is the concept of mutuality as proposed by Korten (1987a), where the power of one is increased by enhancing the power of others. This is also the concept of Gram Swaraj or village republics as suggested by Gandhi, here the element of self reliance comes with a political role.

This analysis has only shown the existence of enabling structures in the context of the rural livelihood system of forest communities and the legal and policy regime as it exists in the state of Orissa. A more detailed analysis, conducted with the community could reveal other provisions that exist which can be leveraged to promote the VLB.

Another point highlighted by the analysis is that even civic driven approaches, do not exist in vacuum, and therefore local level institutions need to negotiate with the State and the Market, so that the benefits can start flowing to the grass roots.

Convergence with the State

With the intent of discussing potential roles that the government should assume to facilitate Village Level Biodiesel production, a stakeholder meeting was organized by the CNBFES, supported by this research. The meeting held in March 2009 had participants from the state bureaucracy (Government of Orissa), bilateral agencies, NGOs and community representatives, and was held in Bhubaneshwar, the capital of Orissa (CTxGreEn and ELDF, 2009). The workshop was a call for recognition, policy and implementation support to replicate VLB. The focus of the workshop forum was to discuss:

- the local production for local use biodiesel model and challenges to replication of the model when recognition, policy support and implementation support for these models are not forthcoming, and
- whether the current policy and the legal framework supports the local-production-for-local-use biodiesel model

It was a very successful meeting with a wide ranging participation from NGOs (41%), media (19%), government and affiliated organizations (18%), educational (6%), private sector including individuals and firms (13%) and bilateral organizations (3%) (CTxGreEn, *et al*., 2009). Two major issues facing VLB were summarized as being technology replication and policy barriers. With respect to the policy barriers it was noted that there were windows of opportunity that could be used to facilitate a government resolution in favor of VLB. With respect to replication, a call was made for partnerships with other NGOs and research organizations and a suggestion to link VLB to the Tribal Development Plan for Orissa. Areas of convergence pointed out by the Chief Secretary, Government of Orissa included conducting training with government support, and availing financial and marketing support through existing government schemes. The Secretary was also in favor of amendments to the excise law to support VLB, and requested a draft outline for a bill that could be further discussed with concerned officials.

VLB, although a community-based micro energy system with potential to catalyze sustainable livelihood opportunities, needs to be reinforced through linkages with the State in order to move forward, beyond the pilot implementations. Nesting (Anderies et al., 2004) the community level organization with in a series of umbrella organizations, beginning with the Gram Sabha, could be a way to build the bridges with organizations at the State level.

We have discussed how the VLB livelihood strategies (livelihood diversity, livelihood intensity and small scale synergies) build resilience of local livelihoods. We have also identified how the VLB can be reinforced through institutional arrangements that enhance the connectedness of the local level organization with organizations at the meso and macro level. While each of these characteristics reduce vulnerability and enhance the capacity of the livelihood to recover from shocks and stresses within the micro-climate, the livelihood system may be vulnerable to impacts of climate change.

8.3.3. Adaptation to Climate Change

Vulnerability, a concept discussed by Chambers (1992) and Scoones (1998) with respect to sustainable livelihoods, is mirrored in the concept of adaptation to climate change (IPCC, 2007; UNFCCC, 2007). Chambers pointed out that livelihoods and human beings are both vulnerable to stresses and shocks. Vulnerability according to him has two aspects: an external aspect, being the stresses and shocks that communities are subject to; and an internal aspect, the capacity to cope (Chambers, *et al*., 1992). A livelihood 'is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation' (Chambers, *et al*., 1992, p.7).

The United Nations defines adaptation as the process by which communities make themselves better able to cope with an uncertain future (UNFCCC, 2007, p.10). Concerned with the rapidness of changes due to the rise in global temperatures, the UNFCCC (2007) recommends implementation of national adaptation plans to reduce the vulnerability of developing countries to climate change. VLB offers a path that has potential to avoid CO_2 emissions, while at the same time promoting sustainable development in communities that are infrastructure starved. In essence, it provides *an ideal link of action at the micro-level with macro-level policymaking, and the potential to use community-based micro energy initiatives to translate the concept of 'adaptation' (as suggested by IPCC, 2007 and UNFCCC, 2007) into solutions that can be implemented*. Additionally, the case studies have indicated that when livelihoods are closely coupled to the agroecosystem (for example in the case of niger cultivation for biodiesel, see APPENDIX VI for details of narrative), adaptation strategies for managing climate risks and confronting impacts of climate change, become important.

We accordingly expand the definition of sustainable livelihoods, which currently addresses vulnerability and enhancing capabilities (Chambers, *et al.*, 1992, p. 7), to explicitly include managing climate risks and confronting climate change impacts (Also see Chapter 3, Section 3.7.5, page46). Defined in this manner, a sustainable livelihood approach is explicitly linked to more resilient outcomes,[67] provided it includes multiple strategies that range from a focus on development to climate adaptation (Mc Gray, 2007). This definition further qualifies our earlier definition of livelihood diversity and livelihood intensity. This also further affirms and emphasizes the argument that the outcomes of a sustainable livelihood strategy are best assessed as a *moving target, against a dimension of time, within a spectrum of niches that they respond to*, rather than as a narrow frozen indicator.

This research assesses the resilience of VLB in Orissa, defined by the sustainable livelihood framework, within this development-adaptation continuum (see Figure-3-5: Adaptation Framework (McGray, 2007). Figure 8-4 demonstrates how in assessing the livelihood outcome of VLB in the cases in Orissa, almost the entire continuum is spanned:

1. VLB providing fuel for water and sanitation addresses 'drivers of vulnerability';
2. VLB initiating watershed activities and providing integrated training on biodiesel addresses 'building response capacity';
3. VLB helps to manage climate risks by
    - reducing CO_2 emissions, replacing diesel and kerosene with biodiesel, and chemical fertilizer such as urea and the practice of slash-and-burn with the use of oil cake;
    - promoting short-duration crops and regeneration of indigenous species like pongomia as multiple feedstock sources;
4. VLB helps farmers to confront impacts of climate change by enhancing the potential for second crop irrigation and promotion of drought resistant crops (in the case of VLB in Orissa, 2004-09, this included short duration niger crops and *ragi*, a form of lesser millets).

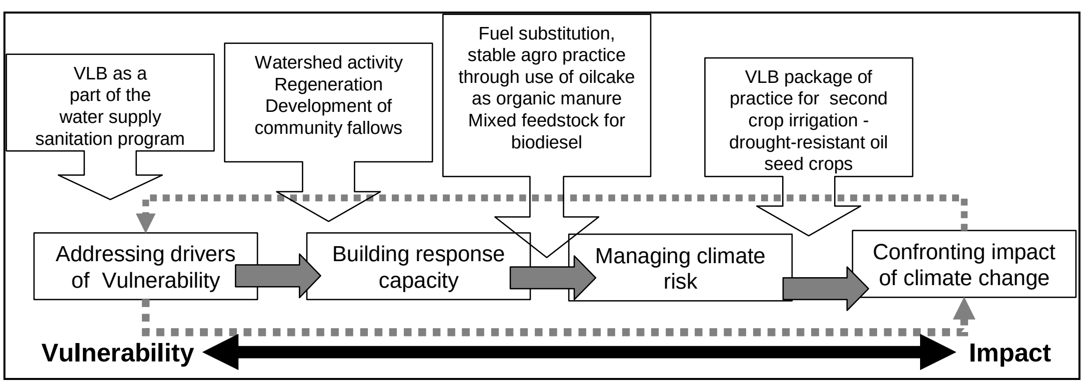


Figure 8-4: VLB in the adaptation continuum (based on McGray, 2007)

A resilient VLB by definition catalyzes livelihoods that span the entire continuum and are not restrained to the 'vulnerability' or 'impact' end. Figure 8-4 demonstrates the utility of McGray's formulation for SLF purposes, and illustrates how each of the case studies are important for adaptation research, even though they are not explicitly about climate change.

This conclusion complements the effort of the World Resources Institutes (WRI), which recommends that funders for adaptation in developing countries should finance efforts for vulnerability reduction and capacity building, along with those for managing and responding to climate risks (Mc Gray, 2007). It is the conclusion of this research that designing strategies that result in livelihood outcomes that span the entire continuum, could be another way to enable development while keeping climate concerns also in focus.

8.4. Conclusion and important findings of the research

8.4.1. Generic conclusions

The SLF for VLB (consisting of Figure 2-3, Figure 2-5, Figure 2-6 and Figure 2-7) has been integrated into a single framework to assist in evaluating sustainability of outcomes, defined by resilience of livelihoods (Figure 8-1). Natural resource base sustainability and resilience of the livelihoods are two important considerations of livelihoods that are sustainable. This study focuses on resilience of livelihoods, and has identified three main outcome considerations to determine resilience of livelihoods. These are (1) livelihood diversity and intensity, (2) connectedness of micro, meso and macro organizations and (3) adaptation to climate change.

While the SLF for VLB is useful in identifying community arrangements for a civic process, the entitlements analysis takes this further by identifying linkages necessary with the State and the Market to ensure that the entitlements are converted to capabilities for livelihoods. Another finding of this study is that analysis of linkages and engagement between institutions is essential for community-driven change.

The importance of assessing outcomes in the sustainable livelihood framework as moving targets against time, and within a spectrum of niches, rather than as a series of frozen indicators is another finding of this research. This research proposes using the Adaptation Continuum (Mc Gray, 2007) as an assessment tool, as it provides a framework for looking at livelihoods through a climate responsive lens (see Figure 8-4).

Previous definitions of sustainable livelihoods address vulnerability (Chambers and Conway 1987, Scoones 1998). We suggest that the definition be reframed to include response capacity and ability to manage and confront climate risks, in emphasizing resilience. Accordingly one conclusion of this research is an expanded definition of processes for catalyzing sustainable livelihood, which reads as follows:

> The combination of (a) agroecosystem resources through (b) appropriate technologies (c) mediated by organizations that convert them into entitlements for the communities, takes place within (d) the rural livelihood system which exists in (e) a legal and political context. The sustainability of the livelihood system is dependent on the sustainability of each of the building blocks (a to e), and is additionally characterized by natural resource sustainability and resilience of the livelihood system. Resilience is the ability of the livelihoods to adapt to external and internal shocks and stresses. Resilience of a livelihood system is characterized by (1) livelihood diversity (multiple strategies including small-scale synergies), and livelihood intensity (characterized by byproduct synergies), (2) better connectedness between micro, meso and macro-level organizations and (3) ability to adapt to Climate Change.

We have found that the SLF for VLB has both theoretical as well as empirical value. It is a useful tool to assess and design strategies for livelihoods and to assess if they have a holistic approach. The tool can also assist in prioritizing action on the ground. More broadly, it provides an important contribution to literature on adaptation and social resilience.

8.4.2. Context specific conclusions

The central question that this research set out to explore was, "Can the development of a grassroots biofuel based strategy catalyze livelihoods that are sustainable?"

VLB creates livelihood diversity and intensity through its three pronged approach which includes sustainable agriculture, local value addition and biodiesel-fuelled livelihoods. It is a conclusion of this research that any livelihood strategy for VLB should include all three as a consolidated package. The research also concludes that community arrangements that anchor VLB in a civic process of change are more likely to be robust if they include more than one community organization. The entitlements analysis has identified the Gram Sabha as an important entity that should be strengthened to negotiate between barriers in the Market such as traders, commercial mill owners and middle men. The Gram Sabha can also be leveraged to overcome obstacles related to duty on excise and access to forest produce, as it is a legal entity with the power to act on behalf of the State. The research concluded that VLB addresses drivers of vulnerability, builds response capacity, manages climate risk and to a limited extent also confronts impact of climate change. The livelihoods catalyzed by the VLB therefore have the potential to span the entire adaptation continuum and are therefore more resilient. The three outcome considerations suggested above, (1) livelihood diversity and intensity (2) connectedness between organizations and (3) adaptation to climate change are potentially satisfied by the VLB. It can therefore be concluded, that VLB as a representative ‘grassroots biofuel based strategy’ can catalyze livelihoods that are sustainable. In its present form in Orissa, connectedness between organizations is still being forged by VLB, although indications are that the steps are in the right direction. There exist opportunities of convergence with the Government of Orissa programs that can facilitate the replication of VLB. In order to overcome policy barriers, steps have to be taken by CTxGreEn to consolidate the opportunities in the policy regime into a formal government resolution for discussion with the office of the Chief Secretary. At the same time discussions should be ongoing at the level of the Gram Panchayat, explaining the implications of the PESA (Ministry of Panchayati Raj, 1996) and the Forest Rights Bill (Gazette of India, 2007). The Gram Sabha should be leveraged to assist in passing a resolution in favor of Village Level Biodiesel.

That would be a triumph at the grassroots.

9. VLB as a catalyst for sustainable livelihoods

Chapter Summary: The challenges to implementation of VLB are discussed in this chapter. The main contributions to the literature and recommendations for future research have been outlined.

We want to organize our national power not by adopting the best methods of production only, but by the best method of both the production and distribution. Mahatma Gandhi, on Village development, n.d.

The case has also been made that our no-conflict biodiesel model (for productive uses) is better suited for replication now than larger biodiesel projects (aimed at consumptive substitution of transportation fuel) that are fraught with serious issues of food-fuel security, and uncertainties arising from a lack of adequate knowledge and/or scientific data about long-term impacts on the environment and for that matter even the viability of the livelihoods of farmers who are being encouraged to take up large-scale mono-culture plantations of non-indigenous species such as jatropha curcas. CTxGreEn, 2008

9.1. Can VLB catalyze sustainable livelihood opportunities?

"Can the development of a grassroots biofuel-based strategy catalyze livelihoods that are sustainable?" In addition, "What are the challenges that such a strategy will need to overcome and how can these be addressed? These are the questions raised by this research.

We have seen in Chapter 8 that VLB, as one example of a biofuel-based strategy, has the potential to catalyze livelihoods that are sustainable. VLB is best facilitated at the grassroot by the Gram Panchayat, which can in turn promote SHGs, VEC, VSS and other local enterprise. The Gram Panchayat is the local level organization mediating between the State and the Market, and ensuring connectedness of the micro level organizations with the meso and macro level. VLB is a three-pronged approach that includes sustainable agriculture, local value addition and biodiesel-fuelled livelihoods as a consolidated package. While livelihood diversity, intensity and small scale economic synergies are addressed through the three-pronged approach, multiple strategies also cater to a spectrum of niches that address drivers of vulnerability, build response capacity, manage climate risks and confront impacts of climate change. These characteristics enhance the resilience of the livelihood system, reducing vulnerability and therefore leading to sustainable livelihood opportunities.

9.1.1. Limitation in using the framework

Natural resource sustainability and adaptive capacity are given equal importance in the framework in Figure 2-5 (p. 29). The agroecosystem analysis helps to map the interactions between socio-economic and biophysical processes (Figure 2-5). However in the analysis of the outcomes, the assessment parameters suggested in Figure 8-1, (p. 183) are limited to the resilient livelihoods assessed in terms of livelihood diversity and intensity, better connectedness (between institutions) and adaptation to climate change. Two specific outcome measures in Figure 2-5, namely (1) regeneration of the natural resource base and (2) food and energy security in terms of the carrying capacity of the resource base, define the desired outcomes of the livelihood opportunities catalyzed by VLB, and also address natural resource sustainability and are illustrative of the inherent connections and interdependencies among resilient livelihoods, adaptive capacity and natural resource sustainability. This research suggests a more detailed examination of the theoretical and empirical relationships between natural resource sustainability and adaptive capacity as an important avenue for future study. As mentioned previously, (Chapter 8, Para 1, p. 182) such an examination, while important, is beyond the scope of this current discussion.

Similarly, the framework in Figure 2-5 includes trends analysis in the system definition (p. 29) to account for implications of population growth for existing resources. Although not explicitly stated in the current research, some of this analysis is embedded in the design of the appropriate technological innovation and the feasibility assessment associated with it, which takes into consideration the supply of resources and the demand for services over a limited temporal period. One limitation of the Sustainable Livelihoods framework used in this study is that it may under-emphasize the inherently dynamic nature of some community-level changes. For example, our framework (Figure 2-5) does not explicitly address time frames, population growth or changes in consumption patterns. It is important here, however, to note the non-permanent role of the Village Level Biodiesel as a community development tool to kick-start the local economy over relatively short timeframes (a few years). Transition to new uses for biodiesel and even the transfer of the technology package to other remote communities once the purpose is served in the present cluster are likely scenarios, based on experience with the initial two case studies detailed in this thesis. While it is important to recognize the limitations (and potential for further development) of the framework summarized in Figure 2-5, it has been highly useful for the purposes of analysis of the VLB approach described in the case studies

Challenges to VLB, and strategies to overcome them, are summarized in the following section.

9.2. Challenges faced: secondary research question

The major obstacles faced by the VLB livelihood strategy during implementation at the micro level can be summarized as: (1) competition with traders; (2) cash-based export-oriented economy; (3) fragile village institutions; (4) unsustainable financing; (5) legal impasse in policy regime (CTxGreEn, 2008a). Each of the obstacles is further explained in Table 9-1.

These obstacles were compiled and presented as a part of this research, during the NGO forum on the 21st -22nd of February, 2008. A facilitated group exercise conducted with 13 participants from ten NGOs in Orissa resulted in developing strategic directions to overcome each of the obstacles (CTxGreEn, 2008). The strategic directions were then correlated to the five building blocks of the SLF for VLB (Figure 2-5). Knowing which of the building blocks to use as the starting point (agroecosystem, appropriate technology as a components of the livelihood strategy, entitlements as a component of institutions and organizations, or rural livelihoods, legal and policy regime as components of the context), for each of the strategic directions, is useful in the preparation of Action Plans to overcome these obstacles. The detailed set of obstacles is listed in Table 9-1, and the strategic direction identified by the NGO forum has been included at the bottom. The building block from the SLF for VLB related to each set of obstacles/strategic direction is also listed at the bottom of the table.

Table 9-1: Obstacles, drivers and strategic directions (Based on CTxGreEn, 2008)

Obstacle: Cash based, export oriented economy
“Mind-set” for immediate profits
Biodiesel being promoted for transportation
Emphasis on large scale production
Local oilseeds (like niger and mohua) becoming cash crops that serve an export market in North America and Australia… *no local value addition* Ready cash offerings to indebted farmers by middle men and traders (*saukars/money lenders*)
Unmarketed byproducts, No market linkages for sale of glycerin and soap
Strategic direction: Integrate biodiesel systems with local livelihoods
SLF for VLB building block: Rural Livelihoods
Obstacle: Legal impasses in excise policy
Permit delays to purchase, store, transport absolute alcohol Permit fees and excise duties adding to the cost of absolute alcohol
For the future: permit needed to manufacture (and use, store and transport). Need to lobby for waiver of corresponding permit fees, excise duties
Follow-up process with the government/bureaucracy tedious and procedures unclear
Strategic Direction: **Empowering Gram Sabhas to initiate legal changes in favor of VLB**
SLF for VLB building block: Legal and Policy regime

Obstacle: Competition with traders exporting seeds
Fluctuating seed prices based on external demand
Distress sales made to illegal traders who pay ready cash
Tribals' *Need* for instant cash in Jan-Feb (*let's sell seeds now, we'll worry later about buying cooking oil for own use*)
Strategic direction proposed: Grassroots dissemination of knowledge and action towards change of policy (Govt. of Orissa intervention)
SLF for VLB building block: Agroecosystem
Obstacle: Fragile village institutions
Absence of strong Panchayati Raj Institutions (PRIs) with understanding of their statutory powers
Tribals not aware of ever-changing forest policies and new PESA regulations
Complex forest policies
Self Help Groups, VEC, VSS not distinct cohesive units, and do not have clear long-term goals nor well-defined roles and responsibilities of members
Strategic Direction: Establish viable marketing linkages involving multiple stakeholders
SLF for VLB building block: Environmental Entitlements
Obstacle: Unsustainable financing
Comparison with price of petrodiesel (subsidized and hence lower in price)
Tariff collection from tribal villagers is difficult
Villagers usually first generation entrepreneurs, lacking basic business or technical skills
Village enterprise needs operating cost support
High cost of ethanol (excise duty, permit to manufacture, store, transport)
Unmarketed byproducts No market linkages for sale of glycerin and soap
Biodiesel being perceived only as hardware without the enviro-social benefits
Local NGO in withdrawal phase, concentrating mainly on building infrastructure
SLF for VLB building block: **Source sustainable micro financing**
Driver: Appropriate technology, Micro energy system

The main obstacles, VLB building block and strategic directions in Table 9-1 have been summarized below.

Table 9-2: Summary of obstacles, drivers and strategic direction for VLB

Obstacle	SLF for VLB building block	Strategic direction proposed
1. Competition with traders	Agroecosystem	Grassroots dissemination of knowledge and action towards change of policy (Govt. of Orissa intervention)
2. Cash based, export oriented economy	Livelihoods	Integrate biodiesel systems with local livelihoods
3. Fragile village institutions	Environmental entitlements	Establish viable marketing linkages involving multiple stakeholders
4. Unsustainable financing	Appropriate Technology	Source sustainable micro financing
5. Legal impasses in excise policy	Legal and policy regime	Empowering Gram Sabhas to initiate legal changes in favor of biodiesel

The NGO forum further concluded from the summary in Table 9-2 that directions 1 and 5 could be merged and that 3 could be merged with 4. The key strategic directions to move VLB forward can therefore be stated simply as:

1. Integrate biodiesel system with local livelihoods: focusing on the context and VLB building block, Livelihood. This implies working with the local community in integration of the livelihood
2. Source sustainable microfinancing, establish viable market linkages with multiple stakeholders: focusing on the VLB building blocks, Appropriate technology and Environmental entitlements. The SHGs play a key role along with other microfinance providers. SHGs have to be equipped to deal with financial institutions and the market
3. Empower Gram Sabhas (Village Council) through grassroot dissemination of knowledge and action towards legal and policy changes: focusing on the VLB building blocks, Agroecosystem and Legal and policy reforms

9.3. Conclusions on the implementation of VLB

The strategic directions indicate the institution and organizations that need to be leveraged to overcome the set of obstacles. In his research on sustainable livelihoods, Scoones (SLSA, 2004) has suggested three thematic areas: livelihoods, institutions and governance. The themes suggested by him can be summarized as follows: (1) livelihoods: "knowing how people gain access to resources and through what institutional mechanisms; (2) institutions: knowing how they affect people's access to resources, and (3) governance: knowing what governance arrangements are necessary to encourage a livelihood approach to rural development (SLSA 2004). The strategic directions identified for the replication of VLB summarized above in Table 9-2, reflect these three thematic areas:

- Livelihoods (knowing how people gain access to resources)
- Agroecosystem and Legal and policy reforms (knowing how institutions affect access)
- Environmental Entitlements (knowing governance arrangements necessary)

The role of appropriate technology is not reflected in the three themes suggested by Scoones although they have been identified in Table 9-2. Technological innovations are a very important component of VLB. The role of appropriate technology is critical as a medium for catalyzing change and as a bridge between traditional livelihoods and the innovations being proposed. The agroecosystem context becomes important in order to scale the technology to local needs.

Microfinance organizations play a key role in seeding the technology locally. When the goal is replication, the legal and policy context become important. Case studies have also shown that the process of technology development itself can become a medium for catalyzing civic driven change. The SLF for VLB can be used in designing other VLB applications, and can also be extended to include other appropriate technological innovations at the village scale. The five building blocks can be combined in any way. The focus could be one or the other of the blocks, but in catalyzing opportunities for sustainable livelihoods, all five must be considered as a part of an open system. The critical link, however, in scaling-up of these small pilot successes are institutions and organizations, and their ability to convert resources into entitlements and ultimately into capabilities. Entitlements seen in relation to the appropriate technological innovation therefore, provide conditions sufficient for catalyzing sustainable livelihoods.

It must be acknowledged therefore that without the correct configuration of institutional arrangements, successful innovations are unable to move forward, beyond pilot implementations. However, it is a recommendation of this research that, because of their strength as a medium for generating civic processes of change, appropriate technology should be added as a separate theme in any discussion on innovations for Sustainable Livelihoods.

The replication of the model was one of the points of discussion during the stakeholder workshop held in Bhubaneshwar in March 2009 (pp. 204-205). Convergence with the government programs is seen as one of the ways forward. Areas of convergence include training, finance and market support. It has been suggested (p. 205) that nesting the community level technology implementer within a series of umbrella organizations ranging from the Gram Sabha could be a way to build a conduit to the State government.

The village level biodiesel model is, however, complex and includes not only the software and hardware, but also other aspects of agronomy and byproduct synergies. Replication in terms of scaling-up and scaling-out would involve carefully selecting potential candidates to be trained to follow rigorous operating procedures. An important step in the replication process, and a key strategy in future development of the larger project examined in this research is the development of an innovative curriculum that includes:

1. Demystification of the technology package including all aspects of byproduct synergy;

2. Integrating aspects of agronomy (use of oil cake, mixed cropping) and natural resource assessment and monitoring (and assessing underutilized and unutilized forest resources);
3. Standard operating practices for the technology and bookkeeping skills.

Two levels of training are envisaged: one an in-depth training for technicians, and a second for end-users such as farmers in the use of oil cake and end-use devices such as pumpsets, tillers, and oil expellers. For the latter, since only commercially available end-use devices are being used, after-sales support and training can be provided by vendors and equipment retailers. The in-depth training of trainers needs to be carried out in a more formal manner for which existing State Government mechanisms can be leveraged through the local institute of technology and management. The following points should be kept in mind in developing a curriculum:

1. Start small with realistic expectations;
2. Develop a broad guideline for selecting candidates for training;
3. Develop a peer-review system including older members of the communities from which the trainees are selected;
4. Integrate local knowledge systems with discussions on the technology innovation;
5. Focus on good log-keeping for the technology as it is necessary for trouble shooting;
6. Include bookkeeping training from the beginning;
7. Integrate with existing government programs and use them to foster the enterprise;
8. Develop a support system for technical, financial and marketing aspects of the enterprise.

9.4. Contributions of the Research

9.4.1. Contribution to academic literature

In the formulation of the sustainable livelihood framework for village level biodiesel (SLF for VLB), based on the work of Chambers (1987) and Scoones (1998), there are three significant inclusions, which make the framework more robust. These are:

- The concept of entitlements to understand power structures;
- The concept of the adaptation continuum to include issues of climate impacts;
- The concept of the rural livelihood system as a complex whole relating the inner reality of the farmer to the outer reality of a swiftly globalizing world.

The other contribution to the literature is the inclusion of appropriate technology as an adaptive strategy and a key building block. This research has shown how the process of technology development can itself become a medium for engaging the community and can catalyze the civic process of change. It is recommended that appropriate technological innovations should only be promoted as a tool, even though this requires a more involved process of community engagement.

An additional contribution of this research is the understanding that appropriate technology without consideration of institutions to mediate issues of access and control of resources is not replicable. Analysis of entitlements, participatory technology development and demystification as discussed in relation to VLB become necessities, and are integral components of the technology (as a means). This research has shown that beyond identifying community arrangements needed to drive the civic-process, an analysis of entitlements is necessary for the success of any community enterprise.

The three outcomes to assess resilience of livelihoods is a major contribution of this research to the literature on Sustainable Livelihoods and Adaptation (to Climate Change). The framework (Figure 8-1) is useful in assessing resilience of a livelihood system, and includes the three indicators suggested for assessing resilience of livelihood outcomes. The indicators are (1) livelihood diversity and intensity, (2) connectedness of micro, meso and macro organizations and (3) adaptation to climate change.

Assessing sustainable livelihood outcomes as a response along a continuum, spanning between vulnerability on one end and impacts (of climate change) on the other expands the concept of sustainable livelihoods to explicitly include concepts of climate adaptation and climate resilience. This makes the concept of Sustainable Livelihoods more robust and relevant in the current discussions that are primarily centered on climate adaptation and mitigation. The assessment of outcomes in the sustainable livelihood framework as moving targets rather than as a series of frozen indicators is a contribution of this research.

9.4.2. Contribution to practice

This research has established that biodiesel and biofuels promoted as producer-driven processes in *a local-production-for-local-use model* such as VLB are more likely to catalyze sustainable livelihoods. Agro-industrial approach to biofuels lead to displacement of food crops, and diversion of local resources, to feed the consumptive transportation sector, undermining the interest of marginal and smallholder farmers in rural areas. In contrast, village level biodiesel adds value to the large quantity of unutilized forest seeds and underutilized short rotation oilseed crops like niger that are currently exported as birdfeed, to fuel livelihoods and boost the local economy. This is achieved by the biodiesel providing fuel for second crop irrigation, small farm and agro-processing equipment on one hand and synergies that are set in motion by use of byproducts such as oilcake as an organic fertilizer. The case studies have shown that the there are enough resources locally available to fuel development within infrastructure starved remote communities, although there may not be enough to meet the transportation needs of the rest of the world. This research proves the potential of VLB to support productive development without fossil fuel consumption.

The Sustainable Livelihood framework adapted to VLB includes a "local-production-for-local-use" model. VLB is a producer-driven model. Such a model is relevant to subsistence communities in the South. But the model also has relevance to the industrialized economies as an anti-consumption producer(ism)-oriented alternative to the overdeveloped infrastructure of North American society (Mancini 2008). The governance arrangement for such a livelihood system is therefore not a traditional market-based approach or a rights-based approach, but a combination of both in *a collaborative community-tools based local-economic development* model. It is recommended that policies to promote biofuels should focus on sustainable livelihoods and *"civic-driven change,"* looking beyond the State or the Market as the delivery medium (Fowler, 2007). This research has also shown that civic-driven change must be nurtured by local organizations that are able to mediate with the State and the Market.

9.4.3. Contribution to methodological development

While the focus of the research has been on developing a livelihood strategy, new insights have been gathered on the process of using micro-level planning as a catalyst to initiate civic processes for change. There are several tools available, yet there is no clear direction on how to practically combine them to respond to complex processes. This research attempts to reduce this gap, by contributing to the literature on methodologies for doing action research as a participant observer, and specifically on integration of technology with traditional livelihoods.

One of the ideas that emerged as central to the community level energy planning process is t*echnology demystification*. It is applicable to any such process involving an external technical input. Even prior to the process of community engagement in the planning, a demystification of the technology, unraveling its nuances, is essential. The participatory technology development phase of the current project accounted for some of this, but training (in the manner proposed by this research) was more useful.

Similarly, mapping in a *spatially relevant manner* emerged as a very strong medium for communication during the planning process. Maps have been used in rural appraisals for a very long time. However they tend to be more qualitative. Making a model of a topographical map with elevations and directions on a scaled grid with the community during the watershed planning exercise, demonstrated how catchments and basins define the habitat within a village. The model also defined the relationships between neighboring villages. The mapping exercise, carried out much like an architectural *charette*, facilitated the planning exercise, making it very interactive and easy to translate into a proposal for action.

These two are important contributions which could be considered for inclusion in future methodologies on technology-oriented energy planning, especially for biofuel-based micro energy initiatives.

9.4.4. Logical framework for future application

The frameworks (Figure 2-5 and Figure 2-6) can be used to evaluate existing projects and assess whether the outcomes of the intervention lead to sustainable livelihoods. Figure 8-1 lays out the overview of the steps to be followed, and should be read in accompaniment with Figure 2-5 and Figure 2-6.

An important step in **using the framework as an evaluation tool to study existing projects** or programs is to identify how many of the building blocks, viz., (A) Agroecosystem (B) Appropriate Technology (C) Rural Livelihood System (D) Environmental Entitlements and (E) Legal and Policy Regime, are included in the project. Some of these may be included by design and others may be integrated by the community. It is useful to analyze the outcomes and the trade-offs and specifically focus on the adaptive capacity of the community. Section 2.7.1 (pp. 30-31) discusses this in more detail. The framework is only a guiding tool, and the emphasis is on participatory processes of information collection and on being responsive to the narrative from the community. A checklist is also offered in Appendix IV, Table IV.1, and p. 228.

Chapter 7 and Figure 3-1 p. 37 (including accompanying tables, in Appendix IV, namely IV.2a - 2d, pp. 228-230) outline the process followed in the Tumba cluster to design strategies that promote sustainable livelihoods.

The framework can also be used as a tool for designing strategies that promote sustainable livelihoods. Case studies in Chapters 5, 6, 7 indicate that community development is complex and no single framework can be used to capture the dynamic process. The emphasis is on collaborative processes, which themselves enhance the adaptive capacity of the community. The framework (Figure 2-5 and 2-6) may be used as a guide to design a livelihood strategy for technological innovations and to integrate them within the local context. We can broadly summarize seven sequential considerations for integrated sustainable livelihood planning:

1. The context is an important determinant of the technological application. Socio-cultural patterns at the community, household and individual level should include both material and existential needs.
   - The rural livelihood system (Hogger, 2000) can be used to identify the inner and outer reality of the people on whom the livelihood is centered. Past trends and likely futures should also be included.
   - The other important elements that define the context are legal and political ramifications of the proposed application, at the regional as well as the national level. .
2. The next step is to identify elements of the agroecosystem. Characterizing the resource base with respect to biophysical and socioeconomic aspects using existing baseline information will help to identify an optimum resource cluster for the technology application. Watershed boundaries are useful in defining the resource clusters. Natural resource assessment and a livelihood study of the geographical cluster are best followed up by participatory workshops with local farmers to validate data collected. Participatory mapping with the community can help to identify inter linkages within and between resource clusters.
3. The third step in subsistence economies dependent on agriculture as their primary livelihood includes documenting traditional practices and analyzing the production and usage patterns of

resources (natural and agricultural) for livelihood and agricultural purposes. This analysis helps in identifying potential conflicts of use with respect to food, fuel and fodder. In the case of the VLB, this step helped to identify unutilized and underutilized resources, community fallows and private and government land for soil and water conservation and land regeneration.

4. Participatory development of the technology application is a concurrent step. In the case of the Village Level Biodiesel (an energy application) this included conducting a community-based (women-focused) assessment of energy needs for domestic and livelihood end uses. Energy sources, collection patterns, consumption and expenditure information on fuel are collected and are useful inputs into the design of any energy-based application being proposed. A workshop with the community and with the women in particular on their priorities with respect to domestic and livelihood energy end-use devices is a very important step.

- User concerns and design inputs into the technology are useful feedback to the technology developers. It is ideal for the community to work together with the technology developers during the development process, as this helps in the process of demystification. Technology demonstrations are important to get feedback on the technology. This makes the technology development process iterative.
- Reassessing the livelihood plan with respect to the availability of resources and the demands of the community (identified end use) validates previous feasibility assessments. This is best done as a workshop with community representatives from villages in the identified resource cluster.
- Technology demonstrations should be followed up with a longer term business (profitability) demonstration. A minimum week long orientation to the business aspects of the technology is needed for key people in the community prior to the business profitability demonstration so that they are able to support the effort. It is important to select older community members who can foster the barefoot technicians being trained to support the technology in the cluster. The barefoot technician training is more intense and for a minimum duration of 6 months.

5. The technology being proposed is considered to be more resilient if it promotes livelihood diversity and livelihood intensity. In the case of the village level biodiesel this translates into a three-pronged approach that promotes livelihood diversity though local value addition,

livelihood intensity through sustainable agricultural practices and small scale economic synergies through biodiesel-fuelled livelihoods. Natural resource regeneration, and food and energy security are measures to assess natural resource sustainability.

6. Another concurrent step to the technology development process is environmental entitlements analysis. Using Leach's framework (1997) it is important to first identify customary laws and organizations operating at micro, meso and macro levels that mediate access to resources necessary for the technological application being proposed. This is very important to understand the power dynamics of the institutions and organizations that govern access and control of resources and to ensure a more equitable distribution of resources. For example the role of the Self Help Group in financing the working capital for the enterprise in Tumba has the dual advantage of lessening the burden of loans for the entrepreneur, while at the same time reducing the monopoly of the private enterprise. Environmental entitlement analysis also includes evaluating the ability of existing community structures to support the technology initiative. This is especially important for a community-driven grass root initiative, which can not exist in isolation from the Market and the State. The initiative requires the nesting of the local organization supporting the technological innovation and enterprise within an umbrella of nurturing support structures. Connectedness as described by this research is this dynamic relationship between different levels of organizations that enables access to resources, control over them and their conversion into local livelihoods that are sustainable.

7. In conclusion it is important to identify the obstacles to implementation of the technological innovation as a community enterprise and assess strategies to overcome them, including possible trade-offs. Outcome measures developed with the community may be useful but should be broad measures for assessing sustainability of outcomes. Some of the measures suggested include respect for the culture of local livelihoods, local access and control including role of women in decision making, local utilization of resources and value addition in the local economy, food and energy security, and regeneration of natural resource base.

A community driven model such as the Village Level Biodiesel is complex and based on a partnership between the technology developers and the community. The steps proposed above are only a road map.

As emphasized before it is not the end product in terms of “biodiesel reactors” that is the goal. If the process of technology development itself is transparent there are other important benefits. Building local self-reliance, reinforcing the adaptive capacity of the community and regenerating the local natural resource base are the desired outcomes that in the end contribute to the goal of development with minimal environmental degradation through sustainable livelihoods.

9.4.5. Recommendations for further research

In villages where organizations have been working with the community for an extended period of time (over two decades), the changing priorities are often not because of the community’s own decisions, but due to the NGOs development agency driven mandates. This often calls for fragmented project-based implementation. There is now some criticism of development agency driven mandates, especially with respect to aid-based international development (Easterly 2006, 2008, Fowler2007) and a “re-thinking of development using evolutionary complex perspective” (Fowler 2008, p1). While these are strong conceptual ideas, there is only an indicative guide to translate them into practice. A rough roadmap based on the experience of designing such a process for VLB is presented by this research. The ability to adapt solutions to the changing aspirations of the community brings in an aspect of uncertainty and unpredictability, like that which is being currently envisaged for climate adaptation projects. A better understanding of this inherent adaptive capacity of communities will be useful when proposing innovations.

A more detailed discussion on the issue of appropriate technology design and village scale adaptation including the chemical and mechanical aspects of VLB, with energy and life cycle computations, would be useful in validating the model further. The holistic approach of VLB can be challenging when concurrently (a) assessing the forest and integrating watershed development and good agronomic practices, (b) looking at policy issues concerning the legal feasibility of the project, and (c) understanding the chemistry and simplifying the mechanics of the technology. The complexity of the current model makes it important to benchmark the VLB approach against other civic-driven approaches to renewable energy technologies such as solar, gravity flow systems and even straight vegetable oil-based water pumping and power generation.

Another area of concern is the gap between planning and implementation owing to the cultural milieu where even now, after over 20 years of NGO presence in the village, decisions are male dominated and often not beneficial to the women. Thus, gender-sensitive planning processes do not always translate into gender-sensitive plans. It would be interesting to study successful women-driven civic processes that have a component of technology of the scale and nature of VLB, to understand better how to integrate women into the implementation process without enhancing their burden of work or jeopardizing their social relationships. It is an area of work that has only been touched on by this study, but would benefit both the current work on VLB and other future technology-oriented interventions.

9.5. Concluding remarks

The journey of the village level biodiesel from the village of Kinchlingi with 15 households to the twin village of Kandhabanta and Talataila with 31 households to the eight village cluster of Tumba with 187 households has been an expanding spiral. The learning has been growing, from the first village application where the focus was on providing water for washrooms, to a complex web of interrelated issues in Tumba, where the activities on the ground ranged from inventory of trees to watershed development to demonstration of use of oil and oil cake. Biodiesel as a technological option was always only in the background. Unraveling this web also meant simplifying: making order of the chaos. Simplification meant recognizing the patterns which connect. One of the patterns that emerged was "livelihoods."

Livelihood is a simple term that can be easily translated. The Webster dictionary explains it as "a means of living, of subsistence." This is exactly how it is translated in Oriya, as "*Jivika*", that which sustains life. This research is based on the strength of this simple concept.

When the biodiesel idea was suggested for Orissa, it was a response to seeing large sacks of niger seeds being shipped from the Kalahandi district in Orissa to retail outlets, from where they would eventually be sterilized and shipped to North America as bird feed. These villages had no electricity in spite of being displaced by the 600 MW Indravati hydroelectricity project. It seemed a paradox, the classic case of darkness under the source of illumination. If niger seeds could be retained, the oil extracted and converted to biodiesel to fuel energy devices for local use, we would metaphorically be killing many birds with one stone: there would be local production of fuel, access to energy for subsistence and economic activities, and the oil cake could replenish the soil. It seemed a perfect conceptual idea: locally produced biofuel would boost the local economy and provide a means of sustenance, *jivika* to the local communities. This was the innovative "high-risk" idea that won the World Bank Marketplace Award in 2003.

The road from then to now has been long, and in that journey today, the project that was launched as the 'Carbon Neutral Biodiesel-Fuelled Energy Services for water supply and sanitation' has evolved into a grounded project that promotes village level biodiesel as an agro-booster. The emphasis on livelihoods is strong.

It was therefore logical to premise this research, which was on village level biodiesel as promoted by the CNBFES project, on the Sustainable Livelihood literature and the seminal works of Chambers and Conway. Sustainable livelihoods developed into a strong grassroot model for development post Rio (1987), when Chambers first proposed it as a practical concept for the 21st century (1992). Scoones (1998) developed the ideas of Chambers into the Sustainable Livelihood Framework. The Framework was used extensively by development agencies in the 90s and early 2000s. Carney (2000) compared the approaches of different organizations that had adapted and adopted the Sustainable Livelihood Approach. This was followed up and updated by Hussein (2002), who studied 15 agencies including multilateral, bilateral and non-governmental organizations that were still using the approach. But by the mid 2000s the initial enthusiasm had died down.

Interestingly, a similar pattern has been observed for the 'Farmer First' concept, another idea proposed by Chambers in the late 1980s which was also recently revived in 2007, two decades after being initially proposed. Chambers and Scoones (July 2009) have called for re-engaging in the debate on sustainable livelihoods. Chambers (2009), in an article entitled "Practicing what we preach", suggests that the concept, until now used only in subsistence communities, should be applied to northern industrialized communities also. Scoones (2009) proposes re-engaging in the concept, and suggests drawing from other areas of enquiry to 'rethink, retool and reengage' in the idea. Some of the gaps that Scoones (2009) points out about the original sustainable livelihood approach are that it does not include: processes of economic globalization (micro-macro linkages); issues of power, politics and links between livelihoods and governance; impacts from long term environmental change; long term shifts in rural economies; and questions of agrarian changes.

This research uses the SLF for VLB to address the issue of power and politics, the impacts from long term environmental change and issues relating to shifts in the rural economy and agrarian change. In addition, the idea of the village level biodiesel bridges the grassroot reality of local livelihoods with the macro issue of global warming. VLB is a catalyst for sustainable livelihood opportunities, a local-production-for-local-use model that provides a source of clean energy, ensuring development without increase in fossil fuel consumption.

In doing so it brings together the principles of Gandhi's local self reliance, and Gram Swaraj and Schumacher's Buddhist Economics for the Path to Right Livelihood.

Convivial tools are those which give each person who uses them the greatest opportunity to enrich the environment with the fruits of his or her vision. Industrial tools deny this possibility to those who use them and they allow their designers to determine the meaning and expectations of others.

Ivan Illich, in Tools for Conviviality

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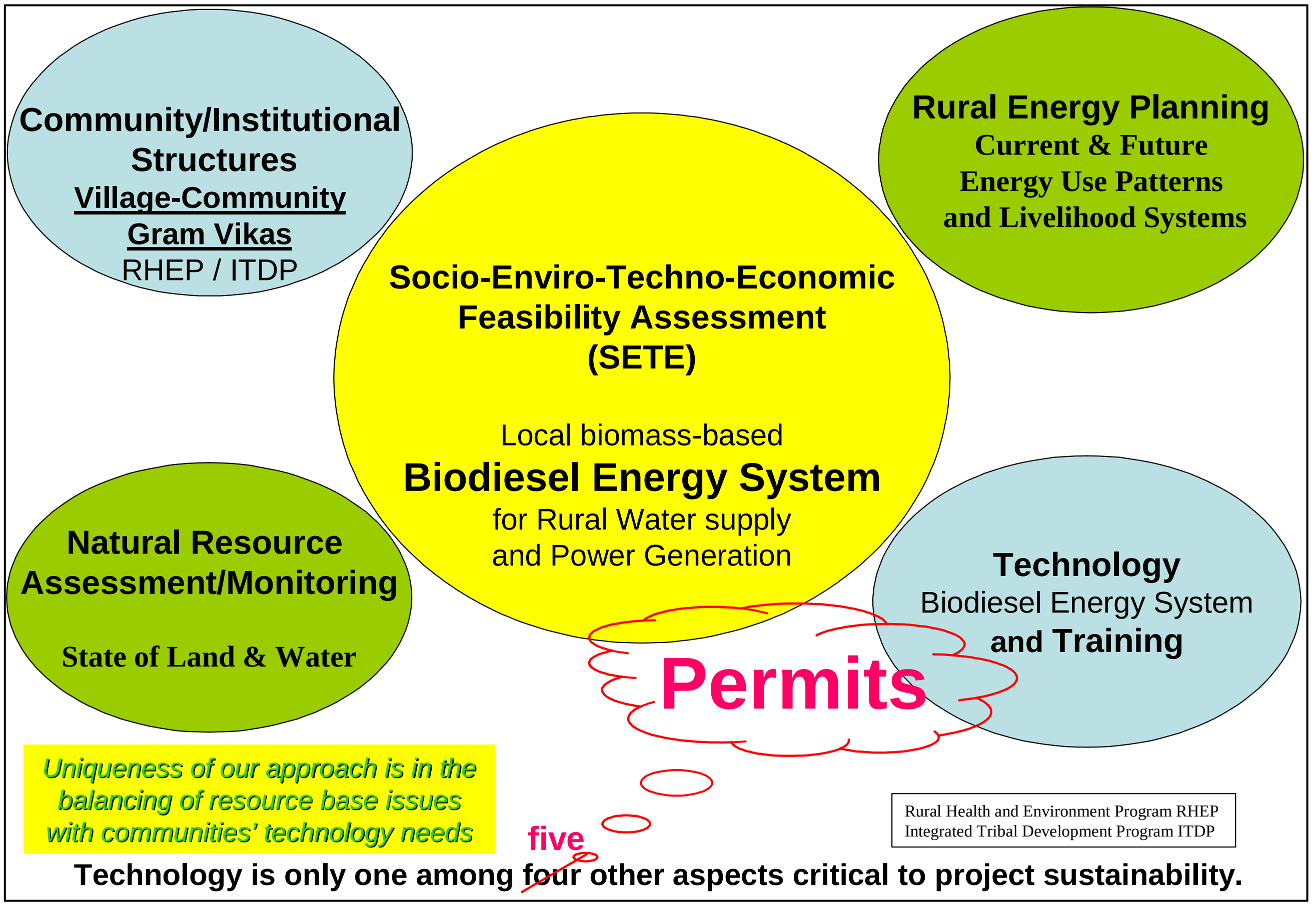
APPENDICES

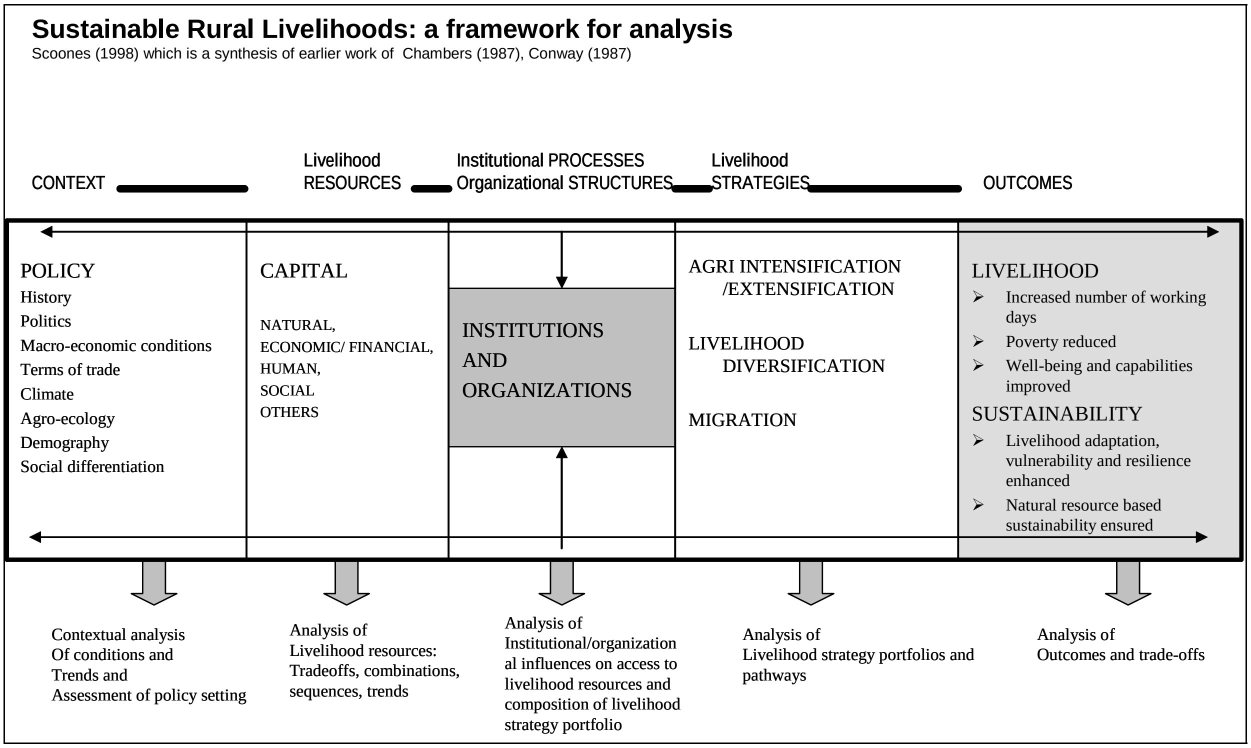
APPENDIX I: CTxGreEn's approach in Orissa, India

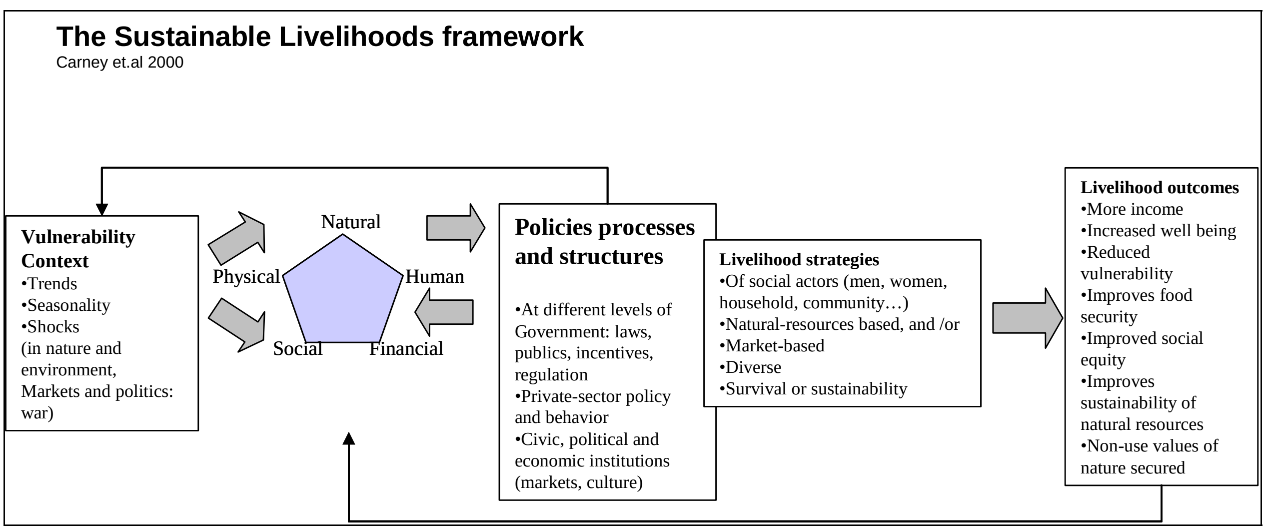
The Carbon Neutral Biodiesel-Fuelled Energy Services, CNBFES Project (CTxGreEn, 2006)



APPENDIX II: Sustainable Livelihood Frameworks

Original from Scoones (1998) and modified version by Carney (2000)





APPENDIX III: Time line of the CNBFES and the Research

Table III.1: Phase 1: Pre-feasibility and research proposal development

DATES	CNBFES ACTIVITIES	Research ACTIVITIES
Feb04	• CNBFES project formally initiated in Orissa India	
Mar-Jun04	• Feasibility assessments, Technology development and biodiesel production and use in the pilot plant at Mohuda	
Jul04-Dec04	• Natural resource and community energy surveys and studies in Tumba and KBTT • First VLB installed in Kinchlingi and biodiesel produced (Nov04) • Second VLB in twin villages of KBTT and biodiesel produced (Dec04)	
Jan-Aug 05	• Natural resource surveys in KBTT • Biodiesel water pumping in Kinchlingi (May05), • Niger, an oilseed crop sown for use in biodiesel in community fallows • Workshop with Project coordinators • **End of the WBDM 2003 project**	• Pre-feasibility and proposal preparation • Previous forest surveys and Energy studies compiled • Livelihood strategic plan for the village clusters developed in workshop with project coordinators and field staff of Gram Vikas
Sept 05-Mar 06	• Water pipeline between villages KB and TT (Mar06) • Pilot testing of biodiesel generator at the pilot plant • Water pumping continues in Kinchlingi • Washroom construction continues in KBTT	**Location: Univ. of Waterloo** • Completion of Course work • Comprehensive exam preparation an completion • Proposals/scholarship applications • Ethics clearance, Lit review

Table III.2: Phase II: Field Work, Part I

<table>
<tr><th>DATES</th><th>CNBFES ACTIVITIES</th><th>Research ACTIVITIES</th></tr>
<tr><td>Mar-Jun 06</td><td>• Pilot testing of biodiesel generator at pilot plant, Water pumping continues in Kinchlingi
• Barefoot technicians trained, Protocols for biodiesel production
• Recipes for biodiesel tested with different oils and production process optimised</td><td>• Visit clusters in project area to initiate research work in the village</td></tr>
<tr><td>Jun/Jul-Dec 2006</td><td>• Biodiesel-based water pumping begins in KBTT
• Pilot testing, training in Mohuda pilot plant
• Biodiesel production and water pumping in Kinchlingi
• Generator testing for KBTT in the pilot plant
• Niger sowing initiated in Kinchlingi and KBTT
• Preparation of policy document on forest produce and on ethanol/alcohol use by Enviro Legal Defence Firm
• Presentation on livelihood /energy plans to Gram Vikas' management team
• Results shared in the Gram Vikas annual review in Sep 06</td><td>• Define an optimum livelihood
• 23Jun-1Jul06 (Tumba) watershed workshop
• Jul-Sept 06 Compile existing data on agricultural system and natural resources
• 26Dec06-4Jan07 follow-up visit to Tumba
• Community Implementation plan
• 25-28 Aug 06; 1- 8 Nov 06
• Livelihood participatory documentation.
• Jul06 to Feb07 of niger cultivation in Mohuda , Kinchlingi, KBTT
• Entitlements analysis
• Preparation of policy document on forest produce and on ethanol/alcohol use, preparation for a stakeholder meeting, concept and brochure preparation (April 06 –Nov-Dec 06), stakeholders identified and contacted with Enviro Legal Defence Firm
• Meeting postponed to early 2008</td></tr>
<tr><td>Jan – Jun07</td><td>• Niger harvested (Jan07),
• Oil Press demonstrations in different villages
• Gravity flow in KBTT (May07)
• Pilot testing and training continues in Mohuda pilot plant
• Feasibility of biodiesel-based lighting, discussions with KBTT community members
• 6 month training of potential barefoot technicians from Tumba
• Presentation on livelihood /energy plans to Gram Vikas' management team
• Results shared in the Gram Vikas annual review in April 07</td><td>Livelihood planning with community
• Technology feedback surveys
• 27-29 January 07 Tumba
• 22-24 February 07 Kinchlingi
• 28-30 March 07 KBTT
Livelihood participatory documentation
• Jul-Jan niger agricultural practice documentation of process in all 3 locations
Community implementation plan
• 4-17 Feb 07 Training KB TT community members, 30Jan–2Feb Kinchlingi villagers
• May 07 KB TT visit to discuss future plans
Livelihood planning (barefoot technicians and self-help group members)
• 14-17 Feb 07 in village #2 KB TT
• 30Jan–2Feb07 in village # 1 Kinchlingi
• May 07 in village #2 : KB TT</td></tr>
</table>

Table III.3: Phase III: Field work, Part II

DATES	CNBFES ACTIVITIES	Research ACTIVITIES
Jun-Sep 07	• Niger sowing • Barefoot technician training for Tumba youth continues • Partnership with Practical Action initiated • Niger sowing included Tumba this time	**Location: Uwaterloo, Canada** • Compile phase I of study as IDRC report • Presentation of case studies and preliminary discussion with PhD advisory committee
Sept-Dec 07		• Sept-Dec 2007 Field work Phase II in India (revalidation of results analyzing and sharing research finding with community)
Jan-Dec 08	• Gravity flow in Kinchlingi (Apr07) • Discussions in Kinchlingi for alternative uses of biodiesel and tiller demonstrated • Focus on strengthening Self Help Groups • Two young girls from Tumba inducted into training program at Mohuda • Business demonstration of oil press in Tumba includes training of barefoot technicians • Business and market feasibility for operations in Tumba conducted by management interns • Visit by representative of BASIX a microfinance organization to Tumba • Byproduct utilization launched: oil cake demonstration in farmers field • Soap making from glycerine initiated • Development of a distillation unit for improving quality of biodiesel	• Field study in Tumba region of Orissa: understanding potential for green enterprise • NGO forum : experience sharing with other local NGOS and developing a strategic framework to overcome obstacles • Discussion of new phase of biodiesel in Kinchlingi: livelihood potential explored • Visiting successful examples of community forestry and Self Help Groups in Orissa • Design of market study, carried out independently by management interns in Tumba. The study design was a result of workshops held with the community as a part of this research • Understanding the legal regimes of forest protection (new forest act)
Jan09 *up to Jun 09*	• Biodiesel-based lighting initiated (Jan09) • Film on the project, camera shoot in Kinchlingi and Mohuda (Jan-Feb09) • Training of village children in running the biodiesel-based charging station • Stakeholder workshop with government bureaucrats in Bhubaneshwar (Mar09) • SHG focused training initiated in Tumba with focus on forest protection • Partnership initiated with the Jagannath Institute of Management for continuity and replication of VLB in Orissa and India	• Case study development and studying the new phase of the biodiesel project (lighting and small farm equipments) • Feb 09 Stakeholder workshop with bureaucrats: legal regime of village scale biodiesel production and use: potential for replication • Mar 09 Case study of Kinchlingi village: evolution from water pumping to electricity. Understanding issues concerning sustainability and extent of local capacities to absorb the technology • Apr 09 Understanding role of young children in technology adaptation • May 09 Consolidation of study finding

APPENDIX IV: Detailed description of Project

Table: IV.1: Objective: Assess effectiveness of VLB in catalyzing sustainable livelihoods

Key Questions to be addressed	Parameters to be studied	Where is information available	How to create data if it does not exist
What is the relationship between the technological innovation and the community? What are the obstacles to VLB in catalyzing sustainable livelihoods?	• Case study of existing biodiesel installation • Sustainable livelihood criteria including strategies to address short and long term vulnerabilities	• Baseline information enumerated by CTxGreEn • Workshop proceeding and internal minutes of meetings	Workshops to get feedback from the larger community and stakeholders on 1. Vision, goals, objectives and barriers to the objectives 2. Strategies to overcome these obstacles 3. Actions plans identifying resources and partners Case studies and ethnographical studies Mapping the tech-development process along the "adaptation continuum"
Milestone	Case studies of Village Level Biodiesel application and assessment of ability to catalyze sustainable livelihoods defined by livelihood diversity and intensity. Case studies include an analysis of (a) context (b) actors, resources and their relationships (b) decision making processes (c) livelihood strategies (d) outcomes		

Table IV. 2a: Objective: Facilitate preparation of VLB-based livelihood strategy in Tumba Agroecosystem focus (A)

Key Questions to be addressed	Parameters to be studied	Where is the information available	How to create data if it does not exist
What are the distinct resource clusters within the identified region? What are the locally available (from forests, agriculture fields, homesteads) • Oilseeds • Fruits *etc*. that can be used to brew alcohol	▪ Assessment of forest, agricultural and homestead produce 1. Inventory of potential seeds and fruits useful for biodiesel production with their current use, list of vulnerable seeds as well as underutilised seeds 2. Systems for collection and use/sale, potential conflict of uses *wrt*. food, fodder, habitat and fuel 3. Traditional agricultural practice, including cropping pattern, seasonality, family involvement, food security ▪ Natural habitat of produce: availability, seasonality, productivity of biomass ▪ Usage pattern of produce: Cultural, Domestic/personal, Economic value, Pathway : own use/sale	• Local community: farmers, village elders • Gram Vikas database • Extension centres of local agricultural colleges • Books on agricultural practices of the region • Database of CTxGreEn	▪ Forest: Identify (with the community) trees, shrubs/bushes, grasses *etc*. that the villagers use from the forest and demarcate areas from which they collect, with reference to their village ▪ Agriculture: Collate information on landholdings, verify info in the villages and use it to select farmers for case study o Conduct case study recording agricultural patterns, inputs (people and material) and outputs in details, techniques and tools, use of harvest- personal consumption or for sale ▪ Community (common) land: Identify current uses and potential for future use, ownership details ▪ Homestead : Identify plants grown in homesteads
Milestone	Resource maps and potential livelihood strategies		

Table: IV.2b: Objective: Facilitate preparation of VLB-based livelihood strategy in Tumba

Appropriate technology focus (C)

Key Questions to be addressed	Parameters to be studied	Where is the information available	How to create data if it does not exist
What are the expectations from the technology and/or its end-uses?	• Components of the identified energy system • Protocols for the technology Refer back to systemic interdependencies. • Socio-enviro-Techno-economic viability of: a) The agroecosystem: community, ecosystem and traditional livelihoods b) Technological innovation	Earlier studies by Gram Vikas and others) CTxGreEn database	Feedback on the (a) technology capabilities and (b)optimization required to match needs of the community during technology demonstrations and training sessions Ethnography, case studies to record planning process Workshop with community members to facilitate technology adoption Workshop to discuss the interconnections of technology and its role
Milestones	Specifications for the technology package matching the needs of the community, adding value to local resources and providing synergies to existing livelihoods		

Table: IV.2c: Objective: Facilitate preparation of VLB-based livelihood strategy in Tumba

Environmental Entitlements Focus (D)

Key Questions to be addressed	Parameters to be studied	Where is information available	How to create data if it does not exist
What is the role of the local level institution in the facilitation of Village-Level-Biodiesel model?	o Formal/informal institutions/organizations existing in the community. o Role of the community o Role of the local NGO	Village records NGO records Village level staff of local NGO Local community	▪ **Stakeholder analysis**: • List all the actors involved directly or indirectly with the resource. Identify the role of the actor and their influence. Identify the interactions with other stakeholders. Assess the dynamics of access and control ▪ **Entitlements Analysis**: • Identify/list institutions and organisation, as well as informal structure that mediate the community's access to resources.
Milestone	System for management of the components of the biodiesel project Potential stakeholders, their roles and responsibilities, linkages between micro-meso-macro organizations		

Table: IV.2d: Objective: Facilitate preparation of VLB-based livelihood strategy in Tumba

Context: defined by rural energy and livelihood focus (B) including Legal and Policy regime (E)

Key Questions to be addressed	**Parameters to be studied**	**Where is the information available**	**How to create data if it does not exist**
What are the existing resources in the community? • Natural, physical, human, economic and social assets at the micro (watershed) level and • Influences from regional (administrative boundary) level	Livelihood information at: o **Households level** 1. Livelihoods (inner and outer reality of livelihood system) o **Cluster/watershed level** 1. Forests: Oil and fruit trees 2. Agriculture: subsistence farming system -traditional and innovations o **Administrative boundaries** 1. Political system: Policies: forest, scheduled areas, energy 2. Economic system: market transactions, traders, bartering systems 3. Cultural systems: Tribal laws, religious beliefs and practices	• Secondary Information of the region (district) and • Primary information (Block, watershed level) o Offices of the Forest Development Agency o Government offices at block, district level o Gram Vikas and CTxGreEn data bases	1. Infer from existing demographic/socioeconomic baseline information (From GV-Village profiles) 2. Participatory Rural Appraisals (resource mapping, seasonality diagrams, social mapping) 3. Transect walks, Focus group discussions, Participant observation, Gender focused studies 4. Survey of markets**:** village markets, barters-traders 5. Mapping using the Rural Livelihood Framework
What are the existing patterns of energy consumption for domestic and livelihood end-uses in the community? What are the expressed and felt needs of the community and especially of the women?	▪ Energy sources, collection patterns, information at the household level on usage patterns: domestic, livelihood, cultural *e.g.* mohua distillation, end-use devices ▪ Identifying extended use of biodiesel and possible end-use options (beyond water pumping) • Brief understanding of techniques/technology available and effectiveness for current use • Prioritization of needs (women focused) • Assessment of needs (individual and shared)	Primary and secondary information sources, including district level census, energy studies (TERI, IGIDR, GV) Evidence in village Gram Vikas field staff, village groups (micro credit, water shed or forest committees, *etc*.), village elders, women, community members CTxGreEn database	• Historical reconstruction, ethnography • Focus group, participant observation, Interviews, case studies, action learning case studies • Stakeholder analysis • PRAs and focus group discussion with different interest group
What are the alternate energy options?	• Currently available technologies • Feasibility assessment based on The priorities assigned by the community and basic criteria (such as economics, reliability, efficiency *etc*.)	• Secondary sources, Literature review, Gram Vikas database Past research studies and experiences of CTxGreEn in the region	• Ranking and evaluating the short listed technologies against criteria established with the community
Milestones	Selection of energy end uses for biodiesel (like lighting, water pumping, ploughing) and integration of innovation into existing livelihood system		

APPENDIX V: Data Sources: Workshops and Surveys

Table V.1: Activities of CNBFES (2005-05) that have informed this research

Activity	Invitees/ Attended by	Venue	Purpose	Dates
Tumba				
Natural resource survey	6 member team of local par-taxonomist led by Parameswar	Integrated Tribal Development Program (ITDP) Tumba cluster	Compile a database on existing forest resources for monitoring state of forest To identify available forest species for biodiesel manufacture	Jul-Oct 04
Understanding Traditional agricultural systems – bogodo in Tumba	5 farmer families, 4 GramVikas cluster coordinators, other Gram Vikas staff Resource persons: Dr Ravi Kumar, Agronomist, Dr Jagannanth, SDC, Geeta	Tadakasahi	Exploring potential for land regeneration through the production of oil bearing crops and trees for biodiesel production Reconnaissance survey to Tadakasahi, Raikhal, Khalasahi, Teparda: 28 Jul-3 Aug 04	1Aug 04 (prep phase) 25-27 Aug 04
Tumba data sharing Workshop	Umakanta Dasababu, Manmohan Barik, Markhand, Kumud Sahu, Durlaba, Ajay Maharana, Saroj Porichha Resource Persons: Geeta and Parameswar	Puriyasahi	Using available data to prepare cluster based livelihood plans And identify potential for biodiesel applications	Mar 3-4 2005
Land use Land cover assessment of Tumba using remote sensing & GIS technique	BN Mishra with ground truth assistance provided by Parameswar	BAM University	To generate Arial statistics of the different land use/ land cover pattern of the study region	Dec 04 – Apr 05
Tree survey on padar lands (middle land)	Manmohan, Markhanda, Umakanta Dasbabu, Damodar and community of the ITDP Tumba area	Raikhal and Burataal cluster	Inventory of trees of interest for Biodiesel Yield of fruits and flowers of specific trees of interest	Jan-Feb 05
Rudhapadar				
Self help group training program	Including the two groups in Kandhabanta and one in Talataila. Facilitated by Judith d'Souza	Kandhabanta Talataila	To explain roles, responsibilities of the group and of CNBFES. Discuss mutually agreeable working plan for the *SHG.*	July 20-21-22 2004
Biodiesel technology training	With the village community of KB and TT, including GV field staff and the biodiesel team.	Kandhabanta	Biodiesel training program and identify day of the week when this can be arranged. Also identify potential barefoot technicians	December 31,
Natural Resource assessment	With the VSS, GV staff (Prafulla), trainer Damodar from Raikhal Tumba. Training facilitated by Parameswar	Jaganathprasad forest range adjoining KB-TT	To develop a baseline for future monitoring and also to assess availability of trees whose feedstock can be used for production of biodiesel	December 2004-March 2005

Very little primary data was generated by the biodiesel project in Kinchlingi as it was the first village installation and the objective was only to demonstrate feasibility of the technology.

Table V.2: Key workshops conducted as a part of the research project (Jan 05 to Jun 09)

Description of meeting	**Invitees/ Attended by**	**Venue**	**Purpose**	**Dates**
Land use and livelihood planning	8 participants	In Puriyasahi	Prepare a livelihood plan for Tumba village	Mar (3-4) 2005
Workshop with project coordinators	20 participants including project coordinators and cluster supervisors from the project	Village locations and in Mohuda		June (6-9) 2005
Workshop on micro planning in the Tumba watershed	26 participants for stage 1, and 8 youth for next three days	Tumba cluster	Prioritize watershed for conservation, identify villages for implementing biodiesel	June 2006
Workshop with Tumba villagers	9 villagers from 4 villages + 1 Gram Vikas supervisor		Understand the village level biodiesel system and its feasibility in Tumba	16-17 Oct 2007
Biz orientation	11 + 2 people, 3 villages represented	In Raikhal	Green Business: aspects of oil press/biodiesel	18-19 Dec 07
Biz training	4 villagers	Mohuda	Enterprise for local economic development	14-20 Jan 08
Biz profitability demonstration and feedback	5 barefoot technicians and 5 villagers participated, while villagers from at least 5-6 villages visited		Setting up and running of the oil press (an integral part of the biodiesel system) to demonstrate profitability	24-Jan-20 Mar08
Stakeholder discussion on the VLB model	13 participants from 10 NGOS in Orissa	Mohuda	Share their experiences, learn from each other and address the issues faced by CT_xGreEn.	21-22 Feb 2008
Biodiesel for livelihoods	16 people (8 women, 6 men, 2 GV staff)	Kinchlingi	Bidiesel for fuelling livelihoods	16 Jul 2008
Tumba SHG workshop and exposure	12 women from 7 villages	Mohuda	(followed by a monthly meeting in Tumba in Oct, Nov, Dec)	24-26 Sep 08
Stakeholder workshop with bureaucrats	About 63 people representatives from the Govt. NGOs, Bilateral agencies, Educational institutions, Private sector, media, and private individuals.	Bhubaneshwar	Recognition, Policy Support, and Implementation Support to replicate our model is needed.	March 2009
Workshop and training	8 youth initially finally 5 trainees	Kinchlingi	To acquaint the trainees with procedures village level biodiesel/electricity generation	Mar 09- for 14 days

Table V.3: Summary of surveys conducted

Surveys	Details	Dates
Household surveys	Kandhabanta Talataila, Kinchlingi, Raikhal (some in Teparda, Khalasahi)	2005-2006
Tree inventory	Tumba, KBTT in community land	Dec06-Mar07
Energy /requirement	Kinchlingi 15 household (hh), KBTT 31 hh	Aug 07
Feedback on tech demo	Villages of Dhanabad, Raikhal , 12 people	15-17 May07
Feedback on oil press demo	Kinchlingi, 15 members	22-24 Feb 07
Feedback on oil press demo	KB-TT 15 members	30 Mar 07
Farmers surveys	Raikhal watershed: 25, Kalahandi: 5	May 08
Secondary source/primary surveys facilitated for other groups, from which data has informed this research		
DOCC	With S. P. Jain Institute of Management and Research (SPJIMR), interns	Mar 2008
Agronomy study	Ravi Kumar	Aug 2004
Forest survey	With Parameswar Gauda, Nina Sengupta, Malay Mishra, BN Mishra	Jun-Dec04-Aug05
SHG strengthening study	With Alexandra Zalucky, Sashikala, Manoj	Sep-Dec08
Legal feasibility study	Sanjay Upadhyay	2005-06

Data was entered in MS Excel worksheets and is in the CTxGreEn database at Gram Vikas, Mohuda, Orissa, India

APPENDIX VI: Description of the ethnographic method used in the research

Three themes were selected for ethnographic analysis, out of the five that are listed as the building blocks of the SLF for VLB. These were directed to answering the central question and to illustrate arguments made in the course of the case study. The themes that have been explored using ethnography are

a) Regenerative technology defined as appropriate technologies tailored to agroecosystems in which they are situated. While catering to a need in the community they catalyze self-renewal process in the agroecosystem. This theme explores the link between land and energy production, and has informed the section on livelihood strategies in the case studies.

b) Power structures as the name signifies explores the interplay of power, raising the question, "Who decides and who benefits?" Focusing on issues concerning women, it also explores whether gender-sensitive planning culminates into a gender sensitive plan? This theme has informed the section on decision making processes in the case studies.

c) Sustainability is the theme that uncovers the adaptation strategies employed by the community to cope with long and short term vulnerabilities. The ability of the community to manage the biodiesel technology independently is also explored under the same theme. This theme has informed the overall analysis of resilience of the VLB.

The documentation from Journals and CTxGreEn official documents were used in a selective manner. Notes have been carefully edited without altering the essence and juxtaposing them with the narrative in the case studies, to emphasize the theme. Taking cues from Emerson *et al., (1995)*, (pg 146), the six questions listed below have been used to understand the themes.

I. What are people doing? What is trying to be accomplished /discussed?

II. How exactly do they do this? What specific means and/or strategies do they use?

III. How do different members talk about, characterize and understand what is going on?

IV. What assumptions are they making?

V. What do I see going on here? What do I learn from these notes?

VI. Why did I include them?

The challenge has been to analyze the information critically and conclude in a manner suggested by Emerson *et al*., (1995) that will interconnect the themes and explore implications of the issues raised (p. 204). The work has been a document-in-progress and emerging issues have had to be added. With each step towards further exploration and reflection preliminary conclusions have had to be modified based on new learning. This may be more obvious in some of the themes such as power structures and sustainability than in the theme on regenerative technologies.

An excerpt from a field journal has been included (in Table V.1) as a sample, to highlight how the technology and agronomic issues weave into the socio-cultural factors. The analysis therefore benefited from having the three thematic questions with the five components of the VLB all interwoven within them, rather than in artificially separating the issues.

Table VI.1: Participant observer: Mohuda: Excerpt from the niger diary (2006)

***18 July, Tuesday**: Plot in Field 2 has to be prepared for line sowing niger (15 July was the early sowing target). The tractor was not working (hydraulic system faulty) and so the field could not be ploughed in the morning as planned. I called for the bullock and ploughshare from Narasingpur village. Rabi Gauda started ploughing Field 1 but quickly realized that the ground had become hard because of the land leveling that had been done earlier and had been parched dry by the hot sun. It was impossible for his ploughshare to make even a dent in the soil. He returned to the village (no payment was made). The tractor was working by 3.30 and we ploughed Field 1 and broadcasted 10 kg Sun hemp seeds. The Field near the lab (field 2) was to have smaller plots for monitoring. We divided the test plots into three parts 21m x 15 m each for 1) early sowing 15th July 2) Optimum sowing 15th August and 3) Late sowing, 15th September. In the early sowing field we made lines 30 cm apart (16 lines) and sowed seeds at approx 30 cm intervals. Savitri (Sr.) and Chitrasen did the initial sowing, followed by Karuna and me. We counted the seeds sown in the last 4 lines: 170, 173, 193, and 184.*
*I had not realized that a device to level was necessary after sowing. (I should have known since we need to cover the seeds with soil). I tried to organize the bullocks with what is called Moi (a flat log attached to the bullocks, which basically just levels the land thus covering the seeds with soil). The Bullocks had gone out to graze so I got the attachment- Moi. We attached the Moi to the tractor and tried to cover the soil. Only a quarter of the field was completed as it was already 6.00 pm and the Moi with Karuna sitting on it to weigh it down and levels the soil kept falling apart- **the mortise and tenon joint was loose. .He would patiently stop and re-attach it.** We called it a day and decided that the rest of the field would be leveled tomorrow.*
19 July, Wednesday**: Ramani was told by Savitri (Jr.) that Rabi had asked for Rs. 100 for the Moi and so she decided to innovate as she thought it was too much money, and arranged for a log to be attached to the tractor and the two Savitris together with the tractor driver: Sura Guru leveled the field. There were minor hiccups: the rope tying the log to the tractor broke and Savitri, who was seated on the log, fell onto the soil (was not hurt). In the meanwhile in field #2 the fencing was being completed but in the process Chitrasen damaged the waterline. The entire day was spent fixing the line**. Still no sign of rain
***20th July, Thursday**: The fence was completed around Field 2. Green grass for compost has been collected. I have to organize the rest of the stuff. Some drops of rain the evening. There was some light rain at night too, hopefully enough to moisten the soil.*

22nd July, Saturday: We prepared a compost heap with Swain from the Dairy. *A plot 5 feet by 7 feet was cleaned and twigs lay on the ground. The heap when completed would be about 5' high. 250 grams of gud (jaggery) was dissolved in 1/2 a bucket of water (8-10 litres). This sweetened water was sprinkled on the ground to attract insects etc. that would do the composting work. The first layer one foot high was green grass and leguminous leaves were spread on top. Gobar (cowdung) slurry from the biogas was diluted with water and then spread on top of this layer. Dry leaves one foot high was then spread on top of the green layer, slurry mixed with about 1 kg of niger oils cake was then spread on top of this layer, followed by a layer of green leaves +legumes. This was the third layer and the middle of the heap. Lime powder - 250 grams was spread followed by one feet of grass. Cowdung slurry mixed with a kilogram of niger oil cake followed, after which two more layers: first of green grass + legume and then dry leaves, each layer was topped with more cowdung slurry followed. When we reached the topmost layer (6th layer) we sprinkled the gud water liberally on top. Using a stake we made 2 holes running through the heap on the narrow side and three holes on the broad side to allow the heap to breathe. Swain covered the heap with large coconut leaves. He said after a week or so we should check to make sure there was no foul smell in the heap. I monitored the temperature of the heap: it was 4- 5C above the ambient most of the time (35- 38 C).*
24th July Tuesday: There are two leaves emerging in the sun hemp. The niger plot where early planting was done is also starting to sprout. Thunderstorm followed by rain. Finally enough rain to moisten the ground and help germination.

Themes that provide inferences to the three questions on (a) regenerative technology (*underlined*), (b) power structures: (*color grey*) and (c) sustainability (***bold***) were identified and used as needed in the discussions of the cases. It should be noted that the issue of climate variability as a risk appeared important enough to be considered as a determinant of the sustainability of any initiative. Adaptation to Climate Change was therefore added into the definition of resilience of sustainable livelihood opportunities being catalyzed by the VLB.

The sources for the study include the field-notes of the researcher, minutes of various meetings as recorded by the villagers, various employees of Gram Vikas and by the technical team represented by CT_xGreEn. Participant-observation of the agricultural-system and feedback-sessions arranged in an informal way with the community has provided key insights. Other primary data was collected through workshops, surveys, feedbacks during technology demonstrations, informal talks and interviews (List in Appendix IV).

APPENDIX VII: Land Data, KBTT

Name	House code	Occupation	Low land (acre)	Middle land (acre)	Upland (acre)	Total Land (acre)	Food crops grown	Cash crops	Rice.. output (kg)	productivity ton/acre	Income from agri. /annum
Krushna-Kanchana Guru	K-15	Wage earning: 100 days/year at Rs. 35/day ,agriculture				0	Agriculture land in forest (padar): allowed to use for 3 years after which the land becomes village community property		200	0.4	1,200
Kumpana-Raibani Jani	K-17	Wage earning, agriculture		Works in Bhubaneshwar.	Does not stay in the village	0	Rice, maize	Brinjal	800	0.4	2,000
Gandhi-Sujavi jinni Maharagi Jani	K-07 + K-08	Agriculture	2	0.5	6	8.5	Paddy, maize, millets, black gram, red gram, horse gram, mustard, castor	Brinjal, yam, cashew	800	0.4	6,000
Rabindra Jani	T-08	Agriculture	1		2	3			500	0.5	2,400
Pralahda-Mahi Jani	K-04	Agriculture	0.6	0.8	5	6.4	Paddy, millets, maize, black gram, red-gram, horse-gram, mustard, oil	Mustard, cashew, brinjal	600	0.6	6,000
Indu-Indra Jani	T-06	Agriculture	0.6	0.2	4	4.8	Rice, maize, millets, black gram, red gram, horse gram, yam	Cashew, brinjal, yam	400	0.7	2,400
Kunja bana-Rebati Jani	K-22	Agriculture	1	0.2	4	5.2	Rice, maize, millets, black gram, red gram, mustard, castor, yam, potato	Cashew, Brinjal, yam	700	0.7	10,000
Govinda-Sashi Jani	K-06	Agriculture	4	2	20	26	Paddy, maize, black gram, red gram, sesame, mustard, castor, lady-finger	Cashew, Brinjal	2,800	0.7	15,000
Dhruba-Surendra Jani	K-05	Agriculture	3	1	4	8	Paddy, maize, black gram, horse gram, red gram, sesame, mustard, castor	Cashew, brinjal	2,200	0.7	14,000
Bhamara-Mayabati Jani	K-21	Agriculture (land leased from Katakati), shop	1.6	0.2	2	3.8	Rice, millets, black gram, castor, yam, potato	Cashew, Brinjal	1,200	0.8	11,000
Ananda Pradhan	K-16	Agriculture	2		2	4	Rice	Brinjal	1,500	0.8	6,000
Sukuri-Bijay Guru	T-03	Agriculture	2	0.2	2	4.2	Rice, maize, mustard	Tomato	1,500	0.8	6,500
Premananda-Manjula Pradhan	K-12	Agriculture	2	0.6	2	4.6	Paddy, millets, maize, black gram, red gram, mustard, castor, yam	Brinjal,	1,500	0.8	7,500
Binoda-Sashi Pradhan	K-11	Agriculture	2	0.6	2	4.6	Paddy, millets, black gram, mustard, yam	Brinjal	1,500	0.8	13,000
Panchu jinni Sanju-Narayan Jani	T-05	Agriculture	0.8	0.2	4	5	Rice, millets, red gram, horse gram, mustard, castor, yam, potato	Mustard, brinjal	600	0.8	4,300
Hara-Krupasindhu Guru	T-01	Agriculture	2	0.2	5	7.2	Rice, millets, maize, black gram, red gram, horse gram, castor, mustard	Brinjal	1,500	0.8	7,000
Jati-Dinabandhu Guru	T-02	Agriculture	2	0.2	5	7.2	Rice, maize, black gram, red gram, horse gram, mustard, castor, yam	Brinjal, yam, mustard	1,500	0.8	8,000
Shayama-Parvati Pradhan	K-19	Agriculture	0.5	0.2		0.7	Rice, millets, maize, black gram, mustard, castor, yam, potato	Brinjal	400	0.8	2,000
Birandra-Basanti Pradhan	K-20	Agriculture	0.5	0.2		0.7	Rice, millets, maize, black gram, mustard, castor, sesame, yam, potato	Brinjal	400	0.8	2,200
Hajari-Savitri Pradhana	K-01	Agriculture	1	0.6	2.2	3.8	Rice (low land), millets, lack-gram, red-gram, maize (middle land)	Brinjal, Ladies-finger, tomato	800	0.8	6,380
Kalabati-Govardhana Guru	T-04	Agriculture	1		6	7	Rice, maize, black gram, horse gram, red gram, mustard, castor, yam, potato	Brinjal, cashew	800	0.8	4,400
Jonaki -Bhobana Jani	T-10	Agriculture	1	7	3	11	Rice, millets, black gram, red gram, mustard	Cashew, brinjal	800	0.8	4,000
Rebati-Linga Jani	T-07	Agriculture	1		2	3	Rice, maize, lack gram, red gram, horse gram, mustard, castor, yam, potato	Cashew, brinjal, yam	1,000	1.0	4,000
Chakradhar-Sumitra Pradhan	K-02	Agriculture	1	0.2	2	3.2	Rice, Maize, Black gram, mustard	Cashew, Brinjal	1,000	1.0	5,000
Bahana-Raibani Jani	K-10	Agriculture	1	0.2	2	3.2	Paddy, maize, mustard, castor	Cashew, Brinjal	1,000	1.0	5,500
Surendra-Padma Jani	K-09	Agriculture, carpentry	1	0.4	8	9.4	Paddy, maize, castor, mustard	Mustard, brinjal;, cashew	1,000	1.0	10,000
Rabindra Rajani Pradhana	T-09	Agriculture	0.5	0.4	2	2.9	Rice, maize, black gram, horse gram, red gram, mustard, yam	Cashew, brinjal, yam	600	1.2	3,300
Santu-Saguni Pradhan	K-03	Agriculture	0.5		3	3.5	Rice, black gram, red gram, horse gram, maize, mustard	Brinjal, Okra, tomato	600	1.2	4,800
Sanatana-Savitri Muli	K-14	blacksmith (Avg. Rs. 40/day)				0	Leases land from Katakati people				2,000
Japan-Malathi Jani	K-18	Wage earning, agriculture	leased for Rs.		0.4	0.4	Rice, millets, maize				1,000
Panu -Sulochana Muli	K-13	blacksmith (Avg. Rs. 40/day), Agri.			0.4	0.4	Paddy, millets, yam	Brinjal	500		3,000
Sova-Ganga Naik							Migrants, settled in Talatalia. Not considered in the village population count				
Phullu-Mantu Naik							Migrants, settled in Talatalia. Not considered in the village population count				
Pratima-Somnath Naik							Migrants, settled in Talatalia. Not considered in the village population count				
Lily-Banamali Naik							Migrants, settled in Talatalia. Not considered in the village population count				
Average			**1.4**	**0.8**	**3.8**	**4.9**			**990**	**0.8**	**5,803**
Sum total			**35.6**	**16.1**	**100**	**152**		**total**	**28700**		

APPENDIX VIII: Energy Consumption Data, KBTT

			Cooking		Time spent				Lighting				Agriculture					
Name	**House code**	**Total People/ hh**	**Cook. kg/day**	**end-use device**	**Fuel coll. (hrs)**	**Fuel Proc. (hrs)**	**Cooking (hrs)**	**Total time spent (hrs)**	**used, Light. litre/month**	**Hrs of use**	**end-use device**	**Torch-cells/ year**	**Occupation**	**Field prep.**	**Sowing**	**irrigation**	**harvesting**	**Threshing**
Hajari-Savitri Pradhana	K-01	4	4	Chulha	1	0.5	2	3.5	3	3	lantern, lamp	12	Agriculture	plough		rain-fed	manual	
Chakradhar-Sumitra Pradhana	K-02	4	5	Chulha	1	0.5	2	3.5	3	3	lamp	12	Agriculture	plough	hand	rain-fed	dau: sickle	ox
Santu-Saguni Pradhana	K-03	5	8	Chulha	4	1	2	7	3	2	lamp		Agriculture	plough	manual		manual	ox
Pralahda-Mahi Jani	K-04	6	8	Chulha	2	0.5	1.5	4	3	4	lamp	12	Agriculture	plough	manual	rain-fed	manual	
Govinda-Sashi Jani	K-06	5	10	Chulha	2	1	3	6	3	3	lamp	12	Agriculture	plough	manual	rain-fed	manual	ox
Dhruba-Surendra jani	K-05	5	8	Chulha	1	0.5	2	3.5	3	3	lantern, lamp	12	Agriculture	plough	hand	rain-fed	manual	ox
Gandhi-Sujavi Maharagi Jani	K-07 + K-08	6	8	Chulha	1	1	2	4	6	3	lantern, lamp	12	Agriculture	plough	hand	rain-fed	dau: sickle	ox
Surendra-Padma Jani	K-09	7	10	Chulha	2	0.5	2	4.5	5	3	lantern, lamp	12	Agriculture, carpentry	plough	hand	rain-fed		ox
Bahana-Raibani Jani	K-10	4	8	Chulha	2	1	2	5	3	2	lamp		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Binoda-Sashi Pradhana	K-11	6	8	Chulha	2	1	2	5	3	3	lantern, lamp		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Premananda-Manjula Pradhana	K-12	2	3	Chulha	1	1	3	5	2	3	lamp		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Panu-Sulochana Muli	K-13	6	8	Chulha	1	0.5	2	3.5	5	3	lamp		blacksmith (Avg. Rs. 40/day), Agriculture	plough	hand	rain-fed	dau: sickle	ox
Sanatana-Savitri Muli	K-14	3	4	Chulha	1	0.5	3	4.5	2	3	lamp		blacksmith (Avg. Rs. 40/day)					
Krushna-Kanchana Guru	K-15	4	4	Chulha	1	0.5	3	4.5	2	3	lamp		days/year at Rs. 35/day ,agriculture	plough	hand	rain-fed	dau: sickle	ox
Ananda Pradhana	K-16	2	4	Chulha	0.5	0.25	2	2.75	2	3	lamp		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Kumpana-Raibani Jani	K-17	3	4	Chulha	0.5		2	2.5	2	3	lamp		wage earning, agriculture	plough	hand	rain-fed	dau: sickle	ox
Japan-Malathi Jani	K-18	7	8	Chulha	2	1	2	5	2	3	lamp		wage earning, agriculture	plough	hand	rain-fed	dau: sickle	ox
Shayama-Parvati Pradhan	K-19	5	8	Chulha	2	1	2	5	3	3	lamp		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Birandra-Basanti Pradhan	K-20	4	8	Chulha	2	1	2	5	2	3	lantern		Agriculture	plough	hand	rain-fed	dau: sickle	ox
Bhamara-Mayabati Jani	K-21	3	4	Chulha	1	0.5	2	3.5	2	3	lantern		Agriculture (land leased from Katakati), shop	plough	hand	rain-fed	dau: sickle	ox
Kunja bana-Rebati Jani	K-22	5	8	Chulha	2	0.5	2	4.5	4	3	lantern, lamp	12	Agriculture	plough	hand	rain-fed	dau: sickle	ox
Hara-Krupasindhu Guru		3	4	Chulha	2	1	2		3	3	lantern, lamp		Agriculture	plough	manual		manual	
Jati-Dinabandhu Guru	T-02	4	5	Chulha	1	0.5	2		4	3	lantern, lamp		Agriculture					
Sukuri-Bijay Guru	T-03	4	10	Chulha	2	1	3		3	3	lantern, lamp		Agriculture					
Kalabati-Govardhana Guru	T-04	4	15	Chulha	3	1	4		2	3	lantern, lamp		Agriculture					
Panchu jani Sanju-Narayan Jani	T-05	7	10	Chulha	2	1	3		5	3	lantern, lamp	12	Agriculture					
Indu-Indra Jani	T-06	2	5	Chulha		1	3		3	3	lantern, lamp		Agriculture					
Rebati-Linga Jani	T-07	3	8	Chulha	2	1	3		4	3	lantern, lamp		Agriculture					
Rabindra Jani	T-08	3	8	Chulha	2		3		3	3	lantern, lamp		Agriculture					
Rabindra Rajani-Pradhana	T-09	3	8	Chulha	2	1	3		4	3	lantern, lamp		Agriculture					
Jonaki -Bhobana Jani	T-10	6	8	Chulha	1	0.5	3		4	3	lantern, lamp		Agriculture					
Total		**135**	**221**					**91.75**	**98**	**92**		**190**						
average		**4.4**	**7.1**		**1.6**	**0.8**	**2.4**		**3.2**			**12**						
kg/year			80665					litre/year	33,489									
Quintal/year			807		**Cost incurred at 10.5/l**			Rs.	351,632									
Per capita kg/day			2		**Per capita consumption**			litre/day	0.7									
Time taken/kg wood (hrs)			0		**Emission factor**			0.026	tCO_2/l	864								
Time taken totally for wood collection			10,083		Wisions PDF CO_2 calculator													
total time(hours)/hh			325		**Notes:**													
Time taken (hours)/kg wood			0		Chulha: Traditional cook stove													
Time taken totally hours, for collection			20,166		Lamp: Wick lamp, also called dibbi in Oriya													
Workday equivalent			2,521		Agriculture: Agriculture													
Equivalent wage lost @Rs. 40/day			100,831		Coll.: Collection													
total time/hh			960		Proc.: Processing													
Total cum			161		Light. : Lighting													
vol. /tree			2		Dau: Sickle													
No. of trees			82															

APPENDIX IX: Yield Data of Trees (oil bearing)

MINOR FOREST PRODUCE, YIELD SURVEY- TUMBA PROJECT							
Sl. No	Village Name	Mahua flower, kg		Tullo, kg		Karanj, kg	
		small tree	big tree	small tree	big tree	small tree	big tree
1	Buratal (upper)	20	30	11	15	10	25
2	Badagaon	16	25	9	12	8	11
3	Gadanga	11	23	10	13	12	18
4	Ankuli	12	20	6	10	11	20
5	Jalior	17	35	8	20	6	12
6	Raikhal	23	34	13	12	9	15
7	Teparada	22	32	12	20	8	12
		121	**199**	**69**	**102**	**64**	**113**
	TOTAL	**320**		**171**		**177**	
	average yield	17.3	28.4	9.9	14.6	9.1	16.1
	Data collected : NR team (2005-06), excerpt from file: yield-rate-trees.xls (sheet1)						
	Small tree: girth less (1-2m), Height 3-5m. Big trees girth >3m and Height > 5 m						

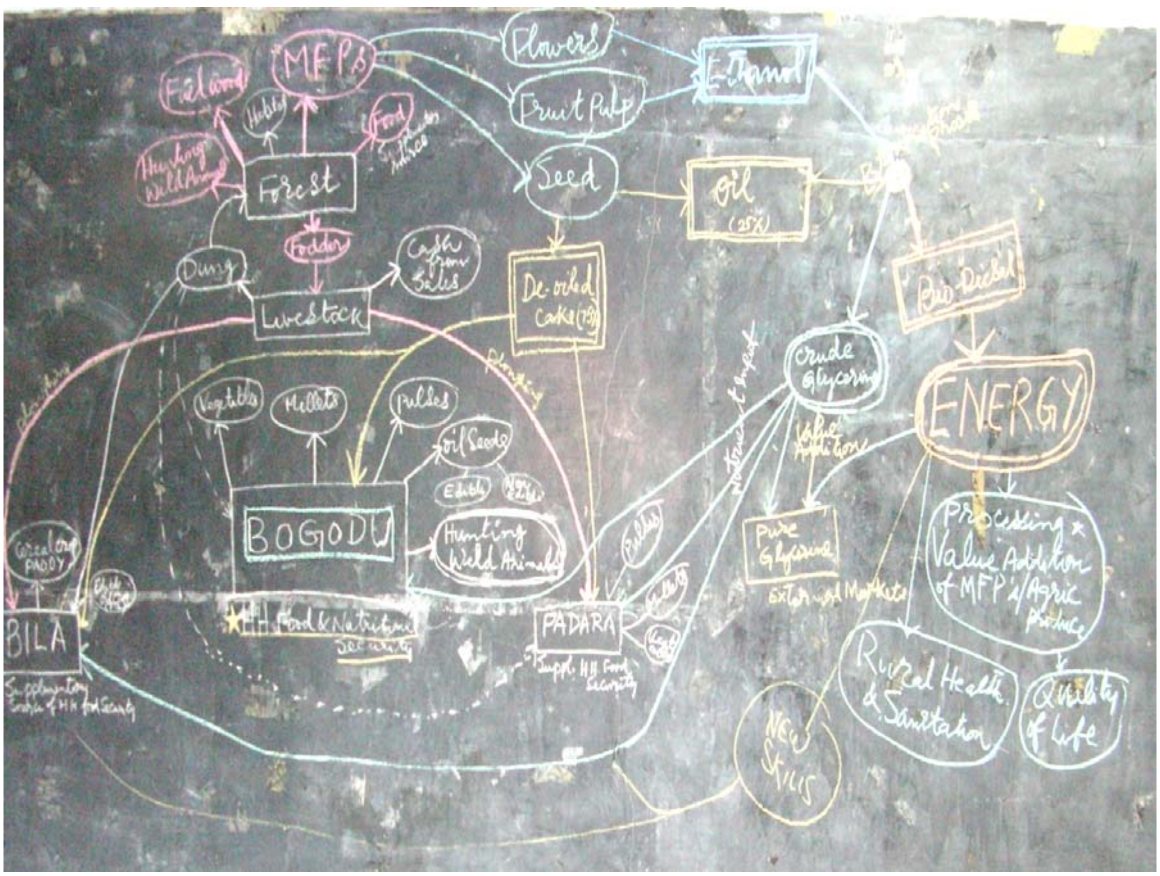
APPENDIX X: Excerpt from Livelihood planning workshop, 3-4 March 2005

The cluster coordinators own livelihood plan

Integrating biodiesel applications in the Tumba region
a cluster approach

Based on primary data and participatory planning
Authors: Ajay, Durlabha, Kumud, Manmohan, Markhanda, Umakant
Guided by Saroj Porichha (Project Coordinator)
Resource persons: Geeta and Parameswar

March 3-4 2005
Puriyasahi, Tumba ITDP



Livelihood linkage diagram

With the Bogodo as the focus
As developed by Dr Ravi Kumar, August 2004

TUMBA CLUSTER
Land use details

Raikhal team's calculation			Burataal team's calculation		
Singharaj RF	**2,150**	**ha**	**Singharaj RF**	**2,200**	**ha**
Bengasahi RF	**10,050**	**ha**	**Bengasahi RF**	**10,350**	**ha**
Area covered by plots in Singharaj	**11**	**ha**	**Area covered by plots in Singharaj**	**11**	**ha**
Percentage coverage	**0.11**	**%**	**Percentage coverage**	**0.5**	**%**
Area covered by plots in Bengasahi RF	**6.15**	**Ha**	**Area covered by plots in Bengasahi**	**6.15**	**ha**
Percentage coverage	**0.06**	**%**	**Percentage coverage**	**0.06**	**%**
Watershed area	**637.5**	**ha**			
Elogola and Kusum Ghati	375	**ha**	**Singharaj RF**		
Plain area	62.5	**ha**	Total area	1,925	**ha**
Forest area (375-62.5)	312.5	**ha**	Crop land	50	**ha**
Surveyed area	4.25	**ha**	Scrub forest	600	**ha**
Percentage covered	1	**%**	Open forest	275	**ha**
Scrub forest	37.5	**ha**	Shifting bogodo	150	**ha**
Rocky	5	**ha**	Rocky area	25	**ha**
Deforested area	275	**ha**	Total dense forest	825	**ha**
Total forest area	312.5	**ha**			
Surveyed area by plots	4.25	**ha**	Forest area represented by survey	1,850	**ha**
Percentage covered	1.4	%	Area covered by plots	11	**ha**
			Percentage coverage	0.6	%
Raikhal forest area					
Total area	637.5	**ha**			
Rocky area	6.25	**ha**			
Scrub forest	125	**ha**			
Crop land	37.5	**ha**			
Open forest	25	**ha**			
Village land	5	**ha**			
Deforested land	200	**ha**			
Surveyed area	588.75	**ha**			
Represented by plots	1.9	%			
Percentage covered	0.32	%			

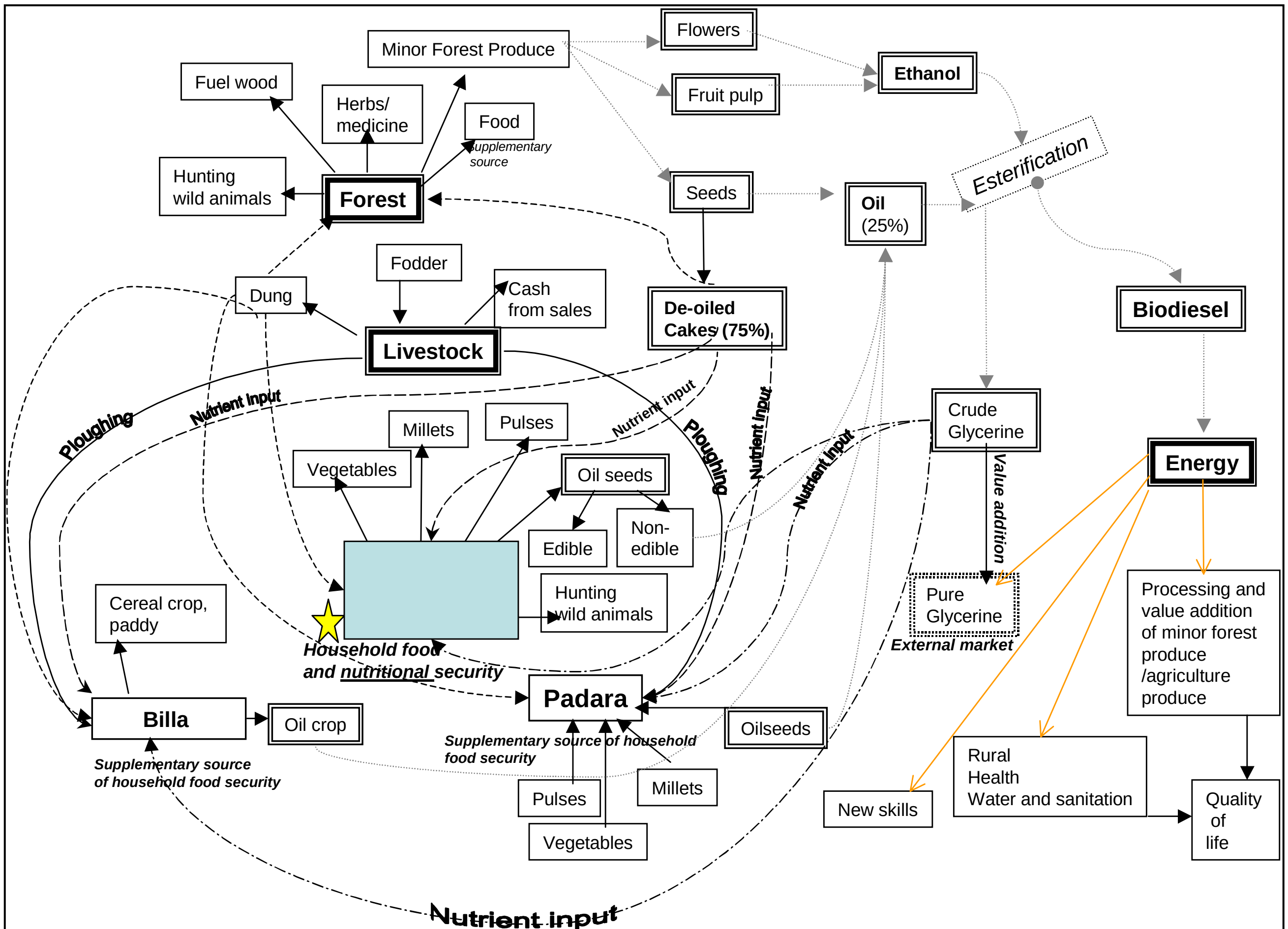
Summarized during the ‘Livelihood planning workshop,’ 3-4 March 2005
Data based on the Excel Works Sheet: NatRes-PLOTDATA-Digital-record_sorted info.xls

Activities currently being carried out under the ITDP umbrella

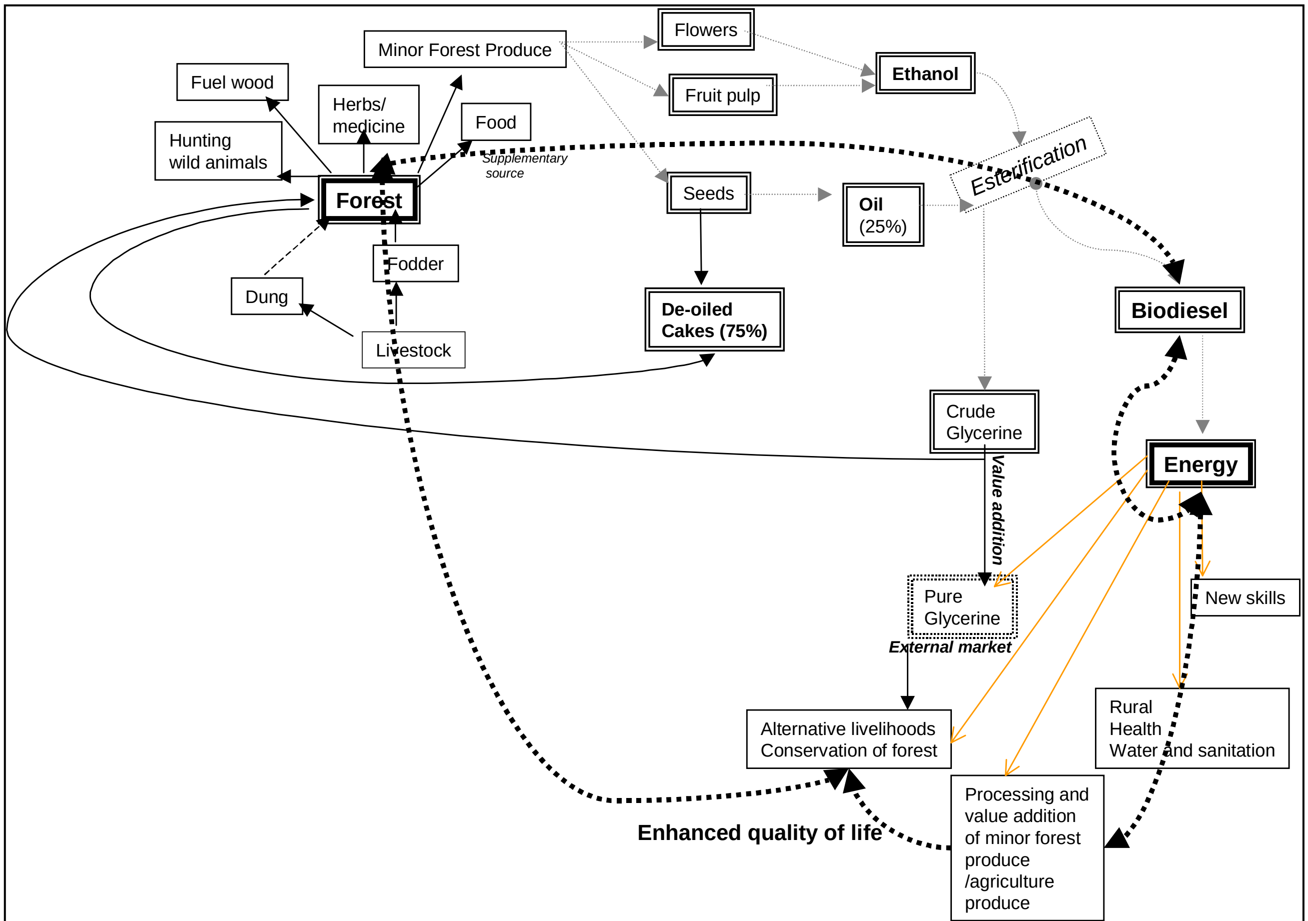
Understanding cross-linkages

Role of the PC/Activities at ITDP Tumba
Education
100% enrollment
Rasing of SF and CS
Strengthening of VEC
Emphasis on girl child education
Higher classes admission for Std III pass children
Developing horticulture for school scustainability
To conduct examinations
Health
100% immunisation for children and ante-natal mot
Health fund
Availability fo medicine
Strengthening of VHW
Infrastructure
Construction of irrigation canal
Housing loan collection
Construction of toilets and bathrooms
Colelction of corpus funds
Secure livelihood
Stone fencing
Land development
Mason training
100% family involvement in savings and credit
Vaccination of livestock
Construction fo cattlesheds
C?B
strengthening of PRIs
Strengthening of WO (women' organization)

Documentation	People Organization, Human and Instituitional development, Training and Exposure	Education	Health	Natural Resource Mangement, Watershed
Record verification	**Peoples organization**	**Education**	Health fund collection	Watershed
Education	Monthly village meeting	Dhanawar, Khalasahi	Immunisation	Site selection
Health	Monthly area meeting	School running	Village clean	use of "A" frame
Savings and credit	PO meeting	School fund collection	Growth monitoring	Strengthen village watershed committee
Housing loan	Village exposure	C/S collection	Health check up	Involve all villagers in watershed work
	conduct village meetings	Kitchen garden raising	Treatment	Treatment of stone bunding
Secure livelihood loan	**Capacity building**	Burataal-Badagoan	Arrange immunisation	Proper use of water
Grain bank	Animal husbandry training	6-14 years children enrolled	Ante-natal care	Proper use of land
Livelihood	Gender training	Prabhat parikrama and banabhaji	TBA, VHW training	Horticulture
SH Group loan	VEC exposure	Bal panchayat	Treatment	Agriculture
Health	PRI training	Facilitator training	Immunisation	Social forestry
Liasion Government PHC		NTFP collection	Growth monitoring	Second paddy cultivation
Conduct immunisation program, Health camp		VEC meeting	TB and leprosy treatment	
Conduct Savings and Credit meeting		Parents meeting	VHW training	
Ensure regular savings		Raise school fund and childrens savings	Kitchen garden	
Saving colelction in meetings		Adult education for savings and credit group office bearer	Common disease treatment	
Members depostiing money in the banks		Dhanabad-Tadakasahi	Immunisation and VHW training	
Record keeping		School running	Immunization	
Documentation		School fund and childrens song	Patient treatment	
Data compilation		Run the balwadi	Chlorination	
MPR highlight report		Kitchen garden raising	Health fund colelction	
Bi-annual report		Parents meeting	Growth monitoring	
Annual report		School teacher	Health check up	
Janshree Bimayaojana		VEC meeting	Strengthen TBA and VHW	
Orissa Development Action Forum		Records keeping	Immunization	
Budget preparation		School horticulture patch		
Budget expenditure		School function		
SMCS work		Material preparation		
Contact panchayat representatives		100% enrollment 6-10 year children		
Checking watershed work		Admission day observation		
Conduct Savings and Credit training program		VEC monthly meeting		
		School horticulture patch		
		Childrens saving collection		



Livelihood linkage diagram



Livelihood linkage diagram

An iteration with a forest focus

Format for livelihood proposals

Livelihood cluster map

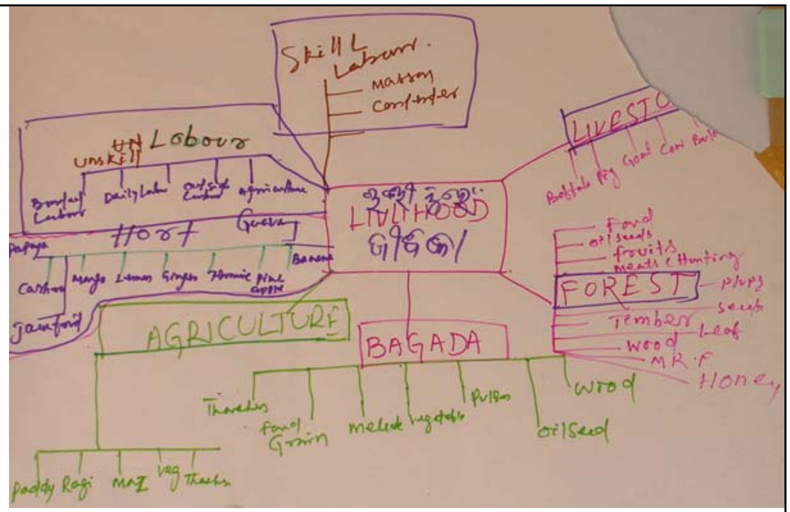
indicating focus village(s), villages linked to the focus village, Watersheds and land use

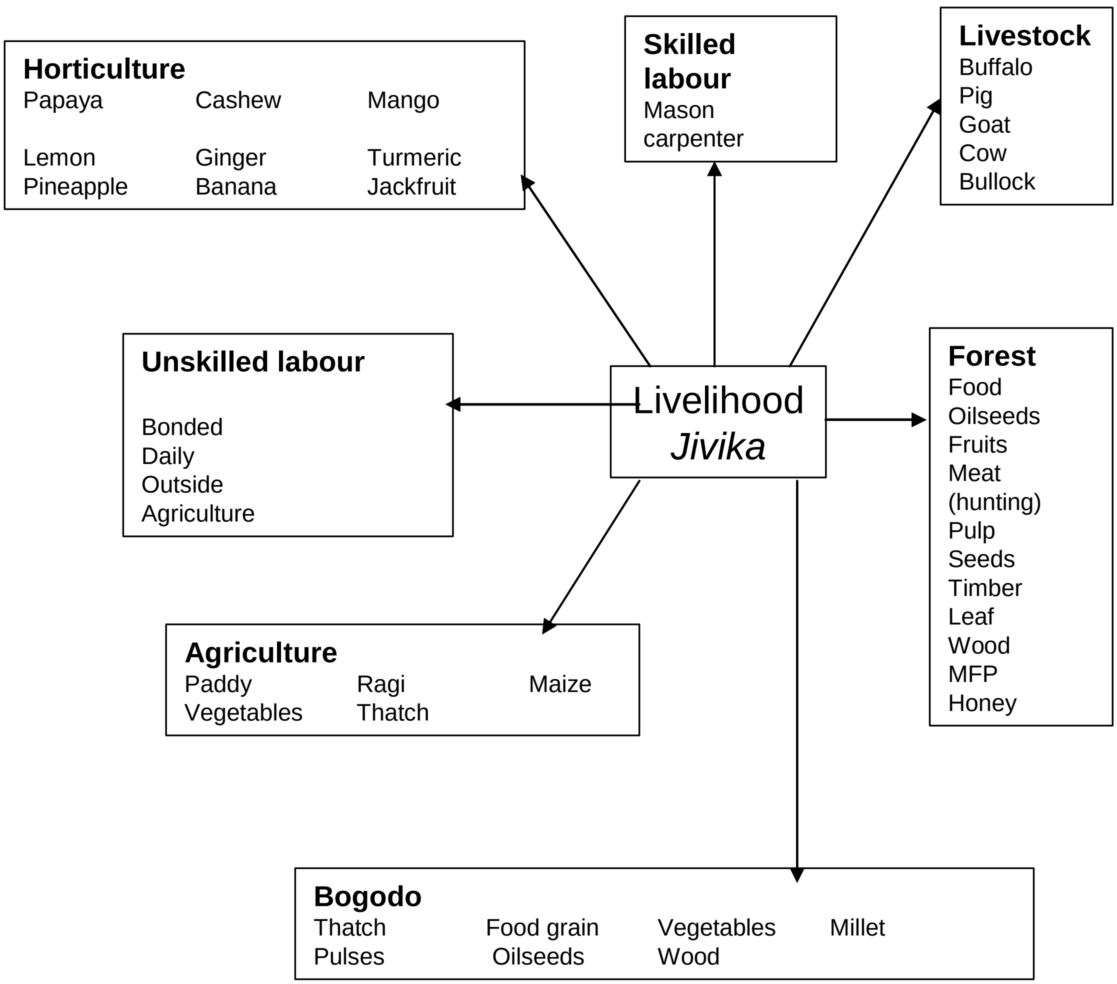
Livelihood resources (using data)

including Natural resources (forest: healthy patches, trees of interest, NTFPs), watersheds, Community assets including Demographic information (population, households, dependents to earning members), Livestock (milch: meat: draught: sale), Livelihoods: Bogodo (productivity, available time), Minor forest produce, Trees of interest, Activity chart (Seasonal for agriculture and forest produce)

Livelihood Proposal

Showing links to existing livelihood activities, to biodiesel, and to resources and external linkages like markets.

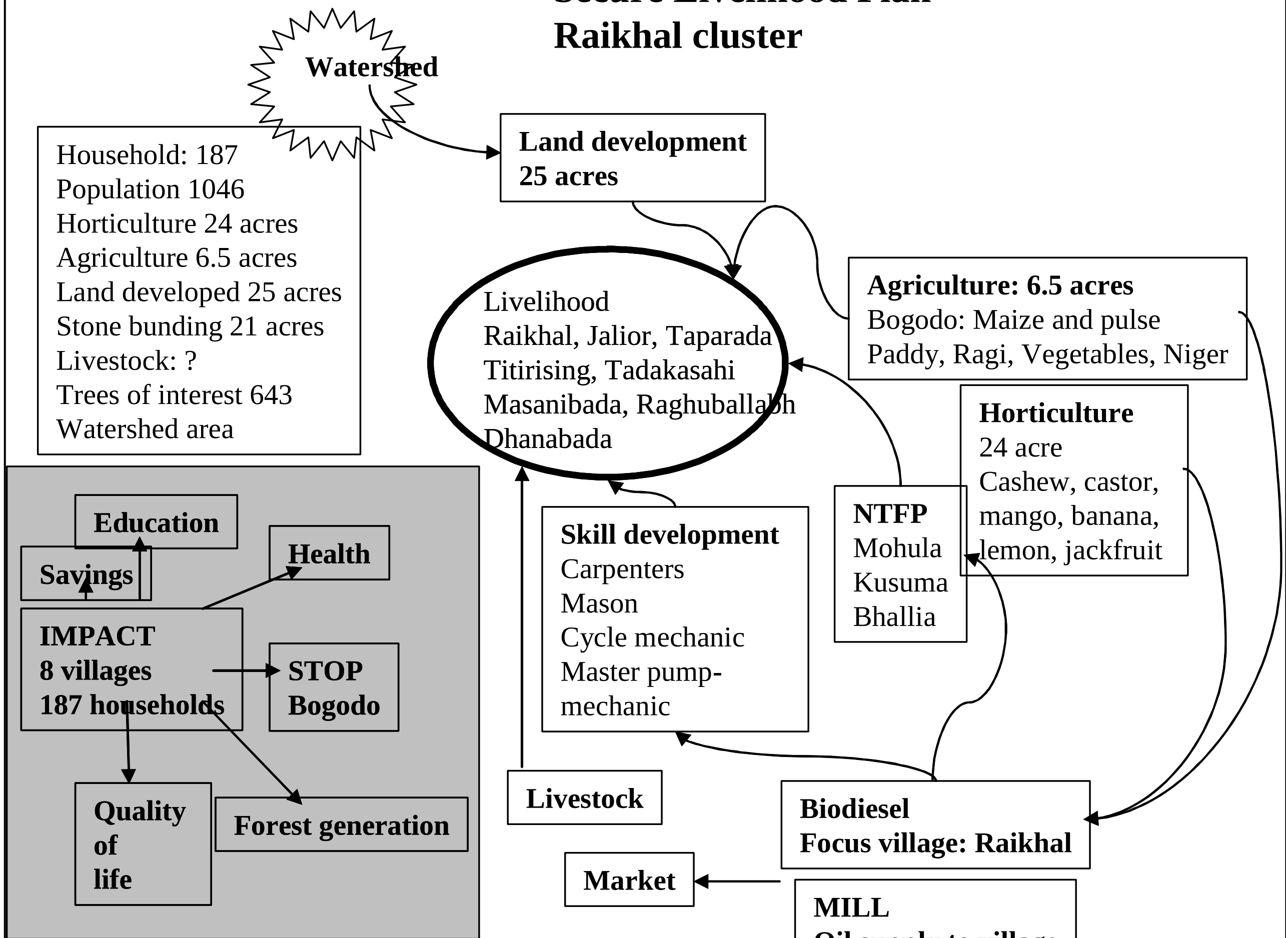


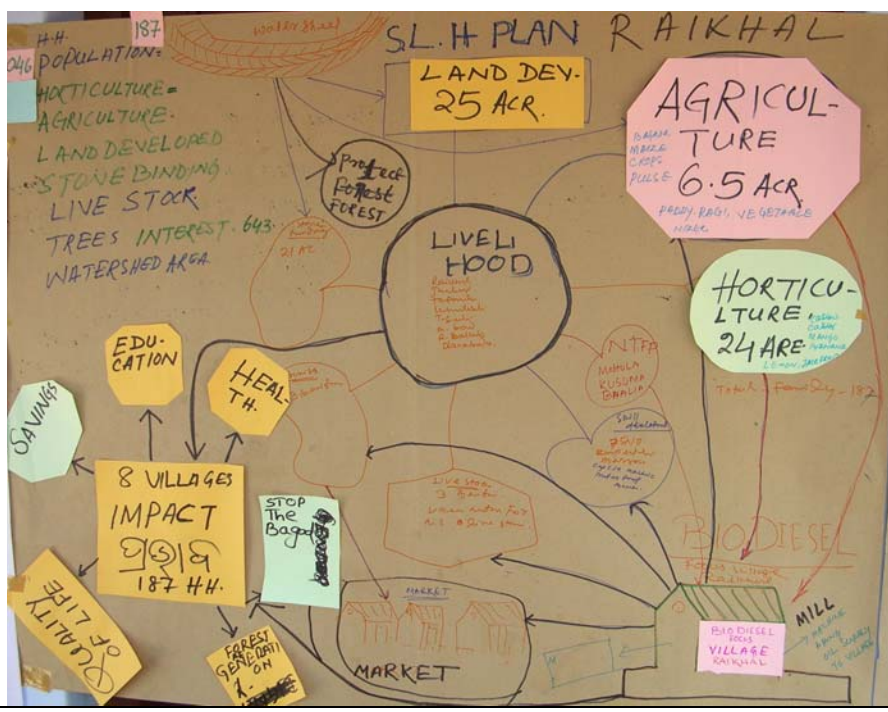


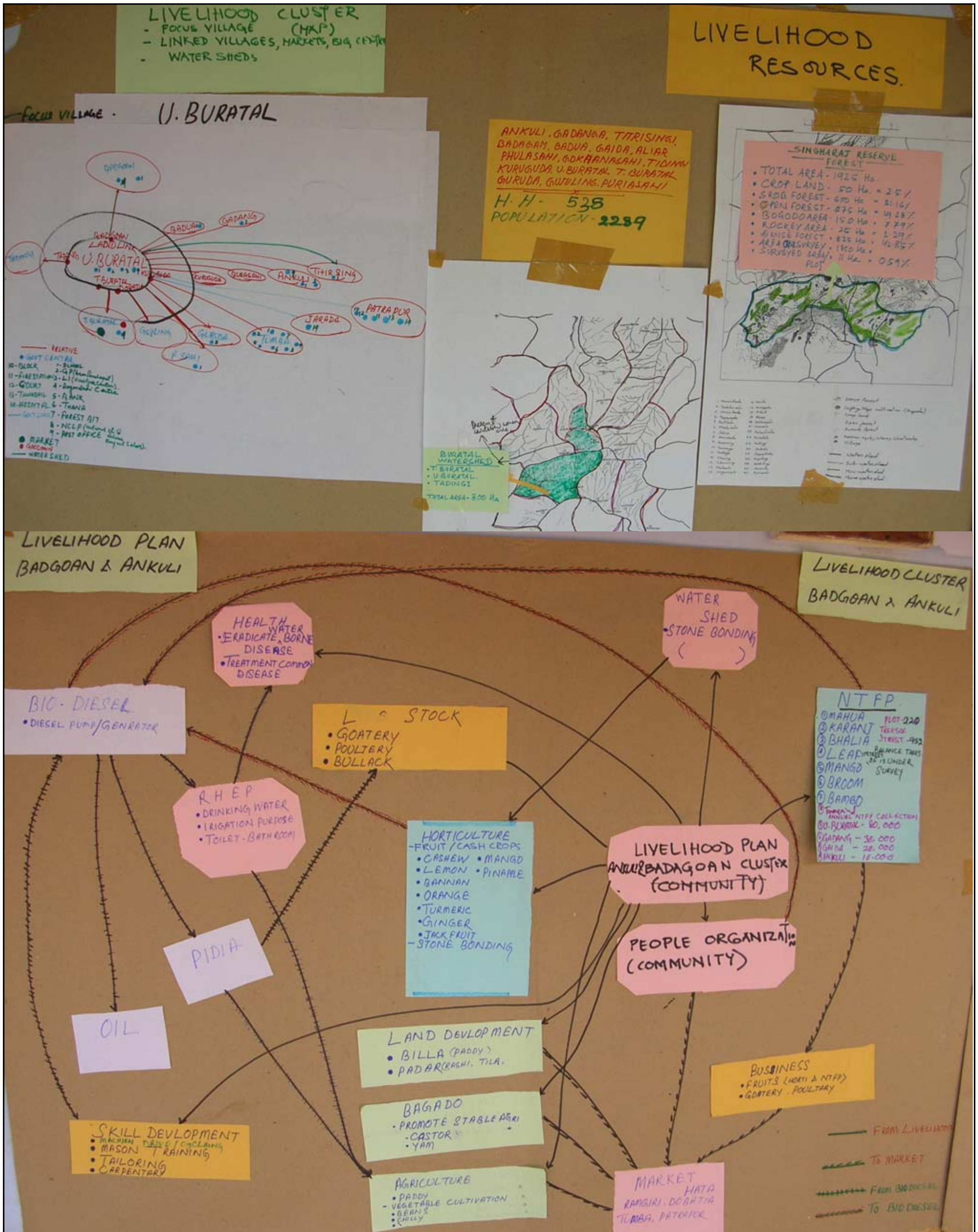
Existing livelihoods in the Raikhal cluster

an interpretation by the members from Raikhal cluster

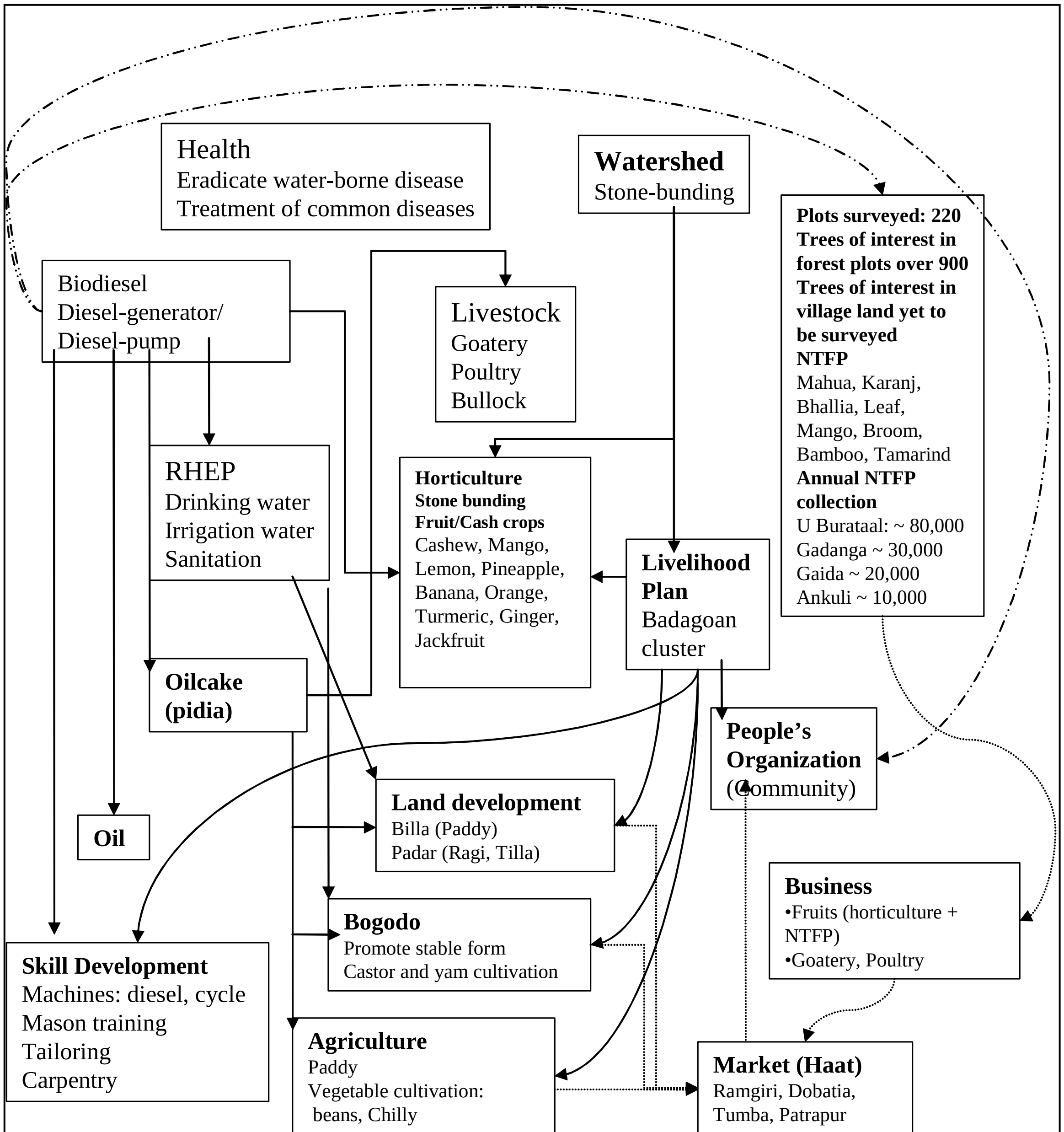
Secure Livelihood Plan
Raikhal cluster







Livelihood Proposal for Burataal Cluster



Livelihood Plan: Burataal cluster
Incl. Badagoan, Ankuli

APPENDIX XI: Excerpt of Proceedings of the Project Coordinators workshop

Biodiesel in Gram Vikas-reflections and future directions

Workshop of the Project Coordinators

6-9 June 2005

Venue: Mohuda, Kinchlingi, KBTT, Goplapur

Proposed program includes field visits

Workshop to review the progress of the biodiesel project and to invite suggestions on:

Gram Vikas Biodiesel project: 2005-2007: the path forward
Technology optimization
Management models (reflections on SETE model)

Workshop Agenda: "Biodiesel in Gram Vikas-reflections and future directions."
June 6th Monday: Arrival in Mohuda
Registration, distribution of information package, logistics, welcome-
Registration form, Feedback form
Afternoon:
3.00 pm to 5.00 pm   Mohuda Pilot plant
Tullo, Niger, CRS oil micro batches
Demonstration on TLC

Demonstration of lime drying

Karanj and rice grinding demonstration (with motor and pedal drive)
Oil press: share yield data

Diesel pump set retrofitting
Corrosion testing
Concluding session 5.30-7.30
Total Biodiesel package:
Cost of machinery
Raw material requirements: requirement planning for Kinchlingi and KB TT
Sample calculation of cost of biodiesel in each of the units
Feedback session 8.00 – 9.00 pm
Logistics for Anandpur, and break up into groups (a small activity/game)
Break-up into groups
Discussion on technology innovations
Plenary: What is adequate and what more may be required
Making a flow sheet and designing a biodiesel facility for each of the village
Preparing for field visit 1
Background on Anandpur pilot plant
June 7th Tuesday: Day 2- Field visit to Village Pilot Plant 1 Kinchlingi
Morning departure for Anandpur (5.00 am)
Field visit to Anandpur 7.00 am – 9.00 am
Reactor demonstration
Water pumping demonstration
Discussion in village on seed collection
Presentation and group discussion 9.30 am to 3.00 pm
Presentation of the volunteer driven model 9.30 am to 10.30 am: Ramani/Geeta
Discussions: understanding the elements of the model 10.30 am to 12.00 am
Split into groups and discuss the model (groups also discuss with the villagers)
Re defining the model: visual representation: 12.00 to 3.00 pm
Afternoon: Plenary: 3.00 pm to 4.00 pm
Presentation of the model by each of the groups
Depart for Rudhapadar: 4.30 pm Arrival: 8.30 pm
Dinner: 9.00 to 9.30
Plenary continued- 9.00 pm to 10.30 pm
Presentation of the Kinchlingi model:
Preparation for filed visit 2
Background on Kandhabanta-Talataila
June 8th Wednesday: Day 3
Morning (5.00 am departure- packed breakfast)
Field visit to Kandhabanta-Talataila 8.00 am to 9.30 am
Demonstration of reactor by SHG
Demonstration of grinder
Demonstration of the water pumping
Discussion with the villagers on seed collection
Presentations and group discussions 9.30am to 5.00 pm
SHG-VSS-VEC based model 9.30 am to 10.30 am
Ramani/Geeta
Discussions: understanding the elements of the model 10.30 am to 12.00 am
Split into groups and discuss the model- Re defining the model 12.00 to 3.00 pm
Lunch 1.30 to 2.30 pm
Presentation of the model: 3.00 pm to 5.00pm
Depart for Gopalpur from KBTT: 5.30 pm
Arrival: 8.30 pm
Dinner: 9.00 to 9.30
Plenary continued: 9.00 pm to 10.30 pm
Presentation of the KB-TT model
Background on Tumba
June 9th Thursday: Day 4
Breakfast 7.30-8.00
Morning session: Presentations 8.30 -10.00
The Biodiesel approach in Tumba
Strategic planning for Tumba (livelihood approach)
Discussion in groups 10.00 -11.30
Reconstructing the SETE for Rudhapadar, Anandpur
Preparing a livelihood strategy for Tumba
Presentation 11.30-12.30
Introducing the ideas of monitoring
Technical and resource
Social-Environmental-Technical-Economic with reference to
Volunteer driven model
Self-Help-Group driven model
Discussion in Groups (contd.) 12.30 – 3.00
Strategy for ITDP and specifics of Rudhapadar
Strategy for ITDP and specifics of Anandpur
Strategy for ITDP and specifics of Tumba
Lunch break 1.30 – 2.00
Plenary session 3.30-5.00
Preparation of presentations for the GV management 5.00 – 6.00
GV management: Plenary presentation 6.00-8.00
Introduction by Urmila:
Part 1: Assessing the present status - Summary of field visits and pilot plant visit -
Part 2: Future Strategic plan
Livelihood approach for biodiesel in Tumba
Overview of Social-Environmental-Technical-Economic with reference to
Volunteer driven model in Anandpur-strategy in Kinchlingi
Self-Help-Group driven model in Rudhapadar: strategy in KB-TT
All plans will also include:
Monitoring plan: Resources, Technology, Management system
Discussions 8.00- 8.30
Concluding session by moderator 8.30 – 9.00
Dinner: 9.00- 10.00
Vote of thanks Ramani: 10.00 – 10.30

Background information for design of VLB in respective project areas

Maximize benefits to community and environment
Socially Responsive Environmentally friendly Techno Economic (S-E-T-E) feasibility assessment

Social	Environmental	Technical/Economic
Institutions /Organization Global (International)/Macro National/Macro State District Pantheist-Village	To be discussed	½ HP pump = 3.5 hp engine 3.5 x 250 ml/h 1 hp = 0.75 kW kW/3 =2.8 kW kW reqd. /80% = 2.8 kW kVa generator x 75% 1.5 kVa 4.5 kW engine /0.75 = 6HP l diesel/hp/h ¼ l/hp/h = 1.5 lph

Developing a management strategy

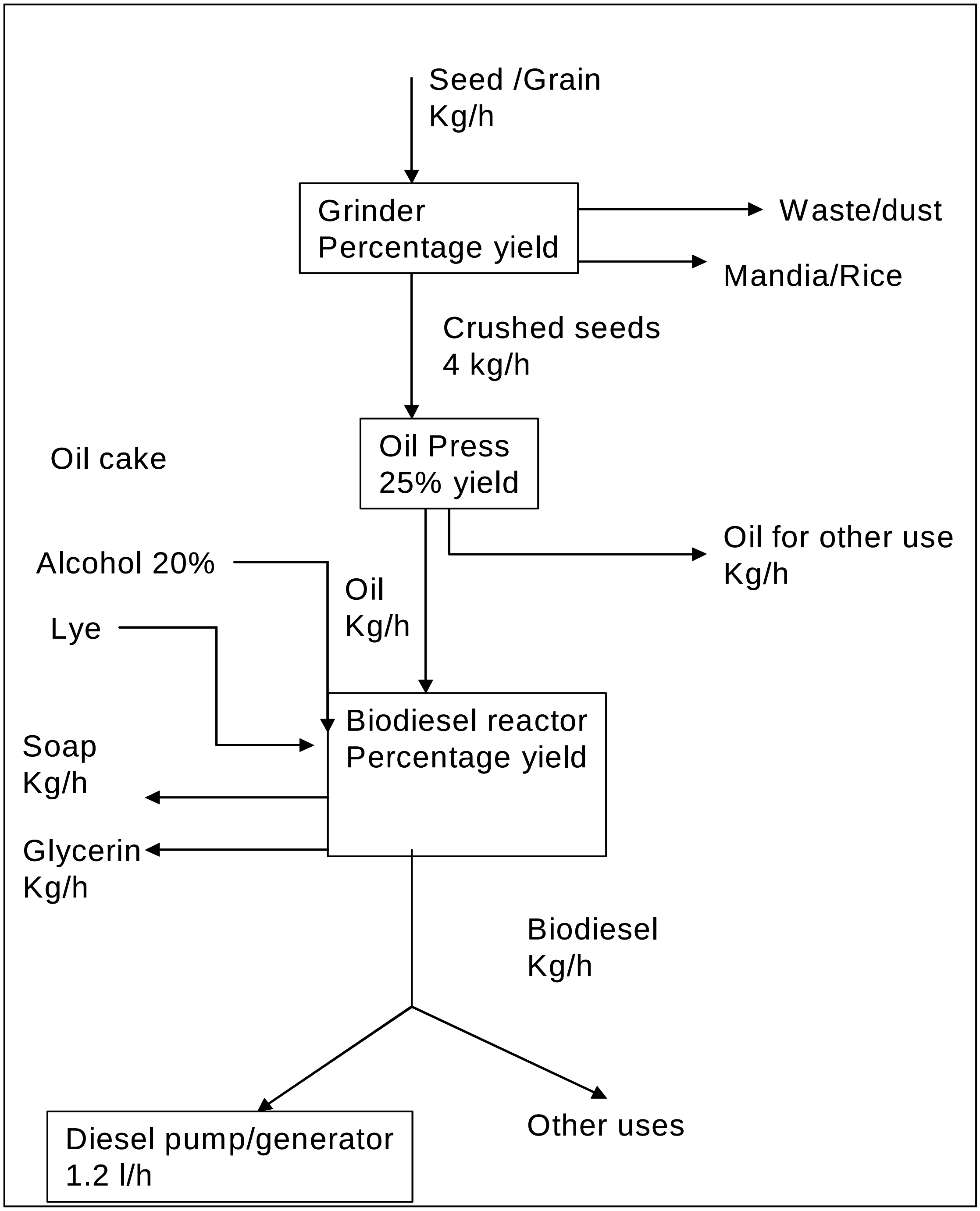
Part 1
People required
Hours of operation
Material procurement plan
Seed type
Source and seasonality: Forest, agriculture
Machine configuration
Raw material requirement
Part 2
Identify all emerging activities Identify who is responsible
Part 3
Linkage with overall plan
Indicator to measure success
Part 4
Technology
What is available what requires more work
Fine tune presentation on the basis of feedback

Presentation format of 3 proposals
Kinchlingi
Kandhabanta
Tumba: Burataal and Raikhal cluster
Evaluate proposals for Social benefits, Environmental benefits and techno-economic profitability
Selection of one proposal based on SETE
Preparation of presentation for Management Group

Sheet 1:
Assumptions
S-E-T-E
Sheet 2
End use
Machine configuration
Raw material
People
Labor
Material procurement plan
Sheet 3
Organizations/Institutions
Legal implications
Sheet 4
Linkage with overall ITDP
Objectives
Monitoring indicators
Will the scheme work in their area

Socially responsive Environmentally Friendly Techno Economic Feasibility
SETE
Aim: Maximize benefits to community and environment (and to the individual)
Techno-Economics
Maximize profits

Fixed costs Rs./year	Variable costs Rs./litre
Capital costs Machines Interest charges Depreciation Labor/operator	Raw material Reagents Maintenance



Flow sheet of the VLB production process (as presented on 9th of June 2009)

Participants of the workshop of Gram Vikas Project Coordinators: 6th -9th June, 2005

Sl. No.	**Name of participant**	**Project** *e.g.* ITDP Tumba	**Field of work** e.g. RHEP, education, health, cluster-in charge	**Contact address**
1	Abhimanyu Mohanty	MANTRA-ITDP Rudhapadar	Project Coordinator	Gram Vikas Rudhapadar
2	Arukh Padmanav	Head Office	HID	Gram Vikas Mohuda
3	Asish Panigrahi	CNBFES	Mechanical Engg.	Gram Vikas Mohuda
4	Bhabani Shankar Sahu	CNBFES	Jr.Engg. Chemical	Gram Vikas Mohuda
5	Digambar Dash	ITDP Thuamul Rampur	Project Coordinator	GV, at Kumardhubhi, PO Sirimaska, via Thuamul Rampur, Kalahandi
6	Geeta	CNBFES		GV Mohuda, vía Behrampur, Ganjam
7	Jeevan Mishra	ITDP, Karadasing	Project Coordinator	Karadasing via Rayagada, Gajapati
8	Kailash Sahu	DIDN'T ATTEND	Project Coordinator	
9	Laxmidhar Bhuyan	RHEP Ganjam	Project Coordinator	Mohuda, Gram Vikas
10	Mukta Roshan Jojo	Mohuda	SHG, ITDP	Mohuda Gram Vikas
11	Naghendra Dash	ITDP, Anandpur	Project Coordinator	Anandpur
12	Narhari Raut	RHEP, Ganjam	Project Coordinator	Mohuda RHEP Section
13	Natobar Padhy	DIDN'T ATTEND		
14	Parameswar Gauda	CNBFES	Mechanical	Gram Vikas Mohuda
15	Ramani	CNBFES	Mechanical	Gram Vikas Mohuda
16	Sanjukta Parida	ITDP, Rudhapadar	Health	Gram Vikas Rudhapadar
17	Sarat Mohanty	ITDP, Rudhapadar	Agriculture	Gram Vikas Rudhapadar
18	Saroj Porichha	ITDP, Tumba	Project Coordinator	Puriyasahi
19	Sasikala Tripathi	ITDP, Anandpur	Cluster Coordinator	Anandpur
20	Srikant Panda	CNBFES	Mechanical	Gram Vikas Mohuda
21	Urmila Senapati	ITDP	Program Manager	Gram Vikas Head Office, Mohuda

MANTRA: Movement and Action for Transformation of Rural Areas, CNBFES: Carbon Neutral Biodiesel-Fuelled Energy System, ITDP: Integrated Tribal Development Program, RHP: Rural Health and Environment Program, HID: Human and Institutional Development

Feedback from the workshop participants

Name	Expectation, in the words of the participant
Mukta Rosanji	Overall idea of biodiesel and long term benefits to Self Help Group in Income Generation Activity
Saroj Porichha	How can biodiesel be integrated in livelihood activities?
Digamber Dash Babu	How can biodiesel be included in livelihoods?
Abhimanyu	How can biodiesel be integrated into livelihood for individual households?
	Why has biodiesel been started in rural areas?
	Process for producing biodiesel?
Narhari	How is biodiesel made?
	How is it managed by the community?
	Cost effectiveness of the project?
Sanjukta	How will biodiesel be sustainable in the future?
	How to provide more benefits and improve standard of life of people?
Lakshmidhara	What is biodiesel and how do we procure/produce it?
	How will the project be implemented in rural area?

Biodiesel to me means….
Natural resource assessment
Self reliance for future fuel
Alternative of diesel
Interesting mechanisms, oil (plants), people’s attitude
More interesting technology people can easily handle
Biodiesel product is important to future of India
Alternative energy to diesel
Alternative energy to technology
Appropriate for hilly areas
Easily handled by poor people
Alternative to diesel
Good means for rural development (utilized in may ways)
Biodiesel can bring improvement in the lifestyle and standard of people
Seeds, oil, biodiesel production
Of all technologies observed biodiesel is easy/self dependent product (energy fuel)
Use of underutilized seeds, alternative for diesel
Locally available diesel, simple technology
(Can lead to) people’s self-reliance

APPENDIX XII: Levels for Decision making by Sector: Additional Tables

TableXII.1: Levels for Decision making by Sector (International and National)

(Adapted from Uphoff 1992)

Levels	Governmental/Quasi-Governmental	NGO /NGO organized	Participatory/ Collective Action	Private/Quasi-Private
International	Intergovernmental Panel on Climate Change, Conservation for Biological Diversity, World Bank, Bilateral funders: Swiss Agency for Development Cooperation, International Development Research Center, Canada, Shastri Indo-Canadian Institute, University of Waterloo, Wilfred Laurier University Automobile manufacturers	Manufacturers (Oil Press from Kickstart, Kenya), ENERGIA, Food and Agriculture Organization	Forum on biodiesel, Wupperatal Institute, Context International	CTx GreEn,: tech know-how, Carbon credit s/offsets,
National India	National Action Plan on Climate Change Biodiesel Mission: Ministry of New Energy Sources Climate change policy regime (blending of diesel) Adaptation policies (First communication reports) Agro-Edible oil import policy University for quality testing, KVIC, Indian Oil Corp.- a GOI undertaking, Central Salt and Marine Research Institute, Bilateral , National Rural Employment Guarantee Scheme, Forest Dwellers Act Panchayats Extension to Schedule Areas, Rajeev Gandhi Village Electrification program Common Minimum Program	Gram Vikas, The Energy Resources Institute, Action for Food Production Organization, MS Swaminathan Research Foundation, OUTREACH. National and International NGOs		Enviro Legal Defence Firm SaDhan (Micro Finance Institution) Commercial suppliers of chemicals Banks Automobile industry Mission Biofuels (and other similar private concerns), e.g., Clean cities biodiesel, Banks, Micro Finance Institutions

Table XII.2: Levels for Decision making by Sector (State, district, sub-district)

(Adapted from Uphoff 1992)

LEVELS	GOVERNMENTAL/QUASI-GOVERNMENTAL	NGO /NGO ORGANIZED	PARTICIPATORY/ COLLECTIVE ACTION	PRIVATE/QUASI-PRIVATE
Regional State of Orissa	Panchayati Raj, Excise, Tribal affairs, Agriculture, Forest department, Agriculture universities, NABARD (National Bank for Agriculture and Rural Development), Rural Banks and Microfinance Institution Right-To-Information Act, Khadi and Village Industries Commission (KVIC), Collector, State Electricity Dept Biju Gram Jyoti Yojana Seed suppliers	Orissa Development Action Forum, Orissa Tribal Empowerment and Livelihood Program, Western Orissa Rural Livelihoods Program: bilateral funds	VLB Working Group	Banks Large biodiesel producers, exporters, importers, Contractors SOUTHCO Machine suppliers: Kirloskar generator *etc.*, Usha Kiran Tillers Jaganathprasad Institute of Technology and Management
District Ganjam Gajapati	District-Rural-Development-Agency, Forest Department (DFO), Department of Science and Tech, Local Universities Central Salt and Marine Research Centre Microfinance Institution (BASIX, others)	NGO (Gram Vikas)		Retailers Small & Med. Oil mill owners material suppliers, seed outlets Private companies
Sub-district/ Block Jagannathprasad, Gosani, Patrapur	Block Development Officer, Police, Forest Range Office (Ranger), Local micro-finances thru National Agricultural Bank for Agriculture and Rural Development Lead Banks (for Microfinance)	Local Biodiesel production units: VLB RHEP team		Local markets, Traders at market Local oil mill owners

TableXII.3: Levels for Decision Making by Sector (local level)

(Adapted from Uphoff 1992)

LEVELS	GOVERNMENTAL / QUASI-GOVERNMENTAL	NGO /NGO ORGANIZED	PARTICIPATORY/ COLLECTIVE ACTION	PRIVATE/ QUASI-PRIVATE
Locality/ Panchayat Banta Latigoan Ankuli	Panchayats Extension to Scheduled Areas, Agriculture extension officer, Forest Officer Gram Sabhas (community land),	Area committees organized by the NGO Gram Vikas, Van Suraksha Samiti, NGOs, jatropha seed and planting material suppliers, Local biodiesel production units	Federations of Self Help Groups Village Level Biodiesel, VLB proponents	Businesses Markets Brewers of alcohol Barefoot technicians Rice huller operator (ex-VLB technician) Local money lenders
Community/ village: Kandhabanta Talataila, Kinchlingi Raikhal	Post-office/bank - savings Primary school Extension worker Ward member	NGOs, Gram Vikas VEC, SHGs User groups for water, energy Barefoot technicians	Forest protection savings group, Kula: Tribal council	Village shops, mosque, committee for village welfare Agro-service centres
Group	Govt. Health Worker Members Gram Sabhas Forest protection committees (VSS)	Self Help Groups SHG run VLB	VLB proponents: Volunteer run VLB	Micro-enterprises for Oil expelling, VLB, Finished product sales, BD services
Household	Citizen/voter/partaker of services	Women member of SHG	Youth, Men, older women	Households with water /electricity connections from Kinchlingi and KBTT + Tumba area Farmers Minor Forest Produce / seed collectors

APPENDIX XIII: Obstacles, directions and players involved

Table XIII.1: Building block: Rural Energy Planning

Obstacle	Micro level players Village, block	Meso level players District, state	Macro player National, Global
Cash based, export oriented economy	**Strategic direction:** Integrate biodiesel systems with local livelihoods		
"Mine-set" for immediate profits	Private farmers, Gram Sabhas (community land) NGOs, jatropha seed and planting material suppliers Local micro-finances thru NABARD (National Bank for Agriculture and Rural Development), Saukars- local money lenders	State Government Forest Department Department of Science and Tech Local Universities Private companies Central Salt and Marine Research Centre NGO (Gram Vikas)	Indian Oil Corp.- a GOI undertaking Automobile industry Central Salt and Marine Research Centre Mission Biofuels (and other similar private concerns), e.g., Clean cities biodiesel
Biodiesel being promoted for transportation			
Emphasis on large scale production			
Local oilseeds (like niger and mohua) becoming cash crops that serve an export market in North America and Australia… *no local value addition* Ready cash offerings to indebted farmers by middle men and traders (*saukars/money lenders*)			
Un-marketed byproducts, No market linkages for sale of glycerin and soap			

Table XIII.2: Building block: Legal and Policy regime

Obstacle	Micro level players Village, block	Meso level players District, State	Macro player National, Global
Obstacle: Legal impasses in excise policy	**Strategic Direction:** Empowering Gram Sabhas to initiate legal changes in favor of biodiesel		
Permit delays to purchase, store, transport absolute alcohol Permit fees and excise duties adding to the cost of absolute alcohol	Entrepreneur SHGs VECs Barefoot technician Biodiesel team Police Gram Sabha NGOs	Orissa (and Bihar) Excise Policy Excise dept. GOO Collector	Biodiesel/Biofuel policy National Action Plan on Climate Change Legal counsel
For the future: permit needed to manufacture (and use, store and transport). Need to lobby for waiver of corresponding permit fees, excise duties			
Follow-up process with the government/bureaucracy tedious and procedures unclear			
Tribals not aware of ever-changing forest policies and new PESA regulations			
Complex forest policies			
Self Help Groups, VEC, VSS not distinct cohesive units, and do not have clear long-term goals not well defined roles and responsibilities of members			

Table XIII.3: Building block: Natural resource management

Obstacle	Micro level players Village, block	Meso level players District, state	Macro player National, Global
Competition with traders	**Strategic direction proposed:** Grassroots dissemination of knowledge and action towards change of policy (Govt. of Orissa intervention)		
Competition with traders exporting seeds Fluctuating seed prices based on external demand Distress sales made to illegal traders who pay ready-cash Tribals' *Need* for instant cash in Jan-Feb (*let's sell seeds now, we'll worry later about buying cooking oil for own use*)	Villager , SHGs Traders at the local market Local oil mill owners Middle men/traders Barefoot technicians VLB proponents NGO	Retailers Med. Size Oil mill owners NGO	Large biodiesel producers, exporters, importers, climate change policy regime (blending of diesel) Agro and Edible oil import policy

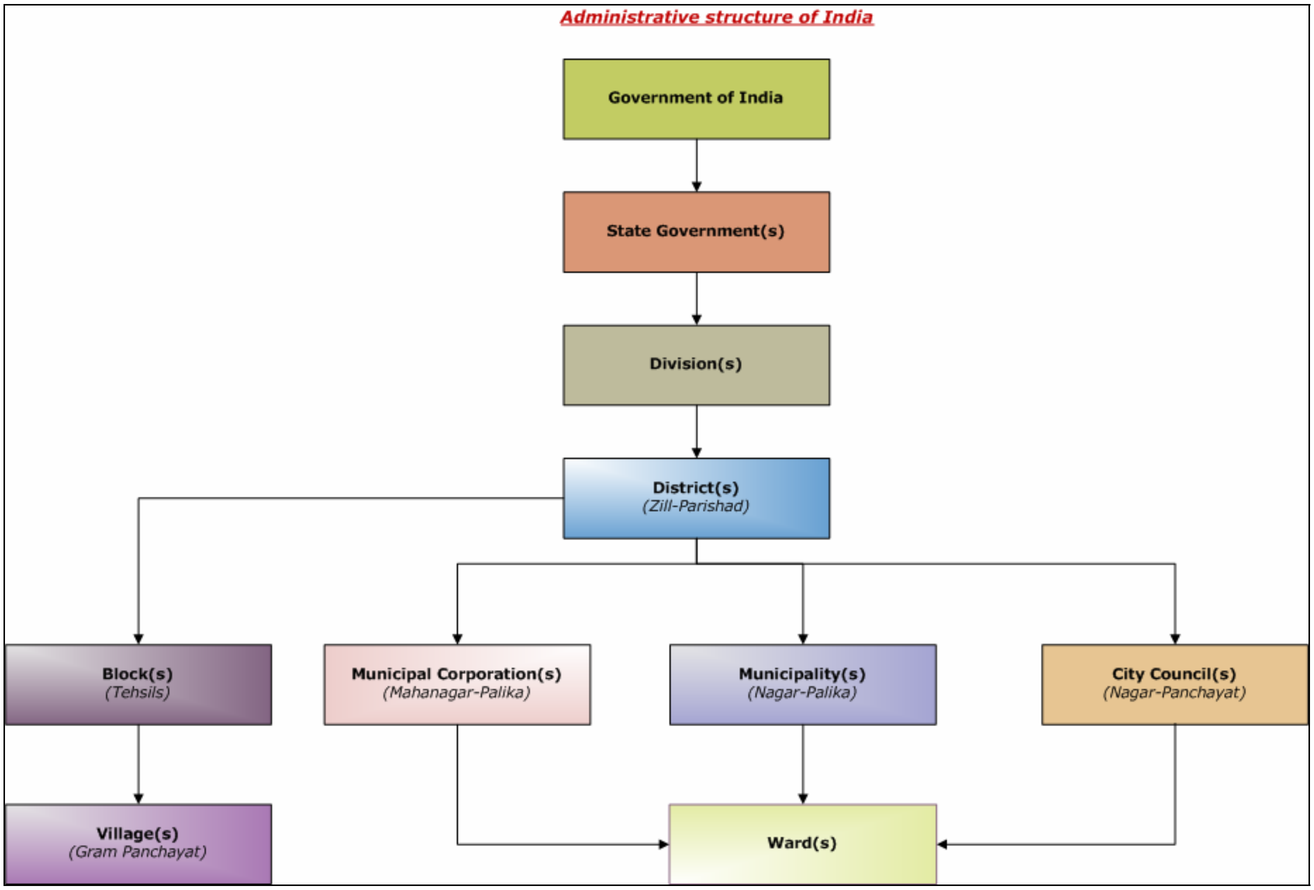
Table XIII.4: Building block: Institutional structures

Obstacle	Micro level players Village, block	Meso level players District, state	Macro player National, Global
Obstacle: Fragile village institutions	**Strategic Direction:** Establish viable marketing linkages involving multiple stakeholders		
Absence of strong Panchayati Raj Institutions (PRIs) with understanding of their statutory powers	Villagers, members of Gram Sabhas, Forest protection committee (VSS), Village Executive Committee (VEC), Self Help Groups (SHGs) NGOs, Gram Vikas Barefoot technicians VLB proponents	Forest Dept. State Government (Panchayati Raj, Agriculture, Excise), District-Rural-Development-Agency NGOs, Rural Banks and Microfinance Institutions. Right-To-Information Act	NGOs, Banks, Micro Finance Institutions National Rural Employment Guarantee Scheme Forest Dwellers Act, Panchayats Extension to Schedule Areas

Table XIII.5: Building block: Appropriate Tech package, Micro-energy system

Obstacle	Micro level players Village, block	Meso level players District, state	Macro player National, Global
Obstacle: Unsustainable financing	**Strategic Direction** : Source sustainable micro financing		
Comparison with price of petrodiesel (subsidized and hence lower in price)	Villagers, consumers of end uses, products Entrepreneurs NGOs VECs Self Help Groups Local markets Local oil expellers Local BD production units Local brewers of alcohol Police RHEP team	State Electricity Dept SOUTHCO Contractors OTELP, WORLP: bilateral funds Excise department Khadi and Village Industries Commission (KVIC) Microfinance institutions, Banks	Ministry of New Energy Sources National Action Plan for Climate Change Adaptation policies (First communication reports) KVIC Banks
Tariff-collection from tribal villagers is difficult			
Villagers usually first-generation entrepreneurs, lacking basic business or technical skills			
Village-enterprise needs operating cost support			
High cost of ethanol (excise duty, permit to manufacture, store, transport)			
Un-marketed byproducts No market linkages for sale of glycerin and soap			
Biodiesel being perceived only as hardware without the enviro-social benefits			
Local NGO in withdrawal phase, concentrating mainly on building infrastructure			

APPENDIX XIV: Administrative structure of India



Source:
http://upload.wikimedia.org/wikipedia/commons/c/cd/Setup_of_India.png

Endnotes and data sources

[1] Edible oil import in the ongoing oil year (which ends in October, 2009), is placed at 5.53 million tonnes against 3.09 million tonnes. Close to 79% of edible oil imported during the ongoing oil year are palm oil(including crude palm oil, RBD palmolein, crude olein, crude palm kernel oil) with the balance being soft oil(soya oil and sunflower oil). It was as recently as March 2009 that the Union government decided to scrap the 20% customs duty levied on soya oil. Palm oil imports are duty free (ET Bureau, 2009).

[2] In April 2009 India's import of edible oil was 659,477 tonnes according to the Solvent Extractors Association of India, as reported on the Wall street Journal, posted 5Jun2009. Retrieved on 17Aug09 from http://www.livemint.com/Articles/PrintArticle.aspx?artid=9E0FAFC2-51BD-11DE-A904-000B5DABF636

[3] India exports about 3000 MT of niger of which 75% is exported to the USA. Other major importers include EU, Singapore, Canada, Mexico, and Brazil. Retrieved Aug 19, 2009 from http://www.agricommodityprices.com/niger_seed.php

[4] The State for the purposes of this research includes political entities at the national, regional and municipal levels.

[5] Market for the purposes of this research is the conventional economic system based on capitalism that encourages commodification (Fowler 2007).

[6] According to Amartya Sen, entitlements are the set of alternative commodity bundles that a person can command in society using the totality of opportunities that he or she faces. (as quoted in Leach *et al*. 1997, p.8)

[7] A watershed is defined as the drainage basin or catchments that drain into a common outlet. A micro watershed covers an area of approx 400 ha. Several micro-watersheds together form a mini watershed. A collective of mini watersheds form a sub watershed and several sub watersheds form a "watershed." Technical aspects in watershed development, Watershed Organization Trust WOTR)

[8] The house consists of a basis of material and non-material resources, spaces ranging from a socio-economic, familial or personal nature and a roof providing for individual, family or collective orientation.

[9] Earlier villages that had been selected within a 10km radius of Gram Vikas had either been electrified or included for other demonstration projects and so Kinchlingi, 100 kms away but easily accessible by road was selected.

[10] India, Agroecological zones, map prepared by National Bureau of soil survey and land use planning, Indian council of Agricultural Research, 1992 (2nd edition)

[11] There are at least 62 tribes in the list of Scheduled Tribes notified (after addition/deletion)as per the Scheduled Castes and Scheduled Tribes Order, 1950 as amended by Modification Order, 1956, Amendment Act, 1976 and The Scheduled Castes and Scheduled Tribes Order (Amendment) Act 2002 No. 10 dated 8.1.2003 of Ministry of Law & Justice republished by the Notification No. 7799/ L dated 7.6.2003 of Law Dep't, Govt. of Orissa

[12] Upadhyay, 2005; CTxGreEn & ELDF, 2007. Policy Imperative #1: Excise exemptions for manufacture of biodiesel including exemptions for scheduled areas. Also in CTxGreEn, 2007.

[13] Inputs were given when CTxGreEn attended the meeting "Discussion of the Draft Biodiesel Policy" 05 Feb 2007, Bhubaneswar, Orissa, India, organized by the Orissa Renewable Energy Development Agency. The most important principle of local production for local use was left out when the policy was finally drafted.

[14] http://www.wakeupcall.org/administration_in_india/poverty_line.php

[15] Survey_updatedKinchlingi_24Jan09.xls in CTxGreEn's database in Mohuda, Orissa, India.

[16] There were over 2000 cashew trees in Kinchlingi, as per an inventory done by Gram Vikas, May 2004

[17] Details of data collected on the niger productivity are in files (Niger BD Cost file-25Apr07.xls, sheet: Niger seeds_KN06_07) in the CTxGreEn database at Mohuda, Orissa, India.

[18] A gravity flow system taps an aquifer at a higher elevation to supply water to the village at a lower level. Except for the capital cost of pipes and a holding tank water can be tapped with almost no operating costs.

[19] RGGJY, Rajeev Gandhi Gram Vidyutkaran Yojana is a program of rural electrification promoted by the Government of India under its Common Minimum Program (2004). That covers un-electrified, de-electrified and partially electrified habitations with a population more than 300. Since many villages in Orissa have much smaller population, the Government of Orissa has launched the Biju Gram Jyoti Yojana to address the need for electricity in habitations with population less than 100. Details are available at http://india.gov.in/outerwin.php?id=http://www.orissa.gov.in/energy/index.htm

[20] The plough with the draught animals is currently available at Rs. 100/hour +meals for the day. A pair of bullock could take up to 8 hours to finish an acre of tilling (two rounds of tilling) and could cost Rs. 700 to 800 (excluding meals). Although at tiller hiring charge of Rs. 300/hour it is more expensive than the plough, at Rs. 200/hour the tiller works out to be cheaper than both the tractor and the bullock, and also allows a profit of Rs. 600/-

[21] Gazette of India (2006). The Rural Electrification Policy, GOI, 2006, in compliance with the Electricity Act of 2003 sets out the 'minimum lifeline consumption of 1 unit per household per day as a merit good by year 2012.'

[22] We refer to them as zero-generation entrepreneurs to indicate that they are at a level even below what a first generation entrepreneur would be, in terms of understanding business economics. The trader usually does all the calculations on their behalf and the villagers just accept whatever he offers.

[23] Voltage consumption was measured twice every day: before the lamps were given to the villagers every evening and again every morning before starting the charging activity. The voltage drop is a measure of the Ah and Wh consumed, and hence it is a measure of the percentage of the battery's charge that was consumed. This index was monitored by the two boys from Kinchlingi, Suresh and Raju, and one of their tasks was to keep the batteries fully charged so that the life of the battery is enhanced.

[24] The housing loan was for a 2-room unit with kitchen and veranda for Rs. 30,000/-.

[25] Details of the data are in the research file Data_analysis.xls (Aug07) in the CTxGreEn database in Mohuda, Orissa, India.

[26] Societies Registration Act of 1860. Can be downloaded from : http://orissagov.nic.in/p&c/ngo/SOCIETIES%20REGISTRATION%20ACT.pdf

[27] Details of the data are in the research file NatRes_PLOTDATA-Digital-record_kbtt.xls (NRJP2_KBTT_13Aug05) in CtxGreEn's database in Mohuda, Orissa, India.

[28] Details of the data are in the research file: tree-counting-KB_TT.xls (Nov 2005), in CTxGreEn's database in Mohuda, Orissa, India.

[29] The yield was calculated for trees at different levels of maturity. Mahua flower yield is 15-30 kg, mahua seed 6-20kg and karanj seed 6-18 kg. Survey dated September 2005.

[30] Details of this data are in the file Eng_workshop_anl.xls (Nov 2004) the workshop was facilitated by the researcher on behalf of CTxGreEn. In CTxGreEn's database in Mohuda, Orissa, India.

[31] Details of the data are in the research file: BD cost_04_08-GV-RS-rev3.xls (KBTT), in CTxGreEn's database in Mohuda, Orissa, India.

[32] Personal communication. Interview with Urmila Senapati, Project Manager, Gram Vikas, conducted by researcher in the Fall of 2004.

[33] Personal communication. Interview with Jayapadma Vaidyanathan, Project Manager, Gram Vikas, conducted by researcher in the Fall of 2004.

[34] Workshop was conducted in November 2004 by Achla Savyasachi, SaDhan, assisted by the researcher.

[35] Details of the data are in the research file: Niger BD Cost file-25Apr07.xls in CTxGreEn's database in Mohuda, Orissa, India.

[36] Details of the data are in the research file: Niger BD Cost file 25Apr07.xls in CTxGreEn's database in Mohuda, Orissa, India.

[37] The emission factor is calculated using the index suggested by WISIONS (www.wisions.net) in their CO_2 calculator: of 0.0258 t CO_2/litre of kerosene

[38] This data was gathered by the researcher during preliminary studies conducted in 2004 to develop a baseline for the Gram Vikas CTxGreEn Biodiesel project. Information is available in data_analysis.xls

[39] Design by Ramani Sankaranarayanan based on option proposed by Rohitha/Ajith on 05Aug07 - w/ACCENDO data 08Apr08. Details of this data are in the research file: KBTT-preFSBlty-Rev3-09Apr08-rcvd-12Jul08-RS28sep08.xls in CTxGreEn's database in Mohuda, Orissa, India.

[40] The Singharaj Reserve Forest occupies about 2100 ha and the Bengasahi Reserve Forest 10,000 ha as calculated from maps obtained from the Orissa Remote Sensing Agency, ORSAC.

[41] The Bagalati dam is a landmark visible clearly in the North in the remote sense image in Fig 3-5.

[42] This is a conclusion from an ongoing analysis of the livelihood system which was initiated through a workshop by the author and an agronomist in August 2004.

[43] Reported IMR by as per Gram Vikas Staff was 161/1000. However since the population of the region is only 2900, with 133 children below the age of one, it is deduced that approx 21 mortalities occurred. The IMR in Orissa is reported to be 96/1000 live births with the country recording an average IMR of 60/1000 (Ref: Singh B. Infant mortality rate in India: Still a long way to go. Indian J Pediatric 2007;74:454-454; (http://www.ijppediatricsindia.org/text.asp?2007/74/5/454/32537).

[44] Nuakhayi literally translates as "eating new food" and signifies the first harvest of any vegetable, cereal or pulse crop.

[45] Varieties of millets (Kangu, Suan, Ghantia), cowpea (Jhudungu), bean (Dungarani), Sorghum (Janna), lentil (Kandulo).

[46] The survey design for the natural resource assessment in Tumba was facilitated by Nina Sengupta, on behalf of CTxGreEn between Apr-Nov 2005. Sengupta, a member of the WBDM2003 team at that time, also trained the village team in Tumba to collect information, and tabulated the data which was later used by BN Mishra in the analysis.

[47] Details of this data are in the research file: NatRes-PLOTDATA-Digital-record_sorted info.xls in CTxGreEn's database in Mohuda, Orissa, India.

[48] Mishra BN. Landuse/ landcover assessment of Tumba region, a part of Ganjam district by remote sensing and GIS technique, Report submitted to the CTxGreEn-Gram Vikas Biodiesel project, BAM university, May 2009

[49] The workshop was facilitated by the researcher (Geeta Vaidyanathan) with assistance from the agronomist Dr. Ravi Kumar. Dr Jagannath from the Swiss Agency for Development Cooperation (SDC) also attended the closing session to discuss the relevance of Dr. Ruedi Hogger's Rural Livelihood Framework.

[50] Details of this data are in the research file: treecount_Raikhal cluster_rev May 22_2006.xls in CTxGreEn's database in Mohuda, Orissa, India.

[51] Details of this data are in the research file: Raikhalwatershed_NR_jun06.doc in CTxGreEn's database in Mohuda, Orissa, India.

[52] In spite of the contributions to the village fund at Rs 4/running foot, a team of 10 people can easily construct between 100 to 200 feet which can earns every person anywhere from Rs 40 to 80 per day (the minimum wage for unskilled labour in the area is about 55/day but in the village the wages earned are usually only Rs 35 .day).

[53]Interview with Rabi Mallick, farmer in the village of Tamana, conducted by researcher on January 29th 2009.

[54] Details of this data are in the research file: NOC-fertlzr-forpaddy-TNB-21Jul08.xls. Composition of the niger cake is as reported to be: N=4.7%, P_2O_5=1.8% K_2O= 1.3% in CTxGreEn's database in Mohuda, Orissa, India.

[55] Details are in the research file: Report_Tumba exposure_16-1707.doc in CTxGreEn's database in Mohuda, Orissa, India.

[56] 3 hours of lighting using LED in 5 villages, would require charging units in at least 4 of the villages. Each of the unit theoretically would be charged at least once in three days using a biodiesel generator for up to an hour. The fuel consumption for this would be 10hours/monthx4generatorsx0.7lph=28lpm or 336 litres/year. For irrigation 4.5acresx2hoursx20days of irrigationx0.7lph=126litres for the season. The total therefore is over 450 litres)

[57] For details see estimate based on yields: consolidated oilseed collection_GV.xls in CTxGreEn's database in Mohuda, Orissa, India.

[58] Details of this data are in the research file: Survey08.xls : the household survey carried out in Raikhal in May 2008, in CTxGreEn's database in Mohuda, Orissa, India.

[59] These details are excerpted from the report: A Pre-feasibility study of the proposed Maa Dwaarashuni oil mill. As a part of the GV-CTxGreEn Biodiesel project's Tumba Livelihood enterprise initiative. Mishra Bishwajita, Mahapatra Nitin, Patil Rajninath. 3May2008

[60] See details of the visit of BASIX team to Raikhal, 10Jun08, in report titled" Visit of Gram Vikas-CTxGreEn Biodiesel project site, Raikhal, Teparda under Ankuli Panchayat. Prepared by Tapas, Biswa and Bhaskar BASIX, Bhubaneswar, Orissa.

[61] According to Amartya Sen, entitlements are the set of alternative commodity bundles that a person can command in society using the totality of opportunities that he or she faces. (as quoted in Leach *et al*. 1997, p.8)

[62] Sankaranarayanan, Ramani (2008). One of four invited panellists, CBD COP 9 Side Event No. 1568: "Making Informed Decisions about Biofuels: The Role of Strategic Environmental Assessment (SEA)," Conference of the Parties 9, UN Convention on Biological Diversity, Bonn, Germany, 27 May 2008.

[63] The oil milling cost of oilseed ranges from Rs. 3 to Rs. 4 per kilogram of seed pressed. The oil cake produced, assuming that the oil yield is 25%, would be about 750 grams. The purchase price of oil cake is presently Rs. 6 to Rs. 10 per kilogram (depending on the type of oil cake).

The value of the cake left behind for every kilogram of oilseed pressed (assuming a sale price of Rs. 8 per kilogram) is Rs. 6, at least 30% higher than the milling charge of Rs. 4/-. Even at the purchase-price of Rs. 6/kg for the oil cake, the value of the cake (Rs. 4.50) is at least 10% higher than the milling charge for oil. In addition, the oil that is milled is usually adulterated with whatever oil was milled earlier, as the oil press is seldom cleaned during the crushing season. The mill owner also retains some of milled oil in the filter of the oil press. The farmer is therefore not getting a good deal. If the farmer were to purchase the cake he would have to pay a premium, which would be 20% higher than the price at which the mill purchased it.

[64] See article by author and Ramani Sankaranarayanan: "Biodiesel – no conflicts here!", as one of five articles examining the impact of biofuels on food-fuel security, Appropriate Technology, Volume 34, No. 3, September 2007, Editor: David Dixon; Publisher: Research Information Ltd., UK. See also www.appropriate-technology.org

[65] Schemes promoted by the State Government of Orissa are Sampoorna Gramin Rozgar Yojana, (SGRY), Orissa Poverty Reduction Mission, Targeted Rural Initiatives for Poverty Termination and Infrastructure(TRIPTI)**,** Mission Shakti, Backward Region Grant Fund, Orissa Development & Marketing Society, National Rural Employment Guarantee Act

[66] The Gram Panchayat is the village level political structure and consists of the Gram Sabha or Village Council where every household is a member, and the Sarpanch or the village headman (See Appendix for diagram of the administrative structure in India).

[67] According to Scoones, an assessment of the outcomes of the sustainable livelihood approach would include: working days, poverty reduction, well-being and capabilities, livelihood adaptation, vulnerability and resilience, natural resource base sustainability (Scoones, 1998).