BIOFUELS FOR SUSTAINABLE RURAL DEVELOPMENT AND EMPOWERMENT OF WOMEN

CASE STUDIES FROM AFRICA AND ASIA

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Foreword

This book of case studies represents a collaborative effort to explore the potential of biofuels to provide sustainable livelihoods and local sources of energy for people in rural areas of developing countries, with a special emphasis on women. Although there are many forms of bio-energy that can be useful in this regard, our focus in this book is on plant products, mostly seeds, used to produce oil - which is then either utilized directly in engines or equipment, or processed into biodiesel.

The research and preparation of the case studies was organized and managed by ENERGIA, the International Network on Gender and Sustainable Energy, with support from the International Union for the Conservation of Nature (IUCN), and SANERI, the South African National Energy Research Institute (Pty) Ltd.

ENERGIA is an international network on gender and sustainable energy with a direct presence in 22 countries in Africa and Asia. ENERGIA has been working in the energy sector since 1996 and focuses on ways in which increased access to energy can improve the lives and livelihoods of women and men in developing countries, with a special emphasis on rural energy access. ENERGIA applies gender analysis to projects, programmes and policies to ensure that women's energy needs, roles, responsibilities, and interests are not overlooked. In many rural areas, poor people still depend on wood and other biomass fuels for most of their household and income-generating activities. The difficult, time-consuming work of collecting and managing traditional fuels - wood, dung or agricultural wastes - is widely viewed as women's responsibility, which is a factor in women's disproportionate lack of access to education and income, and inability to escape from poverty. Therefore, it is important for energy access programmes to have a special focus on women. New options for energy access and sustainable livelihoods, like small-scale biofuels production, can have dramatic benefits for rural women, and their families and communities.

IUCN's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. The aim of IUCN's Energy, Ecosystems and Livelihoods Initiative is to accelerate transitions to energy systems which are ecologically sustainable, socially equitable and economically viable. Since 1998 IUCN has had a gender equity and equality policy in which it recognizes that gender is an essential component in the sustainable use, management and conservation of natural resources. IUCN is committed to mainstreaming gender in its work, and in particular recognizes the importance of gender equity issues associated with its energy programme. In 2008 IUCN entered into a collaborative agreement with ENERGIA to address the complex linkages between biofuels, gender, and environmental issues.

SANERI is a relatively new body, established in October 2004 as a subsidiary of CEF (Pty) Ltd, the state energy company in South Africa. The Department of Science and Technology, together with the Department of Minerals and Energy, are joint custodians of SANERI and assist in providing political and strategic focus for the company. It is the public entity entrusted with the coordination and undertaking of public interest energy research and development, with an emphasis on sustainable benefits to communities. At the 2007 session of the UN Commission on Sustainable Development, ENERGIA collaborated with the Government of South Africa in organizing a panel discussion on “Gender and Energy for Sustainable Development in Africa” which was a starting point for exploring opportunities for collaborative research on increasing energy access and income opportunities for small-scale farmers, especially women.

It is our hope that the case studies and analysis of 'sustainable' biofuels initiatives can provide useful ideas for governments, businesses and organizations undertaking biofuels activities, especially in terms of gender equity, energy access and livelihood opportunities for rural communities.

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Introduction

Examining the Potential of Biofuels for Rural Development and Empowerment of Women

By Gail Karlsson, ENERGIA Senior Policy Advisor, and Khamarunga Banda, Head of the Research and Policy Unit of the National African Farmers Union of South Africa and a member of ENERGIA.

Background

When we began considering local production of biofuels as a possibility for expanding access to energy in developing countries, there was much enthusiasm about the idea of home-grown energy, especially for rural areas where villagers are already engaged in small-scale agriculture. United Nations studies show that available energy systems fail to meet the needs of poor communities, with 2.4 billion people relying on traditional biomass (wood, charcoal, dung and agricultural residues) and 1.6 billion without access to electricity.[1] With prices for fossil fuels remaining high, and energy infrastructure investments for poor countries primarily focused on urban areas and industrial development, many people in rural areas are being left without basic energy services.

Gender considerations come into play because in many developing countries the current lack of energy in rural areas has a disproportionate impact on women. They are the ones primarily responsible for collecting and managing traditional biomass fuels. The long hours and distances travelled by women spend gathering wood or dung, carrying water, growing crops, processing food and caring for their families - all without electricity, motorized equipment or modern fuels - keep them from pursuing education, training and income-generating activities that could help lift them, their families and their communities out of poverty.

In addition, women are the main producers of food crops in many areas. If these women could grow oil-producing crops, sell them for income, and also use the oil for motorized power, electricity generation, household activities and profitable enterprises, this could open up exciting new opportunities for local economic development. Studies have shown that women can also profit by establishing and sharing in bioenergy processing operations.

Definitions used:

Biofuels – Liquid fuels produced from plant products, including pure plant oil, biodiesel and bioethanol.

Biodiesel – A replacement for petroleum-based diesel fuel made by processing plant oil, using alcohol (transesterification).

Bioethanol – A petrol replacement produced by fermentation or chemical processing of sugar or starch crops such as sugarcane, sugar beets, corn and wheat.

At the 2007 session of the UN Commission on Sustainable Development (CSD), which included discussions and recommendations on energy for sustainable development, a number of governments announced that they were launching or expanding biofuels programs. Many highlighted the potential of biofuels as an option to increase opportunities for rural development, diversify energy sources, and reduce air pollution and greenhouse gas emissions. [2]

Women's representatives at the CSD recommended that: "Governments…should explore investments in local production of biofuels for use in meeting the energy needs of the poor in an environmentally friendly way."[3] The women's group also urged governments to undertake documentation of best practices in biofuels production for guidance in adopting gender mainstreaming approaches, and to place more emphasis on small-scale agriculture and informal income-generating activities in which women predominate.

Sustainability of biofuels

Biofuels soon were being viewed with less enthusiasm. Controversy erupted over sharply rising food prices, amid concerns that the diversion of agricultural production from food to biofuels was responsible, at least in part, for food shortages in countries already suffering from widespread poverty and hunger. United States subsidies for production of ethanol from corn came under attack, along with European Union policies promoting the use of biofuels for transportation. In Africa, civil society groups and unions called for removal of some food crops from the biofuels feedstock mix.

In addition to exacerbating food shortages and poverty, biofuels were being linked to deforestation, neo-colonialism associated with the establishment of biofuels plantations on huge tracts of land in developing countries, and displacement of small farmers and indigenous people from their lands – as well as increased production of greenhouse gas emissions, due to the loss of trees and the use of fossil fuels in planting, fertilizing, harvesting and processing biofuels.

There were also concerns that women would be disproportionately affected by large-scale biofuel production if they were to lose access and rights to land and resources they relied on for collecting fuel and water for household needs, growing food, and gathering fodder, medicinal plants and wild food. An FAO report warned that the potential environmental and socio-economic risks associated with large-scale production of liquid biofuels in developing countries might affect men and women differently, particularly due to inequalities in terms of access to and control over land and productive assets.[4] In South Africa, for example, women small-holder farmers questioned whether men with larger farms would be favoured as suppliers of feedstock for biofuel processing operations, and more broadly whether women and other small farmers would be left out of the more profitable parts of the value chain of biofuels production.

Much international attention turned towards defining 'sustainable' production of biofuels, and a number of different processes were initiated to discuss set standards and criteria for sustainability in relation to biofuels. Although earlier discussions focused on the benefits of biofuels in reducing overall greenhouse gas emissions from transportation vehicles, due to the growing concerns over food security and displacement of people from their traditional lands, calculations about biofuel production began to take a broader view. Social impacts began to be more closely analyzed and taken into account, in addition to impacts on biodiversity, ecosystems, soil degradation and water scarcity.

The multi-stakeholder process organized by the Roundtable for Sustainable Biofuels produced draft criteria that included an emphasis on protection of land rights, water rights, human rights and labour rights, as well as transparent, consultative and participatory processes for planning biofuels projects. The draft principle on rural and social development states that: "Biofuel production shall contribute to the social and economic development of

local, rural and indigenous peoples and communities."[5]

Still, even when social impacts of biofuels programmes are considered, women's particular concerns are rarely emphasized. In order to address this gap, ENERGIA has recently recommended that environmental and social impact assessments of proposed biofuels projects or programmes should include an evaluation of gender-differentiated impacts – through consultative processes designed to ensure substantial participation of women – and that gender equity should be one of the principles considered in those assessments.

After reviewing information about a variety of different biofuels projects, it seems that village-level projects have great potential in terms of sustainable fuel production and increased access to energy in rural areas of developing countries – if participatory processes are employed in the development and implementation of the projects. On a small scale, locally produced plant oils and biodiesel can successfully be used to power diesel engines and generators in rural villages – for agricultural processing, new enterprises, and income generation. These systems can also ease the burdens of women and foster women's participation in decision-making processes.

Moreover, although most of the threats related to biofuel production come from the operations of big plantations run on an agro-business model, it also does seem possible to try to protect the interests of small landowners and engage them as producers and processors of biofuels as part of a larger value production and supply chain.

The case studies

As part of a larger programme of work on gender and biofuels, we began to look for concrete examples of projects and programmes that linked biofuels production with rural economic and social development, and that had an emphasis or particular impact on the empowerment of women. One of the challenges was that most projects were just getting underway, and there was little data to analyze.

Assessments of proposed biofuels projects or programmes should include an evaluation of gender-differentiated impacts.

We found some projects that specifically target women, but most of them do not exclusively focus on women. It is certainly possible for women to benefit from biofuels initiatives that are not particularly gender-sensitive. However, because there are many differences and inequities in the traditional roles and rights of men and women, it is generally better for women if there is special attention given to constraints affecting women's participation. This can help ensure that women are not marginalized, or effectively excluded from training programmes, extension services, or other critical elements of the programme.

In **Cambodia**, an entrepreneurial farmer is using growing Jatropha and extracting oil from the seeds to run a diesel generator that supplies electrical power for a mini-grid servicing over 80 homes. The diesel generator has been adapted so it can operate efficiently using pure plant oil.

In **Nepal**, community groups are collecting seeds from existing Jatropha plants, expelling the oil, and using the pure plant oil in place of diesel to run irrigation pumps to promote increased agricultural production.

In **Ghana**, a women's group is growing Jatropha, extracting the oil from the seeds and mixing the oil with diesel (70% plant oil / 30% diesel) to fuel shea butter processing equipment, and as a kerosene substitute for use in lanterns.

In **India**, community groups in isolated villages are collecting local seeds from the nearby forest and using oil from the seeds to make biodiesel in a small pedal-powered processor. The biodiesel is used to run water pumps, an electricity generator, and a tiller.

In **Uganda**, women's groups are experimenting with using biodiesel from plant oils to run a multifunctional platform system that uses a diesel engine to power equipment and generate electricity.

In **Sri Lanka** and **Zimbabwe**, the projects involve enlisting small farmers to grow Jatropha commercially to supply a large biodiesel production plant. The Sri Lanka project is a relatively small-scale pilot project mixing commercial fuel crop production with local energy applications. In Zimbabwe, it is a country-wide project managed by the national oil company through contracts with participating farmers.

The **South Africa** project is also a large scale initiative that involves soliciting and training farmers to grow feedstock for a biodiesel plant – in this case sunflower seeds and soya beans. It has been organized with the collaborative engagement of the government, the private sector and research institutions.

Some of the issues discussed in the case studies:

1. Potential for income generation

Although the global growth in demand for biofuels had been driven by concerns about greenhouse gases and climate change, the interest in biofuels in developing countries is primarily related to new possibilities for income – at the household, village, and country level. Rural villagers and farmers, large or small, are seeking new market opportunities – whether they are producing feedstock crops, pure plant oil, or biodiesel; offering electricity or motorized power using biofuels; or providing goods and services with energy from biofuels.

2. Women's benefits from energy access

For women burdened with difficult and time-consuming agricultural and food processing chores, biofuels can provide welcome relief through access to fuel for motorized equipment or electrical power. But village-level projects producing and/or processing biofuels can also require significant labour and organization, as well as training, management and financial investments. The promise and motivation is that this work will lead to the development of new income-producing activities, so that women can afford to send their children to school, feed their families nutritious food,

provide better health care and living conditions, and have more power to make decisions within their households and communities.

3. Adequacy of supplies and markets

In most of the cases, some new type of activity is required to provide plant oil - gathering previously unused nuts and seeds, using existing crops in new ways, or planting new crops. These are experimental activities; some are at the village level, and some are national in scope. It is not clear that the supplies of feedstock will be adequate for the new ventures, or will support significant expansion. Meanwhile, there are concerns about the marketing and distribution challenges, whether in terms of transporting goods out of remote villages, or establishing links to larger national and international markets.

4. Impacts of large-scale biofuels production on small farmers and communities

Everywhere there are concerns about land. Will agro-business companies be allowed to buy up or control large tracts of land and displace or subjugate small farmers and communities? Government policies are needed to manage and regulate the development of biofuels industries, and ensure that small farmers are able to participate in, and benefit from, new business opportunities, rather than losing ground. In addition, more research is needed on the impacts of large-scale conversion of crop land to produce biofuels, on agricultural productivity and food production, as well as on the consequences for existing ecosystems and biodiversity.

5. Financing/investments in rural energy access

Some biofuels initiatives that support rural economic development are financed by energy entrepreneurs, but in most cases there is considerable public funding or donor financing involved. Biofuels projects that are profitable may not be sustainable, and may in fact cause more problems for rural communities than they were already experiencing. There is some possibility that the carbon markets associated with climate change mitigation efforts will provide new funding for biofuels projects that provide rural communities with otherwise unaffordable access to energy.

Conclusions

The global demand for biofuels is expected to continue to increase due to petroleum prices (or shortages), and concerns about climate change and national energy security. The agro-business model for producing biofuels is likely to have profound impacts on land and labour relations in developing countries, as well as creating risks of food shortages and serious environmental damage.

Governments should develop and promote biofuels policies, regulations and programmes that take into account the needs and interests of small farmers and people in rural communities. As women are the key producers of food

and energy crops in many developing countries, special efforts should be made to allow for their effective participation and voice in decision-making about biofuels policies and programmes.

For biofuels to promote the empowerment of women, it is important for women to be involved in planning and managerial decisions, and to have shares as co-owners or investors in biofuels production companies and processing operations, rather than simply providing labour as growers of biofuels feedstock.

Governments, managers and investors in biofuels projects should also incorporate gender equity as a key element in assessing potential benefits and impacts. Since comprehensive data that shows the differences between the roles and interests on men and women is often unavailable, new initiatives and pilot projects should make an effort to capture gender-specific information as one of the factors in determining whether or not biofuels projects are sustainable.

NOTES

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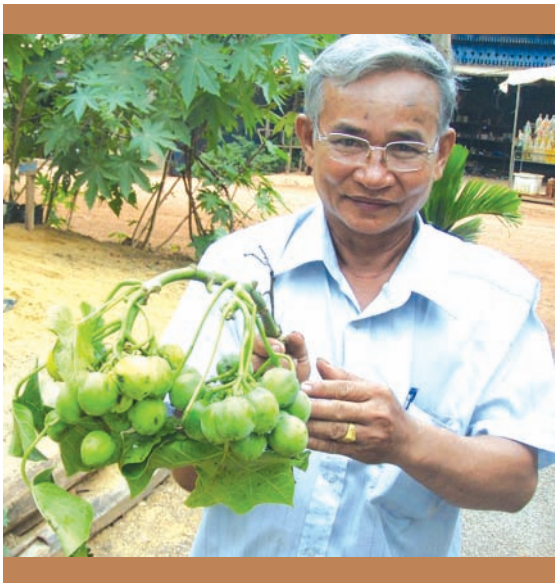
CAMBODIA: Use of Jatropha Oil for Decentralized Rural Electrification

By Tioulong Saumura, President SODECO

Project overview

This project was organized by a Cambodian NGO called 'Solidarity and Community Development' (SODECO), which works on development issues in rural communities, mainly by training women at the village level. The president of SODECO, Tioulong Saumura, is a woman economist who has been a member of the Cambodian parliament since 1998. As part of its work on rural development, SODECO has become involved in activities promoting the production and use of biofuels instead of diesel to run electricity generators. Tioulong Saumura has been directly involved in talking to farmers about what Jatropha can bring to them, planning operations, researching solutions to agronomical and engineering problems, finding funding for many activities and services, and also organizing training sessions with parliamentarians, farmers, and the private sector.

In 2006, SODECO received funding from Vinci, a private French enterprise that built and manages Cambodia's airports, to experiment with growing Jatropha plants in Cambodia. Through this research, SODECO met Mr. and Mrs. Tham Bun Hak, a couple of entrepreneurial farmers from Bot Trang, in Banteay Meanchey province, Mongkolborei district, an area that is out of reach of the national grid. Mr. Hak grows rice, and also uses a generator at his house to produce electricity, which he distributes to over 80 neighbouring families via a system of electrical wires. Up until 2005, he used standard diesel to fuel his power generator. Then he heard about Jatropha oil and started planting Jatropha trees to supply fuel for his generator.



Mr. Hak with a high-yielding branch of a Jatropha plant.

After a few months of using crude Jatropha oil in his diesel generator, Mr. Hak faced the problem of failure of the engine's injector. He reverted to using standard diesel fuel, and was going to destroy his Jatropha plantation. However, after consultation with SODECO – and advice from Dr. Reinhardt Henning, an international expert on Jatropha, and renewable energy experts at GTZ, the German government's international development organization – he decided to convert the engine so it could use crude Jatropha oil without breaking down.

Mr. Hak then entered into a public-private partnership with GTZ, and GTZ provided funding for adaptation of the generator engine – to add a pre-heating chamber for the Jatropha oil before it enters the engine, and a battery to start the cold engine. The conversion of the generator was done by Alexander Noack, an engineer employed by Elsbett, a German company that converts diesel automobile engines so they can safely accept vegetable oil. GTZ also provided funding for Dr. Henning to visit the Haks' plantation and provide advice on selection of high-yield trees, pruning techniques, and mechanical oil-expelling machines (see Box 1).

Financing and profitability

This was initially a private operation funded by investments made by Mr. and Mrs. Hak in their Jatropha plantation and their power production and distribution equipment. After connecting up with SODECO, they entered into a public-private partnership with GTZ. A USD1,500 oil expeller was financed on a 50-50 basis by Mr. Hak and GTZ under the framework of the partnership. GTZ also funded the Elsbett consultancy and conversion kit, and Dr. Henning's visit.

The profitability of Mr. Hak's power distribution business increased immediately after the conversion, because Jatropha oil costs approximately 37% of the price of standard diesel. (See Box 2.)

Mrs. Hak and her daughters have a home-based business producing mattresses and pillows filled with 'wool' produced by Kapok trees (Ceiba pentandra) that they sell at the village market. The profitability of this business has increased since she could afford to switch from pedal sewing machines to electrical ones. Mrs. Hak also sells Jatropha cake, which is the residue left over after the oil is expelled from the Jatropha seeds – as organic fertilizer to nearby farmers and mushroom growers, as animal feed, and for soap-making.

Meanwhile, the Hak family's place has become an attraction. They receive 30 to 50 visitors per day because many people are now interested in this project. Some ask for Jatropha cuttings to plant on their own land, or Jatropha oil to test in their own engines, or Jatropha cake to use as organic fertilizer. Some just ask for advice. Most of the visitors thank the Hak family by donating small amounts of money, thus providing extra income that is not insignificant.

Technology Transfer

Cambodia is dominated by a multitude of subsistence farmers owning less than 1 hectare of land per family. These farmers earn hardly enough to feed themselves and cannot afford to pay high prices for fuel, which has to be transported to their remote rural areas over bad roads. It is much better for them to be able to grow and process their own fuel locally.

The project considered the possibility of making biodiesel fuel from plant oil, but that requires chemicals and processing equipment which are not easily available to poor, remote farmers. There are some engines manufactured in India that can use Jatropha oil without any adaptation, but it would have been impossible for farmers to throw away their existing machines and buy new ones. Instead they determined that it would be cheaper and easier, and more accessible to the farmers, to convert engines so they can use crude vegetable oil, with just some filtering and settling of the sediment.

The concept of conversion kits was particularly attractive because of the potential for easy replication by locals. Alexander Noack, the engineer from Elsbett, brought conversion kits from Germany to Bot Trang and converted the Hak's engine in about one hour, under the eyes of dozens of businessmen, NGO representatives and parliamentarians. It worked immediately, and since then the engine has run on Jatropha or Kapok oil without any problem. In addition, Mr. Hak has successfully converted the engine of a Siam Kubota ploughing machine by copying what he saw Alexander Noack do, and using Siam Kubota spare parts.

Benefits to men and women in the community

When he switched to vegetable oil, Mr. Hak lowered his electricity price by 20%. Before Mr. Hak offered electricity, men in the village would have to take batteries 20 km away to get them charged. At that time, women had to depend on their male relatives to get batteries charged, because it is difficult to go so far on foot, and men are the exclusive owners of bicycles or motorbikes.

Indirectly, the whole village has participated in the Jatropha experiment. Everyone started planting Jatropha trees, and they were excited to confirm that they could produce power from a native plant that they already use for fencing. Jatropha is a good choice because it grows wild everywhere in the area, can be planted easily without much expense, does not need chemical fertilizers or irrigation, survives drought almost indefinitely, and provides other benefits such as organic fertilizer and soap. The villagers also learned how to use vegetable oil as a fuel for their agricultural machines, such as water pumps, rice-mills and mini-tractors.

Electricity distribution to 80 consumers

Local people, especially women and children, found a new opportunity for income generation by collecting the seeds of existing Jatropha trees and selling them for oil production. Picking up Jatropha fruit and peeling off the outer skin is easy, can be done manually, and does not require any special tools such as knives, crushers or pliers.

People also began planting Kapok trees because their seeds, too, can be used to produce oil. Cambodia is a big producer of Kapok wool for domestic use and for export. The seeds picked out of the wool used to be thrown away if they were not needed for planting. Since the seed oil production project in Bot Trang was widely publicized nationwide, farmers throughout the country can now sell their Kapok seeds. The oil content of Kapok seeds is similar to Jatropha, and the efficiency of Kapok oil as a fuel is just a little below that of Jatropha oil.

Demonstrations were also held in Bot Trang and neighbouring villages to encourage the use of Jatropha oil for soap-making, and the cake as an organic fertilizer. In addition, SODECO investigated using Jatropha cake as animal feed, as many farmers noticed that their cattle like to eat the cake when it is placed at the foot of fruit trees to fertilize them. Jatropha cake was known to be toxic to animals and humans alike, but it seems that exposure to sunlight destroys the toxins, and no poisoning of animals has been reported.

Environmental impacts

A major advantage of the project has been reduction of air pollution by replacing diesel with non-polluting vegetable oil. This positive effect was noticeable as early as three months after the shift from diesel to Jatropha oil. The star fruit tree that grows near the power generator had a few branches that were above the exhaust pipe of the power generator. Branches elsewhere flowered and fruited normally each year, but branches above the exhaust pipe never flowered or bore fruit. Three months after Mr. Hak stopped using diesel fuel, all the branches bore fruit, bigger and sweeter than before. Everyone in the village was really impressed and realized that, if the use of diesel affects the health of trees so badly, it must also be affecting human health.

In Cambodia, the most popular machine seen in the countryside is a small ploughing machine. Farmers walk behind it to steer it while ploughing, or they hook up a trailer and it becomes a transportation vehicle for humans and goods. By walking or sitting behind the machine, farmers inhale the harmful exhaust fumes during long working hours. Engines fuelled by vegetable oil produce less harmful fumes, as well as fewer greenhouse gas emissions, and are less noisy than the ones fuelled by diesel.

Jatropha plants also help control erosion, because their roots do not grow vertically deep into the soil but horizontally, which helps hold soil in place.

Participation of women

Easy access to energy in rural areas is a prerequisite for economic development at the local level, and the first step towards increased national development. Actually, this approach to development may be the most socially just and sustainable, as it empowers grassroots citizens, especially women, who are often sidelined when it comes to national-level projects.

The project was not specifically aimed at women because access to electricity benefits everyone in the village, whether male or female. But in situations of extreme poverty, the poorest and most vulnerable are women, and they were certainly the first ones to seize the opportunities offered by the project.

In Bot Trang, a majority of those who participated in training sessions about the cultivation of Jatropha oil and its use as a source of renewable energy were women, in part because the plants are cheap, and easy to grow and to harvest. Women were also the ones most interested in the opportunity to have access to electricity without having to walk long distances or to spend money buying fuel from outside their farms. They were sensitive to the energy independence that Jatropha provides the village. They said "we grow it here, we use it here, no need for transportation on bad roads, and we are not dependent on the evolution of the price of (fossil) oil". At that time, the price of a barrel of crude oil was near historical highs, and the retail price of diesel was going up every day.

Gender-disaggregated data

National data bases are available that contain statistical data separated by gender, such as figures on employment, farm labour, agricultural production, processing, distribution and marketing, energy access, access to clean water, etc. But how accurate and reliable they are is open to discussion. In the case of the Bot Trang project, the issue of gender specificity was not considered relevant, as the misery is such that any improvement in the living conditions of the family in general benefits the weakest elements of the society the most – the women and the children.

In Cambodia where 80% of the female population cannot read and write enough to be properly employed (versus "only" 50% for the male population), it is certain that activities which do not require a high level of education represent attractive opportunities for the most disadvantaged women.

Women who are unemployed because they cannot or do not want to leave their children to find jobs far away, and who do not have the same means of transportation as men, appreciate this kind of approach to energy production as it keeps them in their homes, in their villages and provides them not only with energy, but also with extra income. Educated people and wealthier people will be less interested in, and will benefit less from, this kind of small-scale project because they have access to other opportunities.

Main challenges

The biggest challenge in terms of sustainable development is to find income-generating uses for the energy produced by the project. If energy is used only for domestic use, it is less valuable than if it is used for economic activities that will foster growth and development. This raises broader issues of finding markets to be serviced, raising the levels of education of the population in general and women in particular, increasing the availability of water, and addressing the quality and cost of transportation, roads, and electronic communications.

There is also competition for land from large-scale investors who want to start huge plantations. This raises the price of land and tempts farmers to sell their plots of land. Because of this, it is important to quickly expand small-scale schemes to show farmers that they do not need to sell their land, and that using it to grow crops such as Jatropha provides a sustainable way of earning their living. However, another challenge is that there is a lack of funding for fast and wide replication of the project to other remote rural areas deprived of access to energy.

Relevance as a best practice for sustainable and gender-sensitive biofuel energy projects

The successful completion of the Bot Trang project shows that local access to energy can be improved in the remotest rural areas, at a low cost, by using existing resources. This is important because people without income-producing employment, who cannot afford to buy diesel, can use their labour to produce Jatropha oil for their own use or to sell for income.

It is certain that the Hak family members who benefited the most from the project are not the poorest in their village. Others are much poorer. But the concept of rural electrification on a small-scale basis, such as the Bot Trang power distribution to 80 families, is a concrete example that other groups of people, whether female or male, can replicate easily.

The rural electrification system of Mr. Hak already existed; the project just helped turn it from a fossil fuel consumer to a clean vegetable fuel consumer. In Bot Trang, Jatropha plantations already existed so the cost of creating them was not taken into account. However, if a

BOX 1 - JATROPHA CURCAS L.

The Plant (Jatropha curcas L.) is a shrub or small tree which is planted in tropical and subtropical countries as a living fence to protect gardens and fields from animals. It produces small seeds which contain more than 30 % non-edible oil.

Oil Extraction can be done with manual or engine driven expellers. These are simple machines, which can be operated at the village level and built within the country.

The Products are oil, press-cake and the sediment of oil purification. The oil can be used as fuel in pre-combustion chamber diesel engines and as a lubricant; the oil and the sediment can be used for soap production; and the press cake is a good organic fertilizer. The oil also contains insecticidal properties.

A. Identification/selection of high yielding plants

Up to now in Cambodia, as in many countries, Jatropha has been well known under different names. It was mostly used by farmers to create living fences around their homesteads and gardens, and sometimes also around their fields, to protect crops against roaming animals. The seeds did not play any important role, so farmers did not know which plants had high yields of fruits and seeds.

One can identify high-yielding plants by observing them and their branches during the fruiting time in the rainy season. Since flowers of Jatropha are developed terminally, only plants with many branches can produce many fruits. A good plant should have bunches of Jatropha fruits at the end of every branch.

In Mr. Hak's plantation, we saw bunches of 18 fruits, and even some flowers at the top of the branch. By the middle of the rainy season, this plant (about 3 years old) had already produced 2.8 kg of seeds. So the total yearly yield of this plant can be estimated at about 5 kg. With a density of about 1,300 plants per hectare (2.5 metre distance between the plants in a row, and 3 metre distance between the rows), this amounts to about 5 tons of Jatropha seeds per hectare, a value which is very high and is not yet confirmed by other Jatropha growers in other countries. It is a value at the upper end of a scale defined by Jatropha experts during a conference in Wageningen, Netherlands, in March 2007. The cuttings of this plant also show very good root development in the first 3 weeks after planting them in bags. Such plants should be chosen to take cuttings for plantations. In a second step, these plants from different cuttings can be screened in detail. The best plants with respect to seed production, seed oil content and ratio of female to male flowers should be identified and propagated.

B. Reproduction of high yielding plants

Usually Jatropha plants are produced by cuttings. This is faster than planting seeds because the cuttings are already part of adult plants and inflorescences have developed during the first rainy season. Plants grown from cuttings have the same genetic information as the mother plant, therefore a very exact screening of the potential mother plants is important. The best mother plants should be selected for propagation by cuttings or, in the future, by tissue culture.

new project was to be started from scratch, the cost of establishing the plantation would have to be integrated as well, making the agricultural side of the project very cost heavy. The cost of producing and harvesting the seeds represents 80% of the total cost of production of Jatropha oil. It is therefore important to plant trees that give the highest possible yield, so as to decrease the cost of planting and harvesting. The expertise of Vinci and Dr. Henning, combined with SODECO's experience of local species gained from its 6 test plantations, were put at the disposal of Mr. Hak to improve his plantation maintenance and expansion. (See Box 1 for more details on identification of high-yield trees.)

The Bot Trang project was so successful that Mr. Hak is planning to sign a similar public-private partnership contract with GTZ for the same kind of rural electrification

BOX 2 – BOT TRANG JATROPHA OIL PRODUCTION

NATIONAL CURRENCY: **Riel** • EXCHANGE RATE FOR 1 USD: **4,000 Riels** • WORKING HOURS PER DAY: **8 hours/day**
MINIMUM WAGE PER DAY: **5,000 Riels** • MINIMUM WAGE PER HOUR: **625 Riels**

FOR 1 LITRE OF OIL:

SEED HARVESTING
950 Riels
Amount of seeds harvested in 1 hour: 3 kg
Extraction rate of expeller: 22%
Amount of seeds needed
for 1 litre of oil: 4,55 kg
Time needed to harvest
4,55 kg of seeds: 1.52 hour
Seed harvesting 625 Riels x 1.52 hour
= 950 Riels

EXPELLER'S WORKER TIME 22.5 Riels
Worker time to extract 1 litre of oil
with expeller 1 hour: 55 litres = 0,018 hour
Persons working with the expeller: 2 persons
Expeller's worker time 2 persons x 0,018
x 625 Riels = 22.5 Riels

OTHER COSTS 156.25 Riels
Expeller maintenance, seed storage and
transportation, etc.
0.25 hour x 625 Riels = 156.25 Riels

COST OF EXPELLER DEPRECIATION
6.1 Riels
Local price of expeller (USD 1,500):
6,000,000 Riels
Life time of expeller: 10 years
Working days per year: 225 days
Working hours for 10 years:
225 days x 8 hours x 10 years = 18,000 hours
Oil produced in one year:
1,800 hours x 55 litres = 990,000 litres
Depreciation of the expeller per litre of oil
6,000,000 Riels: 990,000 litres = 6.1 Riels

SUB-TOTAL 1,134.85$

EXPELLER JATROPHA OIL CONSUMPTION
40.85 Riels
Jatropha oil consumption of expeller:
2 litres per hour
Extraction capacity of expeller:
250 kg of seeds per hour
Production rate of expeller
250 kg x 0.22 = 55 litres of oil per hour
Jatropha oil consumption of expeller for 1 litre of oil
2 litres: 55 litres = 0.036 litre
Cost of Jatropha oil consumed to produce 1 litre of
oil 1,134.85 Riels x 0.036 litre = 40.85 Riels

TOTAL 1,175.70 Riels
or 37% of the price of diesel

Note that 95% the cost of production of Jatropha oil is represented by human labour valued at an average opportunity cost of 625 Riels per hour. However, in most cases in rural areas there are few formal employment possibilities, thus the work to produce Jatropha oil does not compete with other possible jobs. In that sense the opportunity cost of producing Jatropha oil is close to 0. Moreover, most of the time farmers do not have 1,122 Riels to pay to outside sellers to buy standard diesel, whereas they do have their land and labour to produce Jatropha oil.

This is especially true for women, who suffer the most from lack of paid jobs, especially in the rural areas. They could never afford to pay 1,122 Riels to buy a litre of diesel, whereas they can work two hours to harvest and extract 1 litre of Jatropha oil.

project in Phnom Srok, 50 km away from Bot Trang. There, Jatropha trees will be planted by local farmers, and Mr. Hak will produce Jatropha oil, and generate electricity and distribute it to farmers in exchange for their Jatropha seeds. This time, Mr. Hak will convert his own engine without assistance from outside.

In itself, the Bot Trang project was not conceived as gender-sensitive, but as an easy and obvious showcase for replication. However, the Phnom Srok project will definitely benefit women more than men because it will be targeted to support women's income-generating activities. It will provide energy to women who grow mulberry to feed silkworms, raise silkworms, produce silk threads, and weave silk fabric. Phnom Srok women also sew pre-cut trousers for nearby Thailand's garment factories, with foot-pedal sewing machines. They will greatly increase the productivity of their silk-related and sewing activities when Mr. Hak starts providing them with electricity in September 2009, in exchange for Jatropha seeds that the women have planted. Women in Phnom Srok will then earn, without the help of men, much higher incomes, which will give them financial independence, dignity, pride, and higher social status in their community. They will be able to feed, provide health care for, and clothe all their children, boys and girls alike. In particular, they will have enough money to send all their children to school.

GHANA: Extraction and Use of Jatropha Oil by a Village Women's Group to Power Shea Butter Processing Equipment

By Mrs. Sabina Anokye Mensah, GRATIS Foundation,
Gender and Development Coordinator, Tema, Ghana

Project overview

This project was the first small-scale Jatropha oil extraction project by women at the village level in Ghana. It was undertaken by a women's group in Gbimsi, a town about 2 km from Walewale in the West Mamprusi District of the Northern region of Ghana, with support from UNIFEM, the GRATIS Foundation in Ghana, and the UNDP-GEF Small Grant Programme. The project concept grew out of a national consultation in which members of the women's group from Gbimsi participated, on 'Energy Use and Technology Needs of Women in Major Economic Sectors.' The project now serves as a guide for all those interested in village biofuel production and empowerment of women, including entrepreneurs, project developers, policy makers and donors. Efforts are also under way to secure funding in order to replicate it in other interested villages.

The adverse impacts of escalating oil prices on the Ghanaian economy, coupled with the need to take action to combat global climate change, have led both national and international development agencies to look for alternative and environmentally friendly sources of energy. In addition, UNIFEM, through its work on the economic empowerment of women in Africa, recognized that the lack of locally-available, affordable energy supplies is a major impediment to the success of rural women entrepreneurs. In order to address these concerns, UNIFEM began working with the GRATIS Foundation on a project named Gender Responsive Renewable Energy Systems Development and Application, Ghana (GRESDA-Ghana), with the goal of demonstrating the use of renewable energy extraction equipment and energy efficient appliances to support sustainable rural industries and economic empowerment of rural women.

The women's group in Gbimsi began growing Jatropha on a farm, using cuttings and seeds grown directly in the field. They use equipment designed by GRATIS to extract oil from the Jatropha seeds. The crude Jatropha oil is then mixed with diesel fuel to run shea butter processing equipment. (The fuel composition is 30 percent diesel and 70 percent Jatropha oil.) Although there are a number of biodiesel projects that have been initiated in Ghana, this is an easier production process for the women's group to manage, since just extracting the Jatropha oil is much simpler than making biodiesel out of it.

Women extracting jatropha oil

The development objectives of the project included:

1. Strengthening women's economic empowerment and contributing to food security in Ghana by enhancing women's ability to reduce post-harvest losses and improving their agro-processing enterprises without contributing to environmental degradation – through an integrated and participatory renewable energy programme, and promo-

tion of gender-responsive energy policies.

2. Introducing women processors in Northern Ghana to an improved shea butter extraction technology that avoids the use of excessive firewood and water, and does not expose processors to smoke and heat.
3. Providing a readily available and renewable fuel to serve as a diesel substitute/additive for motorized equipment.
4. Providing a readily available fuel to serve as a kerosene substitute for use in local lanterns.
5. Strengthening women's economic capacity and sustainable livelihoods as entrepreneurs, producers and rural-based community workers.
6. Developing strategic activities and building partnerships to eradicate feminized poverty.
7. Strengthening the capacity of women processors to access markets and appropriate technologies, and conserve the environment.

Financing

This was a special initiative set up as a public-private partnership, and good collaboration between the partners led to successful implementation of the project. UNIFEM's aim was to work with a rural women's group and enhance the operations of their shea butter processing enterprise by supplying them with improved energy access and equipment. The GRESDA-Ghana project provided coordination for implementing the project and training the women's group members (most of whom were illiterate). GRATIS Foundation manufactured the extraction equipment and supervised its installation and use. The UNDP-GEF/Small Grant Programme funds paid for installation of the biofuel extraction equipment and initial cultivation of a 10 acre (4 hectares) Jatropha farm to supply seeds for producing oil to use in running the shea butter processing plant. The women, through the traditional leaders, provided land and labour, which paved the way for construction of a structure to house the Jatropha oil extraction and shea butter processing equipment.

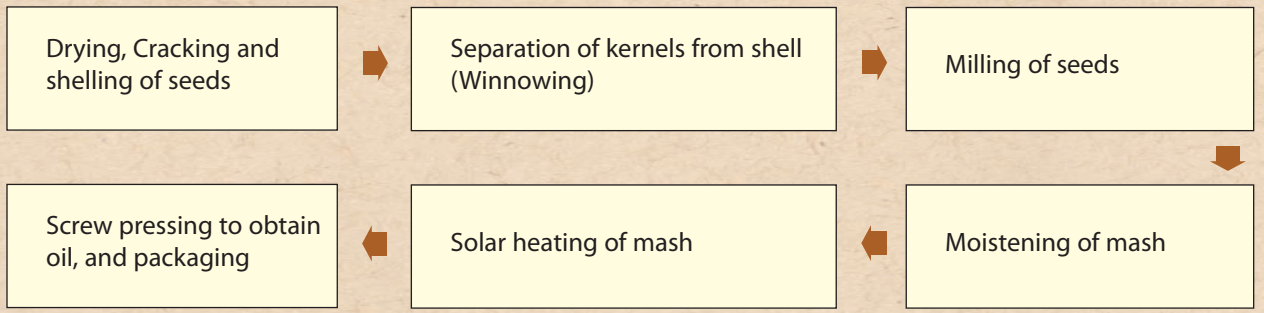
In the future, Jatropha oil production and use in producing biodiesel could be promoted as a Clean Development Mechanism (CDM) project, since biodiesel from plant oils is carbon neutral (biogenic) and can supplement the country's diesel requirement. It could also attract GEF and other carbon-related funding to mitigate high initial investment costs.

Jatropha fruit

The phases and major activities of the project were:

- Selecting the site for Jatropha farming.
- Organizing a series of informational and gender sensitization workshops to build community support for the project.
- Constructing a structure for the processing equipment and activities.
- Acquiring and installing mechanized oil extracting equipment comprising of a crusher, mill, press and diesel engine. (Separate oil extraction equipment is used for the Jatropha oil production and shea butter extraction.)
- Organizing a Rural Women's Technician Corp workshop to train the women in equipment operation and maintenance.
- Training the women in basic accounting and bookkeeping.
- Trial production by the women.
- Opening a bank account with the local community bank.

FLOW CHART OF THE JATROPHA OIL EXTRACTION PROCESS AT GBIMSI



- Commercial production.
- Monitoring the project and training the women in value-addition to the oils extracted.
- Sharing experiences with other women's groups and visitors.

Jatropha, or physic nut, grows wild in Ghana, and is mainly used for fencing and for medicinal purposes. Initially young men and women were mobilized to collect seeds from the wild for the Jatropha oil extraction, until the women's own farm matured. Once the plantation was established, the seeds were then collected from the farm. People in the community collected shea nuts from the wild and sold them to the women's group, and additional nuts were purchased from nearby markets on market days.

Benefits to men and women

There have been both direct and indirect benefits for the target group and the community. The name of the village is now known throughout the district and region as a shea butter and Jatropha oil producing village. Electricity has now been extended to the village, and they have also acquired a toilet facility provided by UNDP-GEF and UNIFEM.

Children of the beneficiary group who hitherto were not attending school are now enrolled in the community school because the families are now able to pay school fees.

For the members of the women's group, much of the drudgery involved in the shea butter processing has been eliminated, and production levels are up. The most direct benefit to the group comes from access to the grinding mill and an alternative method of kernel crushing and pressing for oil extraction. When the complete plant package is utilized, six hours of time can be saved, which contributes to improvements in household interaction; more relaxation for improved health, entertainment, community peace and harmony; and increased attention to other income generating activities. In addition, the group has received seed capital from the local community bank for shea kernel purchasing, which was never available to them before.

Regular group interaction and participation in meetings and workshops has broadened the outlook of the women. They benefit from regular interactions with facilitators from outside their locality, and exposure to cities such as Tamale, Kumasi and Accra. Over all, they have more ability to make their own choices, improved self-esteem, better negotiating skills, more time for volunteering, and greater opportunities for contributing to the household budget. All these benefits were non-existent before the inception of the project.

Before the women received their training in machine operation and maintenance, gender sensitization workshops were held for the District Assembly and husbands of the members of the women's group. The training in gender sensitivity has helped husbands understand their

wives and contribute to running the family more efficiently. The husbands now support their wives in their chores and other activities.

Participation of women

The women have full control and ownership of the agro-processing machines and processes.

Training programmes helped build their confidence, and they then travelled outside their locality to see what kinds of projects other women elsewhere had undertaken.

Once commercial production of shea butter commenced using the installed equipment, the women were trained in bookkeeping and basic accounting, and were able to open a bank account. Profits accruing from the project were entirely for the women's group. The increased production forced the women to seek new external marketing avenues, which yielded positive results.

Main Challenges

Recognition of gender differences is rarely incorporated into village projects of this nature, so the project had to make a major outreach effort to raise awareness among District Assembly members, the men in the village, and the women themselves. Support from ENERGIA in the form of awareness-raising and development of training tools has since helped to boost the image of the project nationally and internationally.

Dealing with a completely illiterate group was a major obstacle for the organizers at the initial stages of the project. Lack of education has constrained women's full participation in community development and political processes requiring adequate knowledge of numeracy and understanding of spoken and written English language.

Learning to operate and maintain the oil extraction machines was a real challenge for the women, but the training sessions helped to boost their confidence, which contributed a lot to the women learning faster than expected. Now the women have learned to handle minor maintenance, which has eliminated time lost due to equipment breakdowns.

Before the inception of the project the women could process 25kg of butter in two weeks. After the project started operating, in December 2001 they delivered 0.3 metric ton of butter valued at two million cedis and yielding three hundred thousand cedis in profit, while in February 2002 one metric ton of butter was delivered, valued at five million four hundred thousand cedis and yielding more than two million cedis in profit. However, with increased production of the shea butter, the women now have to deal with the lack of guaranteed markets, low output prices, and therefore low net margins. There is increased production of shea butter in the area, and insufficient markets for the product.

Jatropha seed

Relevance as a best practice for sustainable and gender-sensitive biofuel energy projects.

The Gbimsi biofuel extraction project has demonstrated that with proper training in gender sensitization and the use of appropriate technology, rural illiterate women could efficiently extract oils to sustain their livelihoods. The Jatropha oil can be used very well to meet rural energy needs for small-scale industries such as shea butter and palm oil extraction. But raising financing to initiate similar projects is a challenge.

Although biofuel has been demonstrated as a potential fuel for rural-based industries, a thorough economic analysis needs to be done to warrant large-scale invest-

ments. Moreover, collaboration is needed to ensure long-term planning and strategic thinking within the country to enable the establishment of the necessary systems and structures to move the industry forward.

The Energy Commission of Ghana set up a Biofuel Committee in August 2005 to prepare a National Biofuel Policy. At this point, reports from subcommittees on cultivation, processing, refining and policy form the basis of a draft document with recommendations for developing a biofuel industry in Ghana. The goal is to reduce the country's overdependence on imported petroleum, improve energy security and reduce greenhouse gas emissions. An assessment of the gender issues related to biofuel production is quite important in order to establish the role of women in Ghana's biofuel industry.

Partnerships should be developed to set up at least three pilot demonstration units in Ghana to allow the compilation of comprehensive data on the integration of gender concerns into energy projects, and the planting, processing and packaging of Jatropha and the resulting biofuel. These pilot demonstration units could be used to build the capacity of rural communities with particular reference to women, as well as consolidate knowledge and experiences.

It is recommended that the Government encourage innovative entrepreneurs, donors and NGOs to venture into well-regulated Jatropha plantations and extraction of the oil. In addition to providing power for small-scale rural industries such as shea butter processing, palm oil extraction and grain milling, biofuel can be promoted with the following objectives:

- As alternative fuel to diesel for stand-alone diesel generators in remote rural communities.
- As a renewable energy and alternative fuel to supplement the nation's overall diesel requirements
- In the rail sector as a supplemental fuel for rail engines.
- As a strategic fuel to mitigate the country's vulnerability to oil price shocks and maintain security of fuel supply.
- As a non-traditional export commodity.

Research support is needed to determine the yield levels and various costs involved in the cultivation, harvesting and processing of Jatropha. The productive life span of the plant in local climatic zones, and the shelf-life of the fruits and seeds, need to be determined for the benefit of interested farmers and investors. Field observations indicate that the plant has its share of vectors, parasites or diseases, but the effect of the plant on soils is still not well known and no known ecological risk analysis has been conducted to assess the impacts when it is moved from marginal lands to arable lands and cultivated on a large scale. Insurance companies may not accept liabilities since so little is known about the large-scale cultivation of Jatropha. All the major cash crop plantations have well-established research support, so the same should be provided for Jatropha.

INDIA: Producing Biodiesel Fuel from Local Seeds for Livelihoods, Water Pumping and Power Generation

By Geeta Vaidyanathan and Ramani Sankaranarayanan,
CTxGreEn, Canada / Gram Vikas-CTxGreEn Biodiesel Project, Orissa, India

Project overview

This project began in February 2004 with a pilot plant for biodiesel production at Mohuda in the Ganjam district of Orissa, set up with seed funding from the World Bank Development Marketplace. The activity was initiated by CTxGreEn, a Canadian non-profit, in partnership with Gram Vikas, a local NGO with 29 years of community development experience in Orissa. The pilot plant acts as a resource centre for testing processes and equipment, and training village technicians. Additional partners include the University of Waterloo and The Working Centre in Canada, and the Indian organizations Enviro Legal Defense Firm, Regional Centre for Development Cooperation, and OUTREACH.

A small-scale pedal-driven processor is used to produce biodiesel in batches of 5 litres or 20 litres. Biodiesel is produced through transesterification: mixing oil with alcohol and lye. Five minutes of pedalling combines the lye and alcohol into a homogenous solution in a small stainless steel mixer. This solution is added to plant oil in a larger stainless steel reactor. An hour of pedalling converts the oil-lye-alcohol mixture into biodiesel. In total, the production process takes about four hours, including one hour of pedalling. The process also produces glycerine, which has a higher density than biodiesel and separates out within two hours. Glycerine can be used to make soap.

The vegetable oil accounts for 80% of the material costs to produce the biodiesel. It is extracted from local under-utilized seeds using a small, hand-operated oil press. The seeds used include niger, which is currently exported as birdfeed, and karanj, a forest oil-seed. Other potential seeds identified include mohua, kusum and castor. Once oil has been expelled from the seeds, residual oil cake remains. This makes a good organic fertilizer or, if edible seeds are used, a low-cost, highly nutritious feed for livestock. Lye and alcohol, which are currently purchased, account for the remaining 20 per cent of material costs. In the long run, these inputs can be produced entirely from local waste fruit and wood ash.

Pedal-powered biodiesel processer

Village installations in the village of Kinchlingi, which has 16 households, and the twin villages of Kandhabanta-Talatailla, with 31 households, have used

the biodiesel fuel produced with the pedal-driven processor to run water pumps, and to generate electricity. A tiller running on biodiesel was demonstrated for use in ploughing, irrigation and threshing rice paddy. Detailed feasibility assessments and business demonstrations have also been done in the Tumba cluster of 50 villages, with about 1500 households, and work is underway to organize financing for biodiesel entrepreneurs there.

Over the past three years and a half, the demand for biodiesel in Kinchlingi has ranged from eleven to 13 litres per month, which is produced in two or three batches. It was used to pump water for three years until a gravity-flow system was introduced in April 2008. Previously women carried water from a stream. In January 2009, a hybrid electrification scheme was introduced. A biodiesel generator provides 1 hour of compact fluorescent lighting through a 220-volt mini-grid, and also charges a battery bank for extended hours of LED lighting.

Use of niger and karanj oil cake was demonstrated in the fields of three farmers during rice paddy cultivation in July-August 2008, and the enhanced harvest has fuelled a demand for this locally available organic input.

The success of the village-scale biodiesel model depends on ensuring local edible oil security through a local (biodiesel-run or manual) oil expeller, and stemming nutrient out-flow by using the by-product oil cake as fertilizer. The surplus (non-edible) oil can then be converted to biodiesel and the fuel used for equipment to plough, pump, thresh and hull rice.

Financing

Seed funding for the pilot activity was supplied by the World Bank Development Marketplace. In the demonstration villages of Kinchlingi and Kandhabanta-Talataila the water-supply systems consisting of a water tank, supply and delivery systems, toilets and bathrooms, were built with Gram Vikas funds. Village communities provided unskilled labour and local materials to subsidize the cost of the washrooms.

The Swiss Agency for Development and Cooperation (SDC), with Intercooperation, funded a legal feasibility study of the village level biodiesel system. SDC also provided funding for training of village level technicians for the period 2007-09, and print and video documentation of the project in 2009. Small research fellowships were received from the International Development Research Centre, Canada (IDRC), and from the Social Sciences and Humanity Research Council in Canada for a doctoral dissertation. In addition, Shastri Indo Canadian Institute is funding a joint policy research project with the University of Waterloo, as a part of their Millennium Development Goals Research Grant (2008-09), on *"Linking people to land regeneration through livelihood-reinforcing energy services - The case of food-secure, low-footprint women-oriented biodiesel-fuelled-energy-services."*

Benefits to men and women

CTx GreEn believes that food and fuel security for isolated rural communities in India can best be achieved by keeping the production of food and fuel at the village level. A three-pronged approach for village level biodiesel production and use can provide:

1. Renewable energy fuel that can be used for water pumping; powering a multipurpose tiller that facilitates ploughing; threshing; irrigation; and electrification.
2. Increased agricultural productivity through increased soil fertility from using oil cake as fertilizer. This will reduce the need for slash-and-burn cultivation and permit the regeneration of local forests.
3. Income to local entrepreneurs from the sale of biodiesel services (lighting, irrigation, oil expelling, etc.) and secondary products from the production of biodiesel fuel (oil cake, glycerine and soap).

Some of the activities have potential for implementation as independent and self-sustaining entrepreneurial activities, including: manual oil pressing; biodiesel-fuelled oil expelling; local resource based biodiesel production; and related livelihood activities, such as farming using mobile irrigation pumps and other small-scale motorized farm implements, and charging batteries and LED-lights using a biodiesel-fuelled generator.

TABLE 1. ESTIMATED DAILY AND ANNUAL REQUIREMENTS OF BIODIESEL **(and capacity and number of production and end-use units) for full-implementation of biodiesel-fuelled livelihood services in a cluster of 50 villages (1500 households) in Tumba**

SI No.	Biodiesel Consumption by Item	L BD/d	L BD/y	Notes and assumptions
2	For BD-fuelled Genset-LED lighting	50	18,250	approx 4 to 6 BD-fuelled gensets
5	For BD-fuelled Oil Expelling	50	12,500	6 BD-fuelled expellers @ 30 kg/h
6	For BD-fuelled 2nd crop irrigation	50.4	12,600	approx 4 to 6 BD-fuelled mobile pumps
8	For BD-fuelled cook stoves			not considered - needs more R&D
	Total BD Consumption Potential	**150.4**	**43,350**	approx 4 BD Reactors - 20L/batch

Note: *The number of BD-fuelled gensets and pumpsets will vary according to the needs, the number of hours of use, distances between villages served (including transportation time,etc.). The number of gensets and pumpsets will need to increase as the project expands after the demo phase. It is also possible that the multi-use power tiller (walking tractor) may replace the genset & pumpset (evening hours for charging batteries and day-time hours for use as pumpset and tractor/tiller) and for rice paddy hulling, oil expelling, etc., in mobile fashion. Lighting through battery- charged LED lights is used as the starting point, so that biodiesel production could be ramped up slowly with demand.*

In the demo phase 2008-09, the business profitability of various end-use devices will be demonstrated with the core group of potential entrepreneurs. Business plan packages will be prepared. Additional survey data (at household and village level) on seed collection, oil consumption, land holding and edible oil seed harvest, etc., will provide more reliable business models than available at present.

So far, access to energy for water pumping has enabled access to running water, reducing the drudgery of fetching water from the stream in Kinchlingi and from the well in Kandhabanta-Talataila. Also, with a biodiesel electrification system, the village of Kinchlingi has access to small-grid lighting through CFL lamps for a fixed period, and to mobile LEDs for extra hours of illumination.

One of the trained technicians has set up his own rice hulling mill and has selected a diesel-operated machine over electricity in the hope of using biodiesel in the future. He is confident that he can purchase biodiesel from the Self Help Group at Kinchlingi, and that in the long run biodiesel will be cheaper than petro-diesel – while also helping his local economy. Before this rice huller was opened, the women of Kinchlingi had to carry their grains at least 12 km for processing.

In remote areas like Tumba, local oil pressing will provide a local supply of edible oil, and oil cake for use in fields, displacing chemical fertilizers. The challenge, however, is to stem the outflow of oil seeds, and ensure that there is local village-level processing for local productive livelihood uses, instead of having all the oil seeds sent to central processing units for conversion to biodiesel for urban transport.

Currently, a lot of land is left fallow because men migrate and women are unable to plough the fields. Training of women to run a biodiesel-fuelled tiller has been initiated and will ensure timely ploughing, sowing and good productivity. All this adds to the burden of work for women, but they gain from their involvement in terms of food and nutritional security, and stemming migration. Agro-service centres are needed for timely inputs such as seeds, oil cake fertilizer, and tilling services for small and marginal farmers. Women who have been trained in the use of the tiller will need to be supported by the community in the management of these centres so that the additional work is shared.

Environmental impacts

The introduction of biodiesel production has local environmental benefits in terms of land regeneration and forest conservation and, because it is carbon-neutral, it also contributes to global greenhouse gas reductions.

In the Tumba cluster the potential daily demand for biodiesel fuel for lighting, oil-expelling and irrigation has been calculated to be 150 litre/day (see Table 1). The use of biodiesel for these purposes, plus elimination of slash-and-burn agriculture and use oil cake as an organic fertilizer, is likely to reduce 10 tons of CO_2 emissions per day. If this reduction were capitalized in terms of marketable carbon credits, it would pay for all the material costs of producing the biodiesel fuel for these villages, thereby

TABLE 2. ESTIMATED CO2 REDUCTION FOR TUMBA after full implementation of biodiesel-fuelled livelihood services

Sl No.	CO_2 Reduction Potential by Item	kg CO_2 per day	t CO_2 per year	Notes and assumptions
1	Avoided Kerosene for home lighting	480	174	approx 4 to 6 BD-fuelled gensets
2	Avoided Diesel for Genset-LED Lighting	160	58	6 BD-fuelled expellers @ 30 kg/h
3	Avoided Urea: Use Oil cake as fertilizer	152	56	approx 4 to 6 BD-fuelled mobile pumps
4	Avoided Slash & Burn acres	9,107	3,324	
5	Avoided Diesel for BD-fuelled Oil Expelling	109	40	20000 trees, 375t seeds; 12.5 kL BD/y
6	Avoided Diesel for 2nd crop irrigation	110	40	1500 acres; 12.6 kL BD/y
7	Impact of 1,500 acres/year replantation			not included
8	Avoided firewood use			Biodiesel stoves for cooking - not incl.
	Total CO_2 Reduction Potential	**10,118**	**3,692**	
	Subset of the above:			
	CO_2 Reduction Potential w/o including Slash-and-burn credits	**1,011**	**368**	avoided slash-and-burn credits constitute more than 90% of 'total (Biodiesel stoves not included)

ensuring development without burning additional fossil fuels (see Table 2). Biodiesel-fuelled cook stoves to replace firewood are also possibility in the future, which has not been included in the 150 litres per day. That could have a significant impact on conservation of local wood resources.

Community mobilization and management models

In Kinchlingi, an Electricity Committee made up of three men and two women is entrusted with the operation and management of the biodiesel unit. They are responsible for: collection of tariffs; cultivation of niger (*Guizotia abyssinica*) on private and community fallow land; collection of karanj (*Pongamia pinñata*) seeds (in Kinchlingi they barter salt for karanj seeds); contribution of labour for production of the biodiesel fuel; and daily operation of the generator. In the long term, the goal is to negotiate with the government for grid electricity, and use the biodiesel only for livelihood activities.

Work is ongoing to strengthen the ability of community self help groups to operate and manage the biodiesel systems and understand the by-product synergies. Although self help groups have been in existence in Kinchlingi and Tumba villages for over six years, they are limited to small saving and credit activities, and are mainly male dominated. Literacy and numeracy classes and orientation to banking techniques will be critical for the success of the self help groups as enterprises managing their finances independently and improving the local economy.

The two month business profitability demonstration of the manual oil press in Raikhal, in the Tumba cluster of villages, was followed by a pre-feasibility assessment by three management students, and an independent rapid assessment by Basix, a micro-finance institution. Both assessments concluded that the manual oil press could be operated as a viable business, with investment loans repayable within 2 years, and profit margins rising sharply after the second year. The concern is with ensuring a steady stream of customers willing to pay a milling charge to extract oil from their seeds, without distress sales of seeds to traders to satisfy perennial shortages of hard cash for buying essential commodities. Solutions are readily available, though, in the form of 'cash' banked by self help savings groups that could be used to pay for the seeds, with the investment recouped within one or two months by selling oil and oil cake profitably. The self help groups, however, would need strengthening to take up this role.

It seems that long-term sustainability and equitable sharing of benefits across the widest-possible spectrum of stakeholders would be most achievable with an entre-

preneurial model. However, the volunteer-driven and self-help group management models may yet be viable in other locations where the situation is different and the self help group capabilities are stronger than in the villages where these models have been tested to date.

Participation of women

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

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

However, although there was a focus on gender-sensitive planning processes and participatory technology design, gender sensitive plans do not always translate into gender-sensitive implementation and engagement of women in decision-making regarding managing and operating the system. It is our experience that even if women are involved in the planning process, men make the decisions during implementation. It is therefore critical to strengthen women's groups in decision-making.

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

In addition, the objective of the Shastri Indo Canadian Institute research at the local level (as stated in their proposal) is "to develop strategies for spinning-off women and youth entrepreneurial service-providers through expanded biodiesel-based livelihood strategies in non-grid villages."

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

Gender-disaggregated data

The focus of this project is on participatory processes. While women are involved in the overall project, and discussions are held in different forums through focus groups and semi-structured interviews, there has not been systematic data collection to monitor impacts on a gender basis.

Some of the discussions within the self help groups have focused specifically on women. Training programmes are designed in coordination with the women on issues pertaining to energy that they themselves identify as being relevant, and so the results feed directly into the project objectives.

National databases from the Central Statistical Organization, National Sample Survey Organization and electoral lists have limited information on the basis of gender, mainly in the area of demographics, health and employment, most of which are district level indicators. Information at the village or block level would be more relevant. Information about self help group enterprises at the block level would also be useful.

Main challenges

A steady supply of seeds is needed in order to produce enough biodiesel to support village systems and equipment. Local seed supplies could be threatened by sales of oil seeds to traders, who double as saukars or moneylenders in times of need. Other competition from large-

scale processers or oil mills could also derail well-intentioned attempts to add value locally. In addition, legal and policy frameworks regarding access to the forest and minor forest products could limit the ability of villagers to collect seeds.

Current excise laws affect access to ingredients, like alcohol, needed to make biodiesel. In this context, the legal feasibility of village-level biodiesel production was studied by the Enviro Legal Defense Firm and a policy brief "Legal Challenges – Village-level biodiesel production and use" was published in 2005-2006 with SDC-Intercooperation funding.

In addition, a forum of Orissa-based NGO's hosted jointly by CTxGreEn and Gram Vikas in February 2008 put together a 'barrier-mitigation roadmap' and 'replication strategy' for village-level biodiesel projects in Orissa with specific roles for various partner NGOs. A stakeholder workshop was organized in March 2009 with key government officials to identify strategies for overcoming barriers and moving forward with replication efforts. Officials in the Government of Orissa are now beginning to look favourably at the waiver of permit fees and excise duty for the "Village-level biodiesel, local production and use model."

With regard to the capacity of village-level institutions, it was assumed that the self help groups would be in a position to take up the management of the enterprise, supported by a barefoot technician. However the self help groups need strengthening. The learning curve for capacity building appears to be dauntingly steep due to the relatively low level of literacy in the community, the need to raise awareness, and their hesitation about taking the first steps towards new initiatives. Exposure to other successful groups is helpful in building a spirit of enterprise and interest in new livelihood patterns.

The project is developing a platform for collaborative partnerships: nationally through a framework for policy support for village-level biodiesel service delivery (including procuring and manufacturing alcohol locally); and internationally through a framework to support a fair trade for carbon credits between village-level biodiesel enterprises and Northern community partners.

Relevance as a best practice for sustainable and gender-sensitive biofuel energy projects

A small-scale biodiesel model for productive uses, which does not impinge on food security, is better suited for replication than larger biodiesel projects aimed at producing transportation fuel. Larger projects are fraught with serious issues of food and fuel security and uncertainties about long-term impacts on the environment. There are also concerns about the long-term 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.

Depending on the context and local availability of underutilized oil seeds, the model can be adopted for fuelling livelihoods and local economic development without any increase in fossil fuel consumption or greenhouse gas emissions.

The objective of implementing village-level biodiesel production and use in an entrepreneurial manner is to ensure sustainability through local participation. Benefits will not only accrue to the entrepreneurs running the hand-operated oil mills, the biodiesel production centres, biodiesel-powered livelihood activities, and the by-product value addition services, but also to the community as a whole, in terms of increased agricultural productivity, progressive reversal of shifting agriculture, more jobs in the local area, capacity building, and reduction in the cash outflow for purchase of edible oils.

For replication, local business profitability demonstrations are needed for the components of the technology package – biodiesel-making, irrigation, lighting, oil expelling, etc. Farmer's schools are needed too, along with assistance with obtaining oil seeds to plant, using oil-cake as fertilizer, obtaining water for irrigation during the hot (dry) season, and provisions for dealing with the post-harvest cash crunch.

The model can be replicated in other agro-climate zones, each with its own specific socio-economic and agro-ecological features, assuming there is availability of under-utilized oil seeds. One commentator, Othmar Schwank, the Managing Director of INFRAS in

Switzerland, observed that: *"The strategic framework used to describe the project makes it a well-developed adaptation approach to climate change that also includes a critical element of development per se – we should be able to begin another industrial revolution in this manner in remote corners of the world (untouched by the last one that started over 150 years ago)."*

Practical Action undertook a 10-day study tour in 2007 and has replicated the project using a wind-biodiesel hybrid system in Sri Lanka. In addition, a pre-feasibility assessment of implementation of biodiesel-fuelled livelihoods in Karnataka in the project area of the organization OUTREACH was completed in 2008 through three exchange visits, and a concept proposal has been put forward.

Women in Kinbhlingi making soap using glycerine, a by-product of biodiesel.

NEPAL: Using Community-Grown Jatropha Oil for Irrigation Pumps to Support Increased Agricultural Production and Rural Economic Growth

By Megesh Tiwari and Jagadish Chandra Kuikel,
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Project overview

The project aims to promote rural economic growth by making irrigation affordable for poor farmers in the Siraha district of Nepal, which lies in the eastern plains region of the country. The idea is to build the capacity of rural communities to produce oil from Jatropha seeds and use that oil for operating irrigation pumps.

Currently, rural households with access to irrigation pumps must depend on scarce and expensive diesel fuel. However, many poor households cannot afford to rent irrigation pumps at the going rate of $2 per hour, and have to depend on rain water for irrigation. Locally produced Jatropha oil is expected to be significantly cheaper than diesel fuel for powering irrigation pumps. Therefore, the project is expected to increase access to irrigation, and enhance agricultural production and rural incomes.

The project has started in communities where Jatropha plants are already growing in the wild or used as hedgerows. Local community groups and coordinating committees are organizing the Jatropha seed collection and managing the operation of high efficiency oil expellers. The oil will not be processed into biodiesel, but will be used directly in pumps modified to run effectively on pure plant oil.

The Center for Integrated Rural Community Development Nepal (CIRCOD-Nepal) is the local NGO implementing this project within the Siraha district. Two government entities, the Poverty Alleviation Fund (PAF), which implements the National Poverty Alleviation Program, and the Alternative Energy Promotion Center (AEPC), are coordinating partners. Winrock International is providing overall management and monitoring for the project – showing local communities how to produce and use Jatropha oil as fuel for irrigation pumps, as well as providing advisory and technical support, coordinating stakeholder activities, and facilitating technology financing.

Men and Women participate in coordination committee meeting.

The impacts of using Jatropha oil in place of diesel fuel for irrigation pumps will be documented by the project. This will include collection of data and analysis of impacts on the rural economy, irrigation coverage, agricultural production, environment, health, drudgery, women, and so on. Efforts will be made to highlight impacts of the project on achievement of the Millennium Development Goals and local poverty reduction. The resulting documentation will be presented to the policy makers for reference and future planning.

Quantifiable targets of the project:

- Seeds will be collected from all existing Jatropha trees (100,000kg) and seed production will be

improved through better tending and pruning.

- Thirty factory-modified Jatropha oil irrigation pumps and three community based Jatropha oil expellers will be established and operated.
- Three hundred households in the Siraha district will be able to use Jatropha oil for pump irrigation on a sustainable basis, and the area served by pump irrigation will be doubled.
- Vegetable production will be at least doubled and additional income will be US$30 per year due to improved irrigation.

Community mobilization

Winrock has developed a community mobilization strategy to prepare the selected households for implementation of project activities. The households are grouped into community groups. On average each group includes 10 households. Awareness programmes are organized for these groups on Jatropha seeds, and on production and energy-related issues. One coordination committee is formed for every 100 households. The coordination committee is comprised of one representative from each participating community group. The coordination committees manage all activities related to Jatropha seed collection, expelling and distribution of oil to the households.

Capacity building

Capacity building is a key feature of this project. Since use of Jatropha as a source of energy is relatively new in Nepal, a series of awareness workshops will be organized for the target households on farming, storing, and using Jatropha oil and oilcake. Training will be provided on operating and maintaining the oil expellers and irrigation pumps. The training will include instructions on how to use Jatropha oil cake (the residue left over after the oil has been squeezed out of the seeds) as fertilizer to increase agricultural production. Income generation training will also be provided to target households, presenting ways of using improved irrigation and bio-fertilizer to improve their vegetable production, and better ways of marketing of their products.

Technology transfer

The project will support installation of one irrigation pump for each community group of ten households. In total 30 irrigation pumps will be installed. The Poverty Alleviation Fund will cover 80% of the costs for specially-modified irrigation pumps, which will be obtained with technical support from the project. Since a pump that can run on crude Jatropha oil is not an off-the-shelf item, the project will work with the pump manufacturers to make necessary modifications on conventional pumps. The project will draw from Winrock's past experience in using Jatropha oil as fuel to recommend appropriate technologies for the target households.

The second phase of the project will support the establishment of three oil expelling centers managed by the coordination committees. There will be one oil expelling center for every 100 households. Winrock will fund 50% of the costs of the expeller center setups; the rest will be contributed by the target households in cash and kind. The project will support the communities in selection of appropriate technologies for the expellers. High-efficiency expellers will be necessary to increase oil yield, and oil yield is a key factor in determining the viability of the project.

Environmental conservation and emission reductions:

The project aims to replace fossil fuel (diesel) with biofuel (Jatropha oil) to operate irrigation pumps. This will allow significant reductions in environmentally harmful emissions, particularly of greenhouse gases. As the production of Jatropha oil will be local, vehicle emissions resulting from diesel fuel transportation to the target households will also be reduced.

In addition, use of Jatropha oil cake as fertilizer will replace applications of chemical fertilizers. This will reduce harmful emissions resulting from the production, transportation and use of chemical fertilizer. Some chemical fertilizers contain internationally-regulated persistent organic pollutants (POPs), which can cause soil and water contamination, and risks to the health of people and animals. Using the leftover Jatropha oil cake as fertilizer is also expected to save costs and increase agricultural pro-

duction, and hence income for the targeted households.

If Jatropha oil cake can also be used to produce biogas, methane emissions will also be reduced, and using biogas for cooking can result in reduced use of forest wood.

Main challenges

The primary challenge to the long-term success of the project is maintaining a sustainable supply of Jatropha oil. The project currently depends on use of existing wild and hedge-grown Jatropha plants to supply seeds. This strategy has been used at first to demonstrate the viability of locally produced Jatropha oil in making irrigation affordable. However, after the successful demonstration, it is expected that demand for Jatropha oil will grow and there will be a need for new plantations to ensure a sustainable supply of seeds.

One solution to meet future demand growth without jumping into mass commercial plantations is to encourage every household to plant 100 to 150 Jatropha plants in their private waste lands or the comparatively poorest sections of their land or fields. This could be on the border of the fields or on a specific part of the field which is relatively poor. Communities can also decide to make use of public waste lands in the vicinity, with necessary approval from local authorities, for new Jatropha plantations and develop modalities for tending, collection, distribution and so on. Winrock will work with the target households to plan appropriate strategies for new plantations.

Benefits to men and women

The goals set for this project are targeted at households, rather than individuals. The project is designed to benefit the poorest households within communities where the National Poverty Alleviation Program is already active. The National Poverty Alleviation Program has methodologies in place to select the most impoverished households, and these households are the ones eligible to receive PAF grants for equipment purchase.

Access to affordable Jatropha oil as an alternate fuel for irrigation will positively impact all members of beneficiary households, as this will reduce household expenses and will lead to higher agricultural production.

Since this project promotes the use of an agriculture-based fuel, the project activities are easily adaptable to the rural lifestyle in Nepal. The activities will be similar to processing of other agricultural crops. For example, farmers cultivate mustard in many parts of Nepal, and mustard oil is used as the primary cooking oil in most rural households. The mustard seeds are collected and taken to nearby mills to expel the oil. The oil cake is also used for various productive uses. Using Jatropha seeds to produce oil and cake and applying these products to enhance agricultural output, is similar to the current use of mustard seeds. This ensures involvement of women, as both men and women as equally knowledgeable on the process.

Women engaged in vegetable farming will benefit directly from making use of the Jatropha oil cake as fertilizer and Jatropha oil to provide adequate irrigation. However, to ensure a better role for women in the use of Jatropha oil and cake, targeted technical and business training will be necessary to build the skills of women in preparing fertilizer from oil cake, using the oil cake and Jatropha oil irrigation pump to improve agriculture production, producing cash crops like vegetables, and marketing and selling these vegetable in the local markets.

Women will be included in the technical and business training provided by the project, and women candidates will be given preference in fertilizer production, vegetable farming, and marketing and selling vegetables in the local markets. Women who participate in the training offered by the project will be able to make significant contributions to household income, and increase their role in spending decisions. For example, with the income from vegetable sales women can decide to purchase essential household goods, pay for children's education, spend more on personal healthcare, or buy personal items.

Participation of women

Since the project goals are at the household level and do not differentiate in terms of benefits to different people within the household, women are not directly designated as target beneficiaries. However, women in the target areas have been active participants in the community

groups organized to execute the project activities, and women will have a significant role in planning and decision-making on Jatropha oil collection, pricing, production and distribution.

During the first phase of the project in 2008, 100 households were involved. Ten community groups were formed, and five of these were made up entirely of women representing their households. During the second phase, which runs until January 2010, the project will engage 300 households, and 30 community groups will be formed to execute project activities.

The project encourages maximum participation of women in all activities. Starting from the formation of the community groups, women are encouraged to be the ones representing households. Similarly, women are encouraged to represent their groups in the coordination committees. The target is to have 5 men and 5 women representatives in each coordination committee. In the first phase, 5 women represented their groups in the coordination committee.

Women's participation is encouraged in all capacity building activities like training and workshops. Special attention will be given to women candidates for the income generation training. This will include training women to prepare and use fertilizer from oil cake and use this organic fertilizer with improved irrigation to increase vegetable production. Business training will also be provided to better market the vegetables in local markets.

With strong representation of women in user groups and coordination committees, they will have a large role in making decisions. Some of the decision-making roles women will be engaged in are: selection of group leaders; selection of coordination committee leaders; approaches used for seed collection, oil expelling, and distribution of oil and cake; setting the schedule for sharing pumps; fixing the prices for seeds, oil and oil cake; planning for vegetable production and sales; and use of the additional income from vegetable sales.

Gender-disaggregated data

The Government of Nepal is increasingly aware of the need to collect national data in a gender disaggregated way. This motive of the government in reflected in the national databases published by the Central Bureau of Statistics in Nepal, which has published Women in Nepal: Some Statistical Facts 2004. This publication has data on women in Nepal in sectors like education, health, employment, income, electricity access, drinking water access, cooking fuel, and sanitation.

The Poverty Alleviation Fund also maintains gender disaggregated data on communities where it operates. This project will use the PAF database to compare the impacts of the project on the livelihoods of both men and women and their economic status. An impact study will be carried out towards the end of the project in a gender-disaggregated manner.

Relevance as a best practice for sustainable and gender-sensitive biofuel energy projects

This project focuses on providing total independence to rural communities in terms of energy supply for irrigation, and possibly in the future for other household energy uses like cooking and lighting. The production process is simple as it allows direct use of Jatropha oil without the need for conversion to biodiesel. With appropriate training, rural households can easily operate the oil production and irrigation systems, and repair and maintain the equipment.

As Jatropha oil is produced locally, with land and labour being the main inputs, the price and supply of the oil will be largely in control of the rural users and will be much less sensitive to the sorts of external factors pertinent to fossil fuels. With the rural users having almost total control over fuel supply and price, this project can be taken as best practice in sustainable rural energy access.

Because this project is simple in terms of the nature of the fuel and technology used, and is similar to current agricultural activities performed by local men and women, the probability of women's involvement in the process of fuel production, pricing and use is higher than in management of other more complex rural energy technologies.

SOUTH AFRICA: Growing Sunflowers and Soya in Limpopo Province for Biodiesel Production

By Khamarunga Banda,
National African Farmers Union of South Africa

Project overview

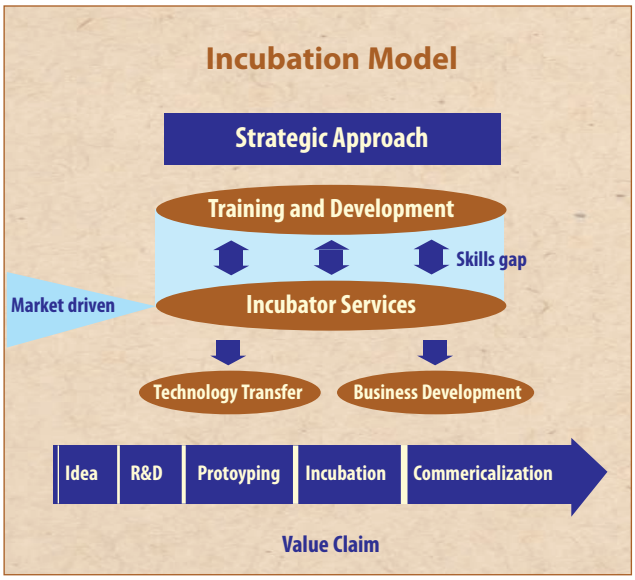
This study examines a project on "Incubation of small-scale farmers for biofuels production through the Mafura-Makhura Incubators." It is aimed at intensive sunflower seed and soya bean production as feedstock for a new biodiesel plant under construction. The project began in 2006 when the former Minister of Minerals and Energy, Mrs. Phumzile Mlambo-Ngcuka, urged Limpopo farmers to search for alternative energy sources as a solution to high conventional energy prices and a new source of income for small-scale farmers. This was followed by a feasibility study by the Agriculture Research Council (ARC), which determined that biofuel manufacturing from sunflower seeds and soya beans could be viable for Limpopo Province, which is one of the poorest provinces in the country. The project was created as a joint partnership of the National Department of Agriculture and ARC, and is being implemented in the Marble Hall, Elias Motswaledi, Makhuthanaga, Tibatse and Fetakgomo districts. It is still in the pilot phase.

Plans for production of biofuels have triggered dynamic and controversial debates about energy and agriculture policies and the economy of South Africa. Those in favour of growing biofuels on a commercial scale argue that biofuels could add to the number of rural jobs and increase economic activity in rural areas. Critics argue that large-scale commercial production of biofuels may threaten food security by replacing food production with fuel feedstock plantations that require excessive irrigation in a water-scarce country. They are also concerned that commercial production of biofuels will entrench hierarchical land and labour relations, trapping farm workers, especially women, in continuing subordinate relationships without gaining benefits from the crops they grow. Environmentalists argue that production costs (such as tractors, fertilizers and harvesters), and the use of pristine land, may release more carbon dioxide than could be saved by use of biofuels in place of fossil fuels.

The South African Government's main justifications for supporting biofuels are that the expected gains from the biofuels industry will contribute to poverty alleviation through job creation, and that the country needs diverse and less environmentally damaging energy sources (African Centre for Biosafety, 2008).

This project operates through an out-growers model, engaging farmers (both men and women) who have between 3-5 hectares of land, although some are acquiring up to 30 hectares. A call for participation is advertised, and workshops in the districts are held. Participants who are accepted attend biofuels training at Tompi-Seleka Agriculture College of Excellence in Limpopo Province. Proof of ownership or title to the land is required for participation in the project. The participating farmers are required to grow either sunflowers or soya beans. Most of the women contacted for this study were involved in sunflower production.

The primary objective of the project is to facilitate economic development by improving the entrepreneurial base of small-scale farmers through an "incubation" model that provides operational and strategic business support services. New trainees sign an "incubation" agreement which enables them to obtain seeds from the project, as well as support in the form of extension advice, fertilizer, pesticides and mechanization to till and weed the land. Under the agreement, they are bound to the project for 3 years.



Source: Siphugu Charles, 2008

Financing

Funding for the project comes from the Government of South Africa's Department of Science and Technology, Small Enterprise Development Agency (SEDA), and the Limpopo Department of Agriculture (African Centre for Biosafety, 2008.). Technical support is provided by the Agriculture Research Council (ARC), a parastatal organization, the Council for Scientific and Industrial Research (CSIR) and researchers at the University of Venda and University of Limpopo.

Benefits to men and women

As South Africa moves towards the development of a biofuels industry, it does so in full cognizance that there may be considerable impacts on the rural poor, both men and women. For this reason, questions about the potential shape of a biofuel economy have attracted interest from policy-makers and practitioners concerned with assessing how this industry will affect socio-economic dynamics. Parties speaking on behalf of the poor have noted that harnessing the potential of biofuels would require overcoming potential conflicts between biofuel crop production and protection of the environment, sustainable development and food security, especially for the rural poor. It is important to examine gender relations now because they will determine women's participation in and benefits from the biofuels industry (Banda, Annecke, and Sugrue, 2007).

The Government of South Africa estimates that by 2009, the project will have created 2100 jobs, with 10,000 hectares under cultivation. They are also planning a 260MT/year biodiesel demonstration plant. Over the long term, it is expected that biofuel production and processing will stimulate the rural economy and lead to the creation of numerous related enterprises. This could provide for diversified livelihoods, especially for miners who have lost jobs in the cities.

The government realizes that gaining the maximum social and economic benefits from the emerging biofuels industry requires widespread engagement of rural women and men to contribute to production of feedstock for the biofuels market. The gendered aspects of the biofuels debate reflect the existing power relations between men and women, and differences in the relative ability of men and women to negotiate for benefits at different levels: within the household and community, and also around boardroom tables.

Interviews with women farmers engaged in the project indicated that sunflower growing for biodiesel production could greatly contribute to their overall welfare and the future of their children through their increased incomes. They were happy that the biofuel production had empowered them economically, since most of them were the key breadwinners in their families. Some have also seen changes in their social relations at the household level since engaging in the project. They made more decisions about not only reproductive issues (e.g. cooking) but also productive issues, such as farm management, use of natural resources, and finances. They had also managed to create a women's support network with their colleagues from Tompi-seleka Agriculture College where the training took place.

However, women felt they need more information about how to obtain more benefits from the biofuels project other than just selling seeds under their prescribed contract. Some women also pointed out the intense labour involved in threshing and sorting out seeds. Others said that it was a challenge to meet contractual targets for sunflower seed production due to cli-

matic variations that greatly affect production, especially in the drier areas of Limpopo Province.

Participation of women

Achieving broad-based participation of men and women farmers in biofuels production requires consideration of the differing impacts on men and women, based on an understanding of the gender dynamics in rural households. This involves analysis of the roles of men and women in terms of their participation in household chores, labour in the fields, financial resources, and decision-making power, especially with respect to investing in technology and agreeing to plant new crops.

Women who were participating in the pilot phase said that they had little say in decision-making related to the design and implementation of the project activities. This was in contrast with management who explained that their objective was to have women participate not only in production but also management of the project; the women were not aware of this. They praised the project but said that they were interested in greater access to the whole biofuels value chain, not just production of feedstock.

Although the project is aiming for participation of 50% women and 50% men in the out-growers group, so far women represent only 30% of the participants in the pilot phase. Women interviewed who were not part of the project argued that the government and other stakeholders should support research on why women's participation has lagged behind. They have called for an overall examination of the conditions of rural women and the many challenges they face, in order to improve participation.

Various factors have been cited with regard to lower levels of women's participation, including institutional gender discrimination, poor information flows, and limitations in the number of women who own land, as this is one of the criteria for selection. Other concerns were raised about water rights, access to agriculture inputs, and financing for biofuels production for women who wanted to venture into this industry.

Land ownership is a critical issue. The government has signed agreements with the women farmer leadership group WARD to facilitate women's access to land under the land reform programme, but the ones who are participating in the project are those who already hold title to land they inherited either from their parents or husbands. The women who are not participating argue that there is need for more land to be allocated to women for production of biofuels. They wondered why the practice of *"women and small land - men and more land"* still persists.

Many of the small-scale women farmers in the area were not aware of the project. They cited lack of informa-

Field of sunflowers in South Africa

TABLE 1: GENDER AND BIOFUELS ISSUES

Biofuels production activities	Gender issues
1. Production of feedstock	• Gender-disaggregated data available on allocation of land and resources? • Access to/ownership of land, water and resources by both women and men • Availability of credit schemes and technology to men/women • Equal access to information and extension support
2. Processing of feedstock/oil into biodiesel and by-products	• Do men and women both control and/or benefit from processing and sale of biodiesel and other products?
3. Marketing	• Income-generating opportunities different for men and women? • Access to markets limited for women?
5. Cross-cutting issues- policies on biofuels, capacity building, training, sustainability, labour, employment	• Labour allocation by gender • Employment opportunities for men/women • Gender sensitive policies? • Women's participation in decisions on biofuels activities and policies?

tion flow, but the calls for participation in the project are posted in all district centres in Limpopo province, so the management thought most of the women must be aware of the project. It was suggested that community radio broadcasts and church meetings could be used to inform other women about the biofuels out-grower project. Some said that reform processes in the extension service have also made it difficult for local farmers to get information and related support services around biofuels.

It is the lure of income through biofuels production that is the incentive for women who want to participate in the project. Asked how they foresaw an ideal model of women's participation, many women said they wanted to participate in the whole biofuels chain. Beyond the growing and harvesting, women said their participation ended and big companies took over. After that it was a "black box". They did not know how their seeds are converted to biodiesel, how much the biodiesel could be sold for, or where it went as an end product. What they were sure of, though, was that those further along the biofuels supply chain were benefiting more from the process than them. For the future, they would like to be more involved in the whole process.

Gender-disaggregated data

This study utilized data from an unpublished SANERI study on gender and biofuels in South Africa (Banda, Annecke and Segrue, 2007), as well as detailed information from women representatives from the National African Farmers Union, interviews with participants in the "incubators", and secondary data detailing global, regional and national experiences.

The SANERI study revealed limitations in terms of the availability of data, especially gender-disaggregated data and information about small-scale farmers' participation, perhaps because the biofuels industry is just getting started. Over all, there is little documentation on biofuels and their uptake in South Africa, particularly with regard to cases studies on women's involvement and benefits. There is also a lack of harmonized effort by key agricultural players (NAFU SA, AGRISA, WARD and YARD) towards a coordinated effort in promoting women and small-scale farmers in the biofuels industry.

Main Challenges

This project represents an attempt by the South African government to address the inequitable apartheid legacy and promote a scheme that engages black small-scale

farmers in a new agricultural production model. There are large numbers of small-scale farmers, especially women farmers, who could potentially benefit from production of biofuels. The primary question is whether and how this can be done to their long-term advantage.

As the government began developing its national biofuels policies, there were plans for introducing large-scale mono-cropping agriculture in degraded lands to gain maximum financial benefits. This led to various questions about impacts on the poor, especially as the targeted 'degraded' lands are mainly in the former homelands - areas that were set aside during the apartheid regime for black people's "homelands." Black South Africans were forced into these areas by means of laws providing for forced removals and restrictive rights of movement. These areas were viewed as having fewer natural resources and less economic value, and yet they had to absorb so many black people that they became overcrowded.

Critics of the government's approach argued that it was based on an aggressive agro-fuels model of biofuel production and did not provide for the engagement of small-scale farmers. Women's groups argued that gender differences in access to resources, decision-making and participation were not considered. With this project, the government has attempted to address some of those criticisms.

The National African Farmers Union of South Africa (NAFU SA) and other groups are in favour of a balance of small and large-scale production of biofuels, saying that large-scale model by itself would perpetuate inequality and further dispossess the already-marginalized small-scale black farmers, especially women. Small-scale farmers also argue that certain food crops should not be considered as feedstock for biofuels because of the impact that would have on food security.

Relevance as best practice

This is a recent initiative and it is yet to be seen how the project will progress. The approach of multi-stakeholder contributions from government, the private sector (input companies) and research institutes is a new model designed to benefit small-scale farmers and women.

However, big companies are currently fighting for large chunks of land for production of biofuels, for example in the eastern Cape region, and the interests of small farmers, particularly the women, could easily be ignored or overshadowed in the current context of big profits. It is a serious challenge for the government to work towards attainment of 50% participation for women within this project. In the future, promotion of a broad-based agenda on land and water rights and access will be crucial so that the project does not end up as just an appeasement to small-scale farmers as the big growers acquire large tracts of prime agricultural land.

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SRI LANKA: Integrating Biofuels into Small Farm Operations for Income and Economic Development

By Dr. Anoja Wickramasinghe, Emeritus Professor of Geography, University of Peradeniya, Sri Lanka

Project overview

The Community Biofuel Project is located in Gurugoda, a remote village in the Kurunegala District, in the Northwestern dry zone of Sri Lanka, four 4 km away from a road with public transportation. The project was initiated in August 2008 as an alternative energy development programme of Practical Action, in partnership with a local NGO, Sangrama, and is designed to be completed within five years.

Working with a selected number of farm families, the project aims to introduce Jatropha as a commercial crop that can be produced in home gardens. Project activities related to commercial Jatropha growing were initiated with 21 farm families for piloting, with the following objectives:

- To assess the possibility of promoting Jatropha in rural villages to address the energy needs of the poor;
- To investigate and identify the most effective methods of propagation and cultivation to obtain sufficient production and yield;
- To improve Jatropha as a commercial crop among the small-scale farmers in the area, particularly to enhance the production of home gardens.

The farm families receive training on the biofuel properties of Jatropha and other oil-producing seeds, and on planting methods using clones, seedlings, and direct seed deposition.

The project is also establishing a biodiesel processing centre to produce fuel, although so far there are not enough Jatropha seeds to support full operations. Until the newly established Jatropha plants produce seeds, the farmers are collecting seeds from Jatropa that already exist in hedges and other varieties of non-edible oil bearing seeds that are available in the area to sell to the processing centre, including Neem, Castor, Karanda, Domba and Mee seeds.

The project is currently experimenting with applications of biofuel to replace kerosene in wick lamps; to contribute part of the fuel needed for pumping drinking water from a well; and in a hybrid engine for a tractor.

Practical Action and Sangrama work directly with a local community organization (Leekolapitiya Praja Sabawa), which has led the process of selection and mobilization of farm households. A number of other organizations are also involved as partners: the Universities of Peradeniya, Moratuwa and Ruhuna; the Rasnayakapura Divisional Secretariat; Nikeweratiya Pradeshiya Sabawa, the local council; and the National Engineering Research and Development Centre (NERD). The universities and the NERD are developing and installing the machinery for oil extraction, designing the field planting, and quality testing and monitoring the performance of the equipment.

The two state agencies - the Divisional Secretariat and Pradeshiya Sabaha - are on the Technical Advisory Board of the project and provide infrastructure, maintain the institutional linkages, and extend the government support for the project. For example, land to establish the biofuel processing centre was supplied by these state agencies.

Financing

Funding for the project has been provided by the Asia-Pacific Forum for Environment Development (APFED), the UN Environment Programme, and the Netherlands Directorate General of Development Cooperation (DGIS). The project began with an initial budget of £4,000 to assess the possibilities of growing Jatropha as a commer-

cial crop. At the next stage, the project received approximately £80,000 for implementation activities, including establishment of a biodiesel processing centre, and support for the farmers to establish a Jatropha production system.

The project is managed by Practical Action, with local funding allocated through the NGO Sangrama to the community-based organization, Leekolapitiya Praja Sabawa (LPS). LPS is the operational arm of the project and provides links between the villages, the agencies and the processing centre. LPS benefits financially by receiving 10% of the amounts paid to farmers for seeds.

Community mobilization

The pilot phase was limited to introducing Jatropha along the boundaries of families' home gardens, and on roadsides adjoining the fences of home gardens. Jatropha nurseries are now located at the processing centre for demonstration, and the distribution of plant materials is being done by project staff with the support of the Leekolapitiya Praja Sabawa.

The most crucial activities at the farm level are preparation of land for planting, planting and weeding. The labour required for these activities is provided by the farm households. Farmers receive Rs. 9 per plant from the Leekolapitiya Praja Sabawa for maintaining a plant. Project support is available for about 500 plants per family.

Main Challenges

The biggest challenge at the moment is to turn the processing centre into a fully functioning biofuel producer. A large amount of capital has been invested in setting it up, but the supply chain and Jatropha production operations are not yet capable of satisfying the requirements for a

RELATIONSHIP TO THE MILLENNIUM DEVELOPMENT GOALS

MDG	Potential benefits
1. Eradicate extreme poverty and hunger	In an area where over 30% of the people live on less than two dollars a day, and nearly 21% of the households do not earn enough to secure their food and non-food needs, producing and supplying seeds to the processing centre provides a means to earn cash, and to expand the community's access to energy for income generation.
2. Achieve universal primary education	In the long term, the possibility of using locally-produced biofuels for multiple purposes (lighting, water pumping, farm mechanization, transportation, cooking and other household uses) could eventually free children from household and farm work and create an enabling environment for children to attend school regularly.
3. Gender equality and empowering women	Over 90% of the growers involved in training, and decision-making on planting and maintaining the Jatropha are women. They are learning skills, building networks, and gaining opportunities to earn income. Use of the locally-produced oil for household lighting, water pumping and possibly for cooking and income generation can ease women's financial and labour burdens and open up new opportunities for them to participate in social and political activities.
4 & 5. Reduce child mortality and maternal health	Possible uses of biofuels to reduce domestic labour requirements could lead to better health for women, easier pregnancy and lactating, and more time and resources for keeping children healthy.
6. Environmental sustainability	Jatropha hedges serve as drought-resistant green fences, providing environmental enrichment, and retaining dust during the dry season. They also reduce surface runoff and erosion, and thereby increase rainwater infiltration which is quite crucial for better resource management. The waste oil cake produced during processing can be used as fertilizer and also as a source material for biogas.

PARTICIPATION OF WOMEN

Activity	Participation of Women
Selecting direct beneficiaries/farm families	• As members of the Leekolapitiya Praja Sabawa; • Expressing interest in growing Jatropha.
Identifying the fences for growing Jatropha	• As the growers - 80 percent are women.
Identifying adjoining areas for avenue planting	• 90 percent are women.
Obtaining information and training	• Women of all 21 farm families obtained *in-situ* training.
Clearing boundary demarcations for planting Jatropha	• 80 to 90 percent of the work is done by women.
Obtaining planting materials or seeds for planting	• 90 percent women.
Preparing planting pots	• 50 percent is done by women.
Planting and weeding	• All done by women.
Obtaining project support – cash payments.	• 60 percent women received cash payments.
Collecting varieties of oil bearing seeds and selling for the processing centre.	• 60 percent are women. • 40 percent are children.

Source: Dr. Anoja Wickramasinghe field visit on 15, 16, and 17th March, 2009.

fully functioning system. The next crucial area will be to reduce the cost of producing the fuel; currently about Rs. 100 is spent on purchasing feedstock to produce one pint of oil. When chemical processing is also added for producing biodiesel, the price will be over Rs. 200. Commercial prospects depend on the price that the end user has to pay, so there is a crucial need to compare options, especially chemical processing versus mechanical processing.

Another critical factor is to convince farmers of the added benefits of Jatropha as a commercial crop. It will help to be able to demonstrate more proven examples of ways that the biofuel can serve as a local solution to the energy crisis, providing multiple benefits through multiple usages.

Widening of the use of biofuel for economic advancement will get it more embedded into farm operation systems. Currently, further work is needed to mobilize farmers to support and sustain the production and supply chain, and to create networks among women to enable them to learn through interaction. A national policy is essential to mobilize resources and maintain standards.

Benefits to men and women

The objectives of the project are not gender specific, but since the focus is on small-scale farmers and improving home gardens, this has enabled women to engage fully in the project implementation activities. Women of the selected farm families are directly engaged in growing Jatropha plants, and the women in the community participate by providing the seeds for the processing centre. Since at this point all of the seed suppliers are women, they and their children secure at least some new income from the project.

The potential contribution of biofuel to un-electrified households is not clearly known, but the current energy use patterns of these households show that replacing kerosene with locally produced fuel could enable them to reduce their lighting costs. Women are primarily responsible for getting kerosene for household use and the current monthly costs of kerosene to these households is in the range of Rs. 400-650 per month. Field discussions revealed that even if the financial benefits were not great, use of locally-produced biofuel would reduce their travel to retail shops to get kerosene and vulnerability to changes in kerosene prices. Income obtained by supplying oil seeds to the processing centre could also help them to cover the cost of kerosene.

The 13 families included in the project's water pump project are enjoying multiple benefits. The women are spared the drudgery of fetching water from distant sources, and that enables them to save at least

three to four hours per day. The convenience of having a water tap at the door step of each household has expanding their use of water for health, sanitation and cleaning kitchen utensils. Men of these households recognized the added benefits of water supply and the positive implications for women.

Gender-disaggregated data

Gender-based data collection in this pilot case is necessary in order to make judgments about the differentiated impacts on men and women of introducing Jatropha as a commercial crop, and developing a local biofuels processing centre. However, the Community Biofuel Project has not established a baseline or gathered gender-specific data. For community information, the project has relied completely on the local community organization Leekolapitiya Praja Sabawa.

The Department of Census and Statistics of Sri Lanka provides data on key parameters (demography, education, employment and income, services etc.) by Grama Niladari Divisions, and then by Divisional Secretariat and District. There is no data available, however, on the division of men's and women's labour by occupations, particularly regarding engagement in the informal sector including farming and home-based economic activities, nor is there gender-disaggregated data on income earnings, production, and marketing. Similarly, data on energy use by gender is not available. The information available on energy shows only household access to electricity and energy sources used in cooking.

These circumstances suggest the need for creating gender-sensitive data collection methodologies and processes that focus on occupational divisions, resource distribution, earned income, and information on energy access, costs and use. Expanded information

Locally available oil-bearing seeds - Sri Lanka

collection by the National Census and Statistics would be very useful. It is important to note that, since household-based data is crucial for planning agricultural activities, land use and biofuel development at the village level, the expanded census collected by the households should be maintained and the data base be made accessible to the users. The following improvements are needed:

- Revising the household survey questionnaire at the national level;
- Maintaining a data-base for various users;
- Providing access to the data-base through respective Divisional Secretariats.

At the village level, project specific data could be gathered to fill the gaps. For follow-up monitoring, it is necessary for the project to maintain a gender-differentiated data base of the beneficiaries, their families, the village economy and the livelihood system.

Relevance as a best practice for sustainable and gender-sensitive biofuel energy projects

This project is exploring the potential for subsistence farming to form the basis for greater energy access and economic development in a remote rural area. The multi-stakeholder partnership providing the technology and training has strengthened the local capacity for experimenting with new agricultural possibilities, for both income and energy access.

There are still a number of challenges to overcome as the project develops, especially in creating a commercially viable biofuel processing facility. The willingness of the community to invest time, labour and land in producing Jatropha seeds depends on there being a market for them, but the investment in the processing centre will remain under-performing if there is not a quickly-accessible and steady supply of seeds in the area, so there are some inherent timing problems associated with this sort of project that need to be worked out.

The strongest element of the project is the simplicity of the concept – building on existing agricultural resources and practices rather than on a high-tech approach. That makes it attractive and accessible to the farmers involved, especially the women.

Going forward, the project should introduce a set of criteria and indicators to measure social, economic and environmental impacts in a comprehensive manner so that multiple benefits can be evaluated. A focus on reducing poverty and gender gaps through income and employment generation, and also reducing vulnerability to livelihood risks, is crucial.

UGANDA: Producing Biodiesel to Power a Multifunctional Platform System

By Dr. Fidelis K. Babagura

Project overview

This is a UNDP-supported project to install Multifunctional Platforms (MFPs) in the rural communities of Masindi on a pilot basis. This phase began in 2007 and runs through the end of 2009. The overall Multifunctional Platform programme is intended to increase opportunities for people in rural villages, especially the most vulnerable, to have access to energy for running motorized equipment and generating electricity. This expands their ability to engage in productive activities, increases local incomes and thereby serves to reduce poverty in the region. The concept was initiated in Mali, and has been expanded to other countries in Africa.

Each MFP consists of a small diesel engine mounted on a chassis, to which a variety of end use equipment can be attached, including grinding mills, vegetable or nut oil presses, battery chargers, welding tools, lights, or even an electrical mini-grid. In Uganda, the objective is to run the MFPs on locally produced biodiesel, using the MFPs to power the equipment used to extract the oil and process the biodiesel, as well as to provide energy for other uses.

The beneficiary communities are partners with UNDP in this project. To ensure maximum benefits to women, the ownership and management of the platforms is typically entrusted to an organized women's group within the village. Training and technical support are provided to build up their management capacities.

The Energy and Development Group in Uganda (EDG) has been contracted to manage the implementation of the project and to provide technical support. The national executing agency is the Ministry of Finance, Planning & Economic Development, Aid Liaison Department. A number of other Ugandan government agencies are involved in an advisory role, including: the Office of the Prime Minister; the Ministry of Agriculture, Animal Industry and Fisheries; the Ministry of Energy and Mineral Development; and Ministry of Trade, Tourism and Industry.

UNDP has supported the installation of MFPs in Kijunjubwa and Nyantonzi, running on biodiesel from jatropha seeds. They are also experimenting with using sunflower seeds. In Kijumbwa, the power provided by the MFP is used to run a milk chiller, bore hole water pump and maize mill. The milk chiller will boost the production and marketing of milk from Kijumjubwa to Masindi and other areas, while the motorized water pump will provide cleaner water at less cost. The MFP at Nyantonzi is operating a rice huller and a maize mill, and is boosting agricultural production in the area. It is also providing energy services for local enterprises, and there are also plans for setting up a mini grid.

The project has a budget of USD 170,000 funded by UNDP through the Energy Trust Fund. It is also supported by the Wisions Sustainable Energy Project Support initiative.

Benefits to men and women

The MFP is a simple, inexpensive energy source at the village level that has been shown to stimulate the creation of employment and the development and modernization of other artisan activities in rural villages. It can also be used to generate electricity for lighting, refrigeration and to pump water, which helps provide clean water to communities, along with improved health care and education services.

The project offers rural women new income-generating opportunities, as well as management experience, so they can become more economically independent and

CONTRIBUTION TO PRODUCTION IN RELATION TO SHARES OF POPULATION AND LAND OWNERSHIP IN UGANDA

Indicator	F (%)	M (%)
Population	51	49
Food production	80	20
Planting	60	40
Weeding	70	30
Harvesting	60	40
Processing/preparation	90	10
Access to/ownership of land and related means of production	8	92

Source: Uganda: From Periphery to Centre: A Strategic Country Gender Assessment, World Bank, 2005

increase their social status. The MFP mechanizes domestic tasks like milling and husking sorghum, millet, maize and other grains, which are normally done with a mortar and pestle or a grinding stone. With the platform, these tasks can become profitable economic activities.

Because women in Uganda represent 80% of the agricultural labour force, they also are responsible for about 80% of the food crop production and continue to contribute about 60% of the labour for cash crop production.

Access to this low-cost technology using locally-produced biofuel means that women in rural communities no longer need to spend as much of their time grinding grains, collecting wood or carrying water. They have more hours in the day to develop profitable activities that could boost their productivity, enabling them to sell better quality products and increase their income using low-cost, effective technology. In addition, girls will be able to attend school more consistently and less likely to find themselves forced to drop out to help their mothers.

The benefits of the MFP have already been proven in parts of West Africa, where processing shea nuts for butter is a common economic activity. In Mali, for example, crushing 10 kilograms of shea nuts manually yields 3.5 kilograms of butter in eight hours in comparison to 4.5 kilograms in four and half hours using the platform.

It is estimated that in Uganda, biodiesel production could relieve the country of an estimated $230 million per year spent on importing approximately 400 million litres of diesel.

Some of the benefits cited on local biofuel production include opportunities for farmers to diversify their income and employment opportunities. A number of concerns were also raised. Both men and women show concern that with increasing interest in the production of biofuels, demand for land to cultivate feed stock might result in less access to land for poor people. There is fear that the government may start to take land from rural poor people for its own economic gains. The most controversial proposal so far in Uganda was a plan to turn over a large portion of the Mabira Forest reserve for sugar cane production to generate ethanol and electricity.

Women were concerned that men will start to grab land so as to maximize the profits generated from growing feedstock. The women will then be required to work on the land with very little or no benefit. There is also concern that the women might be forced to spend most of their productive time cultivating biofuels instead of producing food crops for household consumption.

Participation of women

In setting up an MFP a participatory feasibility study is made in each village before the platform is installed, in order to identify key services required and to enable the definition of baselines against which performance should be benchmarked. The project conducted a baseline survey to benchmark and enable design of the appropriate MFPs in Masindi District, and the implementation models chosen for the MFPs were selected in consultation with the communities.

The MFP programme is designed to be managed by women's groups. Women in the villages have mobilized themselves into groups to be part of this project.

They grow the crops and produce the fuel. The project uses local NGOs to back up the women's groups with skills training and support. The women see their participation in the project as critical to contributing to household incomes.

Main challenges

The Ugandan government is supporting a number of new biofuel initiatives in the country, but there is currently no specific regulatory framework for biofuel development. Without a specific biofuels policy or strategy, the government is therefore working within the renewable energy policies and other agricultural policies. There are conflicts around land use, especially clearing of large tracts of land.

The country has not reached the stage of scaling up biofuel production, yet there are already concerns that foreign companies focused on export will set the direction of biofuel production, without supplying energy access or economic benefits to the local population, or farmers.

There is a noted lack of consultation in the development of biofuels in Uganda. There seems to be insufficient flow of information about biofuels getting to the farmers so there is not a platform for effective dialogue and discussions. In terms of women's participation, there is no clear direction on how it will play out ultimately.

Financing for the MFPs so far has been through development financing, given the relatively high cost of diesel engines/generators in comparison to rural incomes. Additional investments are needed in order to scale up beyond the pilot project.

Relevance as a best practice for sustainable and gender-sensitive biofuel energy project

This MFP project is expected to contribute to the objectives of the East Africa Community's regional energy access strategy, which was adopted in 2005 with the aim of providing rural and peri-urban populations with energy services, including mechanical power for agro-processing.

The country's energy policy now includes as one of its objectives: "To increase access to modern affordable and reliable energy services as a contribution to poverty eradication." In order to achieve this objective the government is promoting the development of markets in energy technologies and services and putting in place a conducive environment to accelerate rural energy supply and access. In addition, the energy policy requires the government to ensure that environmental considerations are given priority by energy suppliers and users, and promote the use of alternative sources of energy and technologies which are environmentally friendly.

Meeting of a farmer's group growing vanilla as well as Jatropha as a side product.

In general, the benefits of producing biofuels locally are that it is an economically self-sustaining activity. Given conditions of a stable economic and political environment, together with the necessary technical and partnerships in Uganda, there is a big opportunity for biofuel production to be sustainable. However, the project is still at the growing and production stage therefore and parameters are still to be drawn on how it can be replicated in other parts of Uganda.

The MFP project uses simple and appropriate technology and is an economic, practical and sustainable solution for many of the problems faced by rural communities. Its flexible, decentralized and client-oriented approach is adaptable to specific situations encountered in different villages.

ZIMBABWE: Women's Roles in the National Jatropha-Growing Project

By Sithabiso Gandure

Project overview

Zimbabwe's national Jatropha-growing project was institutionalized by the government in March 2007 within the National Oil Company of Zimbabwe (NOCZIM), a parastatal tasked with the procurement, research and quality control of fuel and oil importation. Through a five-year out-grower scheme for Jatropha, NOCZIM is working with willing farmers who have land and the capacity to grow Jatropha.

The project is aimed at intensive production of Jatropha plants, with the ultimate objective of massive processing of biodiesel thereafter. The current plan has 3 main stages: sourcing of seed from nurseries; distribution of seedlings; and implementation of the out-grower scheme. A large biodiesel processing plant has been built on the outskirts of Harare in Mount Hampden, which is currently producing biodiesel mostly from cotton and sunflower seeds.

The Jatropha project is guided by the following specific objectives:

1. To produce biodiesel to meet 10% import substitution (approximately 100 million liters per year).
2. To produce 360,000 tons per year of feedstock base (this yields about 100 million liters).
3. To establish about 120,000 hectares of Jatropha plantations.

The project targets willing small-holder and large-scale farmers who have access to land and have the capacity to produce Jatropha. Individual farmers, farmer's groups, and women's groups are all covered in the scheme. Although gender issues are not specifically addressed, nevertheless women small-holder farmers play an important role in the national Jatropha-growing effort.

The production of Jatropha in Zimbabwe dates back to time immemorial, although it was originally limited to the small-holder farming sector and grown mainly as a hedge. The deliberate exploration of Jatropha as a potential source of fuel began in the late 1970s and intensified in the 1980s. An estimated four million Jatropha plants were planted in Zimbabwe by the end of 1997 covering nearly 2,000 hectares.

Mass mobilization of out-growers

Within NOCZIM, the project has a staff of 11 members, including the program managers and officers in each of the country's eight provinces. NOCZIM works with other relevant government departments, including the agricultural extension service AGRITEX, the Forestry Commission, the Ministry of Youth Development, and the Ministry of Women Affairs, Gender and Community Development, as well as agricultural training colleges and NGOs such as Environment Africa, Binga Trees, and PELUM.

Financing

The project of growing Jatropha in Zimbabwe has received high levels of political commitment coupled with financial resources from the Reserve Bank. It is hoped that its promotion will help the government meet its target of at least 10 percent fuel import substitution by 2010. The Government and donors are the main

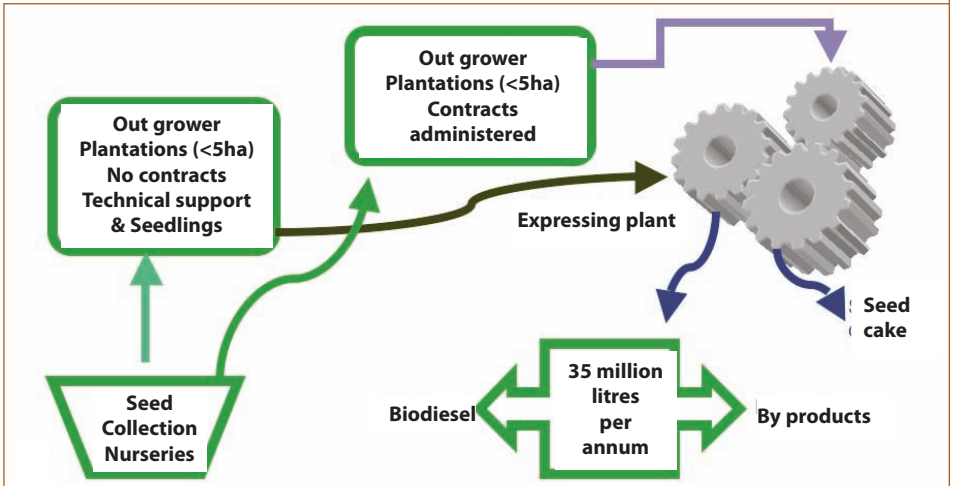
Current Zimbabwe Jatropha Growing Model

Contracted seedling production. Jatropha can be propagated directly from seed in the field, or the seedlings can be raised in nurseries before transplanting. The crop is planted during the warm and main agricultural season between December and April. NOCZIM directly purchases Jatropha seeds from traditional growing areas throughout the country (such as Mutoko district). Sourcing of seed is done before the planting season to ensure adequate supply.

Throughout the country, farmers under contract with NOCZIM, both small-holder and large-scale farmers, receive Jatropha seed supplies and then grow Jatropha in nurseries. The seedlings are transplanted after three months or when they are 15cm tall and pencil-thick. There is need for good fertilization, weed control, pest and disease management in the nursery for ensuring healthy seedlings with greater chances for survival. Over 40 million seedlings were produced in over 90 large nurseries during 2008 (Mashaka and Revanewako, 2009). NOCZIM is currently buying the seedlings at a cost of USD 0.0015 per seedling.

Distribution stage. Jatropha seedlings are distributed to growers using the cluster method to improve economies of scale. A number of diverse institutions in each province participate by offering their staff and services for transporting the seedlings. NOCZIM provides the bulk of the support with 6 lorries and 44 pick-up trucks (bakkies) dedicated to this process. The seedlings are distributed to all willing farmers with land under two types of out-grower schemes outlined below.

Out-grower scheme. The out-grower scheme operates under two conditions. In the first, NOCZIM contracts farmers with 5 hectares or more of land to grow Jatropha plants. The contract specifically states that this is for the purpose of producing seed to be used as feedstock in the production of biodiesel. Proof of ownership or title of land is required. Since this scheme aims at massive production of Jatropha, farmers are supplied with seedlings that cover the agreed hectars at no cost, plus tillage support through access to tractors. Technical assistance in the form of training and maintenance is provided by NOCZIM provincial officers throughout the contract period.



Source: Mashaka and Revanewako, 2009, National Oil Company of Zimbabwe

sources of funds for the project. External funding is channeled through NGOs and supports Jatropha growing among small-holder farmers.

Those farmers owning land less than 5 hectares participate in the program on a non- contractual basis. In this scheme, farmers do not receive any tillage support but have access to technical support as well as free seedlings. These farmers use simple hand tools like ox-drawn ploughs and hoes.

Both out-grower schemes are supported by mass mobilization events that take place throughout the country using print, audio and visual advertisements, although their effectiveness has never been assessed.

Under both scenarios, mature seedlings are planted using either direct seeding or by vegetative propagation. Direct seeding involves planting seeds in a trough or basin 30cm in diameter with weeding done in the first and subsequent years. Vegetative propagation involves the use of cuttings which are about 40-50cm and 3-4 cm in diameter, consisting of two year old shoots. Average weekly planting rates are targeted at 3 million plants, but the current rate stands at 1.5 million plants, slightly above half of the desired capacity. Jatropha has been found to take 3 – 4 years to start bearing fruits when propagated from seeds while 1 – 2 years are taken when cuttings are used.

Benefits to men and women

In the long term, it is anticipated that the project will build resilience of rural households against major

TABLE 3: EXAMPLES OF CURRENT BENEFITS FROM JATROPHA IN THE SMALLHOLDER SECTOR

General uses of Jatropha	**Current benefits** (based on local level research)
Biodiesel production Industrial uses: e.g. Jatropha crude oil as a substitute for paraffin	Used as a lubricant Oil used for cooking and lighting Diesel/paraffin substitute
Manufacture of Soap, candles	Oil used for soap, candle making, cosmetics
Medicinal purpose as a laxative	Pesticides
Rich in nitrogen, seed cake excellent organic fertiliser	Organic fertiliser for improving soil fertility
Glycerine has more than 1500 uses	Glycerine
Source of financial security	
Environmental – controls erosion, rehabilitation of degraded lands	Hedges –protection of homesteads, fields and gardens

Source: Nyikahadzoi, 2009; Tigere et al., 2006; Foldi and Kashap, 1998; SIRDC, 1998.

shocks of climate and other macro-economic challenges. The project will also offer communities an opportunity to access cash.

The Jatropha project is uniformly distributed in the 8 provinces, but specifically targets arid and semi-areas, since these areas (for example, Matabeleland North and South, Masvingo and Midlands) suffer the worst food insecurity. The support of biofuel production in these areas is a noble attempt towards alleviating hunger and vulnerability.

However, at this stage, market forces of supply and demand are crucial. It appears the primary goal is to achieve economic and national supply targets rather that reducing inequalities. There is no deliberate attempt, for example, to purchase feed stock from socially disadvantaged members of society, including women. Moreover, Jatropha production is driven without any clear policy direction. There are current talks of a draft biofuels policy, although this has not been discussed publicly.

Since Zimbabwe has not yet progressed into massive processing of Jatropha into biodiesel as part of the national project, the analysis of the benefits so far will include those farmers who traditionally grew the plants. An insight into the current benefits of growing Jatropha is informed by several local level studies in Zimbabwe (e.g. Nyikahadzoi, 2009; Tigere et al., 2006; Mashaka, 1988). These indicate that so far rural households derive the best benefits from the by-products of Jatropha such as organic fertiliser, soap, glycerine, rather than biodiesel.

Participation of women

It is well understood that women in Zimbabwe are major producers of the main staple food crops and are responsible for securing energy at the household level. Thus, the development of Jatropha has a potential for benefiting women. However, at the national level, gender considerations are currently not taken into account systematically, and not taken seriously.

Gender issues have been mainly added on to the project, advocated and driven by the Ministry of Women Affairs, Gender and Community Development. This arrangement lacks accountability and efficiency and because there are no monitoring and evaluation mechanisms in place, its effectiveness remains questionable.

Nevertheless, the Draft Energy Policy of 2007 broadly states the need to:

> "accelerate representation of women at all levels by ensuring gender balance to avoid discrimination in ownership and management of various energy projects." It is not clear how this will be achieved.

Women's participation in the planning and design phase of the Jatropha activities is best analysed at the local level. The participation of women is most visible in farming activities, as they are considered a reliable source of labor, at either the household level or through women's groups.

Actually the programme is largely driven by women

small-holder farmers, but their roles have not been carefully studied nor documented. There is no deep understanding of women's projects, their profitability, or how profits and benefits are shared. In sum, there is no gender-disaggregated data on the socio-economic benefits of Jatropha.

Local level studies (e.g. Nyikahadzoi, 2009) show that the number of women engaged in Jatropha cultivation is more than that of men because of several factors. First, because of their role in the households, which includes cooking, cleaning and providing care and support, the benefits derived from by-products of Jatropha-growing (including paraffin, soap and glycerine) make the activity very attractive. Second, because benefits from Jatropha accrue over a period of time, like in many other projects, women have the necessary high level of patience and reliability. Third, the generally low levels of return realized from these by-products make them less attractive to men.

It has also been shown that the picking of the Jatropha crop usually coincides with that of crops like maize and other food crops. In such cases, many farmers have opted for maize production over Jatropha because of the minimal returns currently received from the latter.

Jatropha is a fairly labor-intensive crop, especially during the weeding and picking stages, and this exerts an added pressure on women. In addition, shortages of land and lack of rights are major constraints for women farmers. Furthermore, because the Jatropha project is poorly documented, it is currently unknown how many women have benefited from the training programs provided under the various schemes.

In Zimbabwe, it is also well known that women are the major drivers of innovations and many interventions. They are reliable, hard working and yet they are also disadvantaged and discriminated in many circles. For example, in practice, some widows in Zimbabwe are not recognized as surviving spouses and therefore according to the law receive nothing from their husband's estate including land: this is due to the disharmony that exists between culture and the law. In addition, widows face difficulties from relatives who fail to understand that they are entitled to their husband's estate. A stronger attempt to recognising gender issues in the sectors will contribute the project's future sustainability.

Environmental benefits

The project is driven by a poor macro-economic environment and political interest, rather than environmental benefits. However, the use of biodiesel over other fuels will contribute to the mitigation of climate change by reducing global greenhouse gas emissions. This is a desirable condition for a country like Zimbabwe, which suffers from frequent droughts and floods that have caused vast amounts of suffering.

Furthermore, the use of plant oil for domestic purposes will reduce air pollution and improve the health of rural women who are usually exposed to a lot of smoke in non-ventilated environments.

Jatropha hedges have traditionally been found to be useful in protecting gardens and irrigation areas from animals. Its use as a hedge reduces the cutting down of trees that are normally used as fencing poles and thus preserving biodiversity of many threatened forests in Zimbabwe. Apart from being used as a hedge, it is a good environmental rehabilitation crop that can be used in gully reclamation and repairing degraded lands.

Jatropha residue used as an organic fertiliser is environmentally friendly, increases soil fertility and controls soil erosion. This is an important attribute which can boost Zimbabwe poor soils in arid and semi-arid areas.

Main Challenges

It is estimated that about 5000ha equivalent of Jatropha existed as hedges prior to the 2007 national project. In addition, 10,000 ha equivalent was planted in 2007/8 and 20,000ha equivalent in 2008/9 (Mashaka and Revanewako, 2009). However, the project faces a number of challenges. (See Box 1).

One of the underlying causes for these challenges has been the persistently poor macro-economic conditions, coupled with an uncertain political environment. The country has not been receiving external financial

BOX 1: MAJOR CHALLENGES OF THE JATROPHA PRODUCTION PROJECT

- Limited financial resources
- Shortage of human technical capacity
- Limited advocacy and publicity
- Limited tillage support,
- Shortages of agro-chemicals, fertilizers
- Shortages of farm labor
- Overstretched NOCZIM extension officers
- Poor documentation of activities
- Monitoring and evaluation constraints

Source: Mashaka and Revanewako, 2009

aid from major institutions such as the World Bank and the International Monetary Fund (IMF). Furthermore, there is a need for legislated support for biofuels development, especially as it relates to tax concessions on all biofuel blends – for production costs as well as on the equipment – plus duty free importation of equipment or accessories for both processing feedstock into oil and processing it into biodiesel.

Relevance as a best practice

Zimbabwe demonstrates a well-developed strategy on biofuel production in Africa. Despite the macro-economic, political and human resources challenges, it has pursued its agenda and progressed fairly well. It is envisioned that with improvement of the economy, the sector can move into greater heights. External funding will be key in this, however.

Jatropha production in Zimbabwe is currently driven from the top down, without a clear policy direction and without learning from those who have traditionally grown the crop. For example, although the goal of government is to produce biodiesel for fuel generation, small-holder farmers are seeing the value in use of the end products. Yet local level studies indicate that little income is generated from this activity.

The large number of women participating in the project is commendable, and could be seen as a spring board towards achieving good practice in the biofuels industry. However, lack of data and monitoring mechanisms on gender issues makes the effectiveness of the initiative difficult to assess. Moreover, the level of participation of poor small-holder farmers (in the contractual out-grower scheme), and particularly women, is constrained by access to land and the non-availability of tillage support in the form of tractors. The Jatropha project is currently providing more support to those with greater resources, such as large-scale farmers.

Recommendations

1. There is an urgent need for a clear policy direction on biofuels, including gender issues. NOCZIM needs to lobby on this with relevant government entities. Working with women at this stage will ensure that gender issues are clearly accommodated.
2. The design and implementation of the project needs to consider women's access to land and other resources. A detailed study that analyzes these dimensions as they relate to biofuels would be useful.
3. Women should be allowed to choose the best option in Jatropha production. A national level biofuels working group can be established that represents all interest groups, including women and girls.
4. Women should be part of the whole value chain of Jatropha production.
5. The need for regular gender disaggregated data in the growing of Jatropha. Because of manpower constraints, working with extension officer who currently collect information on crops would be an advantage.
6. A market analysis is needed to provide insight into the value chain of Jatropha production, and also to consider the comparative advantages for farmers and women's groups.

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