

Pongamia's Journey from Forest to Micro-enterprise for Improving Livelihoods

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Introduction

India ranks 6th in terms of consumption of energy, which is 3.5% of the total world's commercial energy. The current consumption of diesel in India is about 40m t (40% of the total petroleum product consumption) and is expected to reach 52.32m t by 2006-07 as the demand is growing at a rate 5.6% per annum. Where as domestic production of crude oil and natural gas will remain around 33.97m t during 2006-07. Hence there will be a huge gap between demand and supply which needs to be met through increasing fuel imports or increasing production of biodiesel through developing biodiesel plantations without sacrificing the food security of the country. Biodiesel is renewable energy resource generated from rehabilitation of waste and degraded lands.

Bio-fuel is a fuel comprising of mono-alkyl esters of long chain fatty acids of vegetable oils or animal fats, which is derived either from plant or animal. Use of bio-fuel requires very little or no modification of engine when blended with diesel up to 20% (B20). Use of bio-fuel results in substantial reduction of un-burnt hydrocarbons by 30%, carbon monoxide by 20% and particulate matters by 25%. It has almost no sulphur. Besides, it has nearly 10% in-built oxygen, which facilitates combustion and also favorable Cetane number (51). The lower limit for the Cetane number is 46 for good combustion.

Bio-fuel Plantations in Wasteland Rehabilitation

As per the various statistical estimates the wastelands in India are ranging from 38.4 m ha to 187 m ha (Table 1). The Govt. of India has identified 146 districts from 19 States in micro planning for rehabilitation of degraded lands. Nearly 83% of India's wastelands are

in states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and UP.

Table 1. Various estimates of wastelands in India.

Source	Area (m ha)	% from total Geo. area
National Commission on Agriculture (NCA-1976)	175.0	53
Directorate of Economics & Statistics, Dept. of Agril & Cooperation	38.4	12
Ministry of Agriculture (1982)	175.0	53
Society for Promotion of Wasteland Development (SPWD-1984)	129.6	39
Department of Environment and Forests (BB Vohra, 1980)	95.0	29
National Wasteland Development Board (MoEF-1985)	123.0	37
National Bureau of Soil Survey & Land Use Planning (ICAR-1994)	187.0	57
National Remote Sensing Agency (NRSA-1995)	75.5	23
N.C. Saxena (Sec. RD-WD)	125.0	38

Source: V.B. Eswaran, Chairman SPWD, New Delhi, In Proc. of Seminar on Wasteland Development, March 2001, P-14

Bio-fuel plantations can be successfully used in rehabilitating degraded and waste lands of forest by adopting well tested and successful Joint forest management (JFM) and community forest management (CFM) approaches. Integrated watershed management approach involving landless people self-help groups (SHGs) could be used for development of non-forest low quality private and common property resources (CPRs) lands in the villages. Ministry of Rural Development (MoRD), Ministry of Agriculture (MoA), Ministry of Environment and Forests (MoEF) are pursuing specific programs for such activities on large scale in the villages. In this process recently the National Mission on bio-fuels has identified 13.4 m ha of land that can be readily utilized for bio-fuel plantations (Table 2).

Table 2. Estimation of various lands can be used for bio-fuel plantation.

Land type	Total area (m ha)	Potential area (m ha)
Under stocked forests	31.0	3.0
Protective hedge around agricultural fields	142.0	3.0
Agro- forestry		2.0
Fallow lands	24.0	2.4
Waste land under integrated watershed development and other poverty alleviation programs of Ministry of Rural Development	2.0	2.0
Public lands-railway tracks, roads, canals etc.	1.0	1.0
Total	197.0	13.4

Scope of *Pongamia pinnata* in Energy Plantation

Self-reliance in energy is vital for overall economic development of India and other developing countries in the world. The need to search for alternative sources of energy which are renewable, safe and non polluting assumes top priority in view that fossil fuel sources are finite, are the major source of releasing sequestered carbon to atmosphere as CO₂ and CO causing global warming. In addition, uncertain supplies and frequent price hikes of fossil fuels in the international market are posing serious economic threats for developing countries. Amongst the many species, which can yield oil as a source of energy in the form of bio-fuel, *Pongamia pinnata* has been found to be one of the most suitable species in India being widely grown, it is N₂-fixing tree, not browsed by animals and oil is non-edible. It is tolerant to water logging, saline and alkaline soils, it can withstand harsh climates (medium to high rainfall). It can be planted on degraded lands farmer's field boundaries, Wastelands / fallow lands and could be grown across the country .

Pongamia seeds contain 30-40% oil. *Pongamia pinnata* belongs to the family Papilionaceae. Other species viz. *Pongamia glabra* also exists. It is a medium sized evergreen tree with a spreading crown and a short bole. The tree is planted for shade and is grown as ornamental tree. It is one of the few nitrogen-fixing trees producing seeds

containing 30-40% oil. The natural distribution is along coasts and riverbanks in lands and native to the Asian subcontinent. It is also cultivated along roadsides, canal banks and open farm lands. It is a preferred species for controlling soil erosion and binding sand dunes because of its dense network of lateral roots. Its root, bark, leaves, sap, and flower also have medicinal properties and traditionally used as medicinal plants (Fig.1).



Figure 1. A 10-year old Pongamia tree

The seeds are largely exploited for extraction of non-edible oil commercially known as ‘Karanja oil’, which is well known for its medicinal properties. So far there is no systematic organized collection of seeds. Mixture seeds consist of 95% kernel and are reported to contain about 27.0- 40% oil. The yield of oil is reported to be about 24 to 26.5% if mechanical expellers are used for the recovery of oil from the kernels. The crude oil is yellow orange to brown in color, which deepens on standing. It has a bitter taste, disagreeable odour, and it’s non-edible.

Pongamia seed oil as a bio- fuel has physical properties very similar to conventional diesel. Emission properties, however, are cleaner for Bio- fuel than for conventional diesel. It has no polyaromatic compounds and reduced toxic smoke and soot emissions. A drastic reduction in sulphur content (<350ppm) and higher cetane number (>51) will be required in the petroleum diesel produced by Indian refineries. However, bio-fuel meets these two important specifications and would help in improving the lubricity of low sulphur (0.13-0.16%) diesel. The present specification of flash point for petroleum diesel is 350 C which is lower than all the countries in the world (>550C). Bio-fuel will help in raising the flash point, a requirement of safety. The other properties of bio-fuel in comparison with petroleum diesel are as follows:

Table 3. A comparison of bio- fuel and standard petroleum diesel

Property	Bio-fuel	Petroleum diesel
Viscosity (cp) (30°C)	5.51	3.60
Specific gravity (15°C/4°C)	0.917	0.841
Solidfying Point (°C)	2.0	0.14
Cetane Value	51.0	47.8
Flash Point (°C)	110	80
Carbon Residue (%)	0.64	0.05
Distillation (°C)	284 to 295	350
Sulfur (%)	0.13 to 0.16	1.0
Acid Value	1.0 to 38.2	
Saponification Value	188 to 198	
Iodine Value	90.8 to 112.5	
Refractive Index (30°C)	1.47	

In addition the same oil is used as fuel for cooking and lightening lamps. The oil is also used as a lubricant, water-paint binder, pesticide, and in soap making and tanning industries. The oil is known to have value in folk medicine for the treatment of rheumatism, as well as human and animal skin diseases. It is effective in enhancing the pigmentation of skin affected by leucoderma or scabies. Incorporation of leaves and the presscake used traditionally for improving soil fertility as leaves and cake are good sources of fixed N

biologically. Dried leaves are used as an insect repellent in stored grains. The press cake, when applied to the soil, has pesticidal value, particularly against nematodes.

Energy Plantations Serving as a Micro-enterprise—Case Study on Powerguda, Adilabad District

Indigenous production of *Pongamia* oil could save foreign exchange worth of several million dollars and also generate employment opportunities in rural areas. Such plantations could generate employment opportunities for land less men and women, tribal communities, and small farmers. Especially women self-help groups in rural areas can generate additional income from selling *Pongamia* seed oil and press cake after extraction with the help of oil expellers.

Powerguda a tribal village was selected for the case study because it suffered from many social, economic and natural resource problems. The village comprised of indigenous people who lived in poverty. The productivity was low on agricultural lands. Therefore, the people migrated to nearby towns in search of work. At the same time, the community decided to overcome their problems by working with the local government. Thus, Powerguda was selected for assistance under the IFAD- funded Andhra Pradesh Participatory Tribal Development Project. The Integrated Tribal Development Agency (ITDA), Adilabad district requested International Crops Research Institute for the Semi-Arid tropics (ICRISAT), Patancheru, Andhra Pradesh to provide technical support for raising the income levels in the village by introducing Integrated watershed Management technology.

As a supplementary activity, sequeling IWM, since October 2003, Powerguda discovered a new income generating activity in raising *Pongamia* nursery. An additional investment was made by ITDA in an oil extracting machine (worth Rs. 375,000) to support income generating activities of the community. Seeds of *Pongamia*, *Neem* and other seeds can be crushed in this machine to extract oil that is sold in the market (Fig 2).



Figure 2. Pongamia oil expeller unit

This oil mill has become an important source of income to the village. The women earn Rs.2 kg⁻¹ *Pongamia* seed crushed with machine. The plant has the capacity to crush 50 kg seed h⁻¹. Powerguda became an environmental pioneer by planting *Pongamia* seedlings and when it sold the equivalent of 147 t of carbon dioxide in verified emission reduction to the World Bank. To neutralize the emissions from air travel and local transport by the participants of international conference held in Washington from 19-21 October 2003, the World Bank paid US\$ 645 to Powerguda women self help groups. This was the first Indian village the multilateral agency made direct payment for exporting environmental services. This has given the people a sense of pride in the village and put Powerguda on the map of the world. The community decided to invest in *Pongamia* nursery Rs. 30,000 received from the World Bank as part of environmental service payment. The nursery with the a capacity of 20,000 saplings was grown out of which 10,000 were planted on community land and the rest sold to nearby villages and to the forest department. The income generated by selling the saplings was ploughed back into further nursery investment. With the introduction of a

forest protection committee (Vana Samrakshana Samithi) in the village, it is likely that forest department will become a potential buyer for the saplings and local nursery will remain a viable business proposition (Fig 3.).



Figure 3. The pongamia nursery has become a new income-generating activity in the village

The by-product (press cake) of *Pongamia* seed oil extraction process has been tested as an organic source of plant nutrients as it contains 4.0% N, 1.0% P, 1.0% K. On farm trials for using seed cake for soil amendment were conducted in Adilabad district in farmer's fields. The preliminary trials clearly indicated that the use of nutrient rich press cake enhanced the soil fertility, nutrient availability and yield of crops like maize and soybean (Table 4). Thus the farmers in the village acknowledging the importance of nutrient rich press cake and motivated to purchase from women self help groups running the oil expeller at the rate of Rs. 5 per kg. The women are able to generate income from selling nutrient rich by-product of the *Pongamia* seed oil extraction process.

Table 4. Response of soybean and maize to the application of *Pongamia* press cake and inorganic fertilizers –cost benefit analysis.

Treatment	N-equivalent applied (kg ha ⁻¹)	yield (kg ha ⁻¹)	Income (Rs ha ⁻¹)	Cost of fertilizer input (Rs)	Benefit (Rs ha ⁻¹)
Soybean					
Farmers practice	16	900	10800	450	10350
<i>Pongamia</i> cake	12	1340	16080	1500	14580
Fertilizer	23	1450	17400	250	17150
Fert.+ P.C	17	1650	19800	1500	18300
Maize					
Farmers practice	40	1200	6000	1125	4875
<i>Pongamia</i> cake	71	2240	11200	4000	7200
Fertilizer	92	2390	11950	1000	10950
Fert.+ P.C	81	2560	12800	5000	7800

Conclusions

The experience from Powerguda village has opened up new vistas not only in terms of increased livelihoods opportunities but also in terms of opportunities to increase the soil fertility through amendments with the byproduct from the oil expeller plant. Further, the illiterate women self help group have established the novel mechanisms for providing the global environmental services through the verifiable emission reduction of carbon dioxide mechanism which could benefit the poor sections of the society who primarily look after the C sequestering or C replacing plantations using the well established mechanisms of JFM or CFM or integrated watershed management approach for developing the CPRs through SHGs. It is remarkable feat that through knowledge sharing and capacity building the community could harness the benefits so far untapped benefits from the natural capital existing in the village. There are number of lessons emerging from this initiative and opens up number of opportunities to improve their livelihoods further through establishing the market linkages, proper institutions for multiplying the benefits on sustainable basis. The mechanism of collective action and cohesiveness in the community enabled them to get in the forefront areas such as trading C units to outside world and enhanced the awareness about environment protection. It's a win-win proposition for all the stakeholders to use

biodiesel plantations for rehabilitating the waste lands and also increase their incomes from agriculture and other allied activities associated through value addition chain. The *Pongamia* seed cake which is a byproduct of the oil extraction plant needs to be popularized and marketed properly to improve the livelihoods of indigenous people living in the remote areas.



About ICRISAT



The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization belonging to the Future Harvest Alliance of Centers supported by the Consultative Group on International Agricultural Research (CGIAR). Established in 1972, ICRISAT generates and shares cutting edge technologies that support the livelihoods of more than 300 million people - the poorest of the poor in semi-arid areas of the developing world.

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