

INDIAN PROGRAMS ON JATROPHA CURCAS

The National Mission on Jatropha Biodiesel

In April 2003, the committee on development of BIO-FUEL, under the auspices of the Planning Commission of India, presented its report that recommends a major multi-dimensional programme to replace 20% of India's diesel consumption. The National Planning Commission has integrated the Ministries of Petroleum, Rural Development, Poverty Alleviation and the Environmental Ministry and others. One objective is to blend petro-diesel with a planned 13 Million t of bio-diesel by 2013 (>>1000 times compared to the present world Jatropha cultivation and production), produced mainly from non-edible Jatropha oil, a smaller part from Pongamia.

For this end, eleven millions ha of presently unused lands are to be cultivated with Jatropha (for comparison: annual loss of Brazilian rain forest 2.4 Mio ha). A similar program was started with Ethanol production from sugarcane molasses, which is to replace 5% of transport petrol in the first phase. Announcements and discussion of this program have already now brought numerous institutions, private investors and some farmers to prepare and even start with work on a major Jatropha program. The move towards large-scale utilization of Jatropha is thus mainly coming from the energy discussion, with its increasing environmental and health burden and foreign exchange cost; but as well from the Forestry and Rural Development Sector, looking for future income potentials. In March 2004 a first portion for a National Program on Jatropha was released with RS. 800 Crore (161) Mio. S/Euro) to support cultivation of Jatropha on new fields and plantations of 200.000 ha. This is the first portion of a total program approved with a volume of RS. 1.500 Core (300 Mio S/Euro) and 400.000 ha, to be realized within five years. The program intends to replace 5% of diesel consumption by 2006 with 2.6 Mio t of Jatropha bio-diesel produced on 2.2 Mio ha, based on yields expected by the Government.

To plant 11 Mio ha Jatropha, the program is to become a "National Mission" and mass movement and wants to mobilize a large number of stakeholders including individuals, communities, entrepreneurs, oil companies, business, industry, the financial sector as well as Government and most of its institutions.

In the first phase, within a demonstration project, the "viability of all components" is to be tested, developed and demonstrated by Government with all its linkages in different parts of the country, sufficient production of seeds and a wide information and education of potential participants and stake holders to allow for a self-sustained dissemination. The demonstration project consists of 2 phases, each with 200.000 ha planted in 8 states of 2 x 25.000 ha "compact area" each.

Each state will have one esterification plant, which is meant to be economical from 80.000 t of bio-diesel onward, expected to come from 50 to 70000 ha each. Compact areas in each state will be further subdivided into 2000 ha blocks of plantation to facilitate supply of planting material, procurement of seed and primary processing through expellers.

Expected outputs from 400,000 ha are meant to be 0.5 Million t of bio-diesel, compost from the press cake, and massive generation of employment (16 Mio days/year) for the poor. The program is meant to assist to achieve emission standards and climatic targets approved by Government, to improve degraded land resources, and income to 1.9 Mio poor families at 4 families per ha, on a base of 5 Rupees/kg of seed sold.

For 2007, when the process is meant to move self-sustained, a scheme of margin money, subsidy and loan is planned to be instituted. Expansion of processing capacities is meant to run on a 30% subsidy, 60% loan, and 10% private capital basis. Additional support for mainly market based "Phase II" from 2007 onwards, is sought from International Funding Agencies, since the program addresses global environmental concern and contributes to poverty alleviation. Spat~te legislation on bio-fuels is recommended.

Land available for Jatropha curcas plantations (million hectares)

Forest areas	Agriculture (boundary Planation)	Agriculture (agriforestry)	Cultivable fallow lands	Wastelands under intergrated watershed development	Strip lands such as roads, railways, canalbanks	Total	Additional wastelands
3.0	3.0	2.0	2.4	2.0	1.0	13.4	4.0

The National Mission on Biodiesel, is therefore proposed in two phases as below:

1. Phase I consisting of a Demonstration Project to be implemented by the year 2006-07 with an investment of Rs. 1500 crore (\$300 million) on 400,000 ha.
2. As a follow up of the Demonstration Project, Phase II will consist of a self sustaining expansion of the programme beginning in the year 2007 leading to production of Biodiesel required in the year 2011-12.

Rationale for the Program

India is sixth in the world in energy demand accounting for 3.5% of world commercial energy consumption. A large part of the population has no access to commercial energy from hydrocarbons at all. India's import of crude oil is expected to go up from 85 million t to 147 million t by 2007. Hydrocarbons, in India predominantly diesel (ca. 80 %, in Germany >40%) are responsible for most of the transportation fuel in India; the transport sector is the most problematic as no realistic alternatives have been found so far. Overall transport crude oil demand was >50 Mio T in 2001.

In India, a larger share than in other countries is needed for transport purposes, in particular for diesel. Consumption is expected to rise at an annual 5.6% rate and by 65% until 21). Domestic supply can presently satisfy 22% of demand and dependence on crude oil imports (>18 billion \$/a) is increasing. There is a growing demand gap between production and consumption. At the same time, per capita consumption with 480 kg oil equivalent and 260 Mio people below the poverty line (>20% worlds poor) is quite low. Indian petrol reserves are expected to last for another 20 years plus. Rising and volatile prices and respective foreign exchange costs are one of the main risk factors of the Indian economic and social development prospects.

In Europe and the US blends between 5 and 20% of bio-diesel are used as well without engine modification, in the US so far a total of 400.000 m³/a. In France 135 (5% bio-diesel blend) is mandatory. Sometimes a low percentage additive for lubrication and sulfur removal from diesel fuel is used as well. In Europe bio-diesel is mainly made from rapeseed, sunflower, in the US from soybean and in Malaysia increasingly palm oil is being utilized. Nicaragua is cited as an example where Jatropha oil is used for bio-diesel to replace petrodiesel.

From a total of RS 1500 Crores total Government contribution (300 Mio S/Euro) the major share (RS 1200 Crores) is earmarked to be spent for nurseries and plantations. Legislation is to secure that use of B5 (5% blend) and successively B20 (20% blend) become mandatory all over India.

Bio-energy, as a replacement for transport fuel can be alcohol, bio-oil or bio-diesel. Bio fuels are to reduce negative environmental effects through lower emissions and climatic impacts. Local production of bio energy is projected to have a broad range of positive economic, social and environmental implications. Upgrading eroded and deforested land, creation of employment and income is part of the argument. The national program wants to stop soil and forest degradation and its environmental implications, generate employment for the poor, in particular for women, reduce climatic change and improve energy security.

Alcohol, mainly in form of ethanol is planned in India in be made from sugar cane directly or from molasses and to replace 5% of motor spirit for spark ignition engines. The alcohol program has started already. Bio-oil, without further processing, is only suitable for sturdy compression ignition engines (diesel), or asks for considerable motor modifications and

maintenance. Therefore, the Indian Government focuses the processing to bio-diesel from plant oils. However, a direct use in rural engines, water pumps, tractors and generator sets to produce electricity are additional options to provide rural energy and energy security to the rural population.

Bio-diesel, considered an equal replacement of petro-diesel (with 5% less efficiency), can be made after transesterification from virgin or used vegetable oils (both edible or non-edible). It is meant to be produced in India mainly from *Jatropha curcas* and, to a lower extent, from other non-edible virgin oils (in particular *Pongamia pinnata*, called honge or pinnata, as well as Neeni, Mahua). It requires little or no engine modification up to 20% blend and minor modification at higher percentage blends. The use of bio-diesel results in substantial reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters. It is considered to have almost no sulphur, no aromatics and has about 10% built in oxygen, which helps to burn it fully. Its higher cetane number improves the combustion quality. Almost all present emissions standards are expected to be reached with bio-diesel.

While the country is short of petroleum reserve, it has large Arable land as well as good climatic conditions, potential to produce biomass to be processed into bio-fuels. Demand of edible oil is higher than production, so edible oils, as mainly used in Europe and the US for transport oil, are considered not eligible. As well, edible oils are much more expensive, sometimes by a factor 3-5, in India.

Instrument to promote non-edible oils is hoped to be buy-back arrangements with oil companies to be put in place and mandatory use of bio-diesel blends. The *Jatropha* program is to be combined with other programs of the Ministry of Rural Development to attract growers, entrepreneurs and financial institutions so that a "self sustaining programme of expansion takes off" on its own, with the Government playing mainly the role of a facilitator. Hence, for the expansion phase, the Government will need "to give only marginal financial support". The rural community will have the first right of access to the oil for its own use. Responsibility for availability of sufficient processing units will be with the Ministry of Petroleum. Studies have revealed that "direct and indirect impact of bio-diesel e.g. employment generation, balance of trade, emission benefits etc. are substantial and need to be accounted for" while considering the duty structure on bio-diesel and HSD.

However, a clear comparison between the yields and economics of different edible and non-edible oils, and why production of non-edible oils for farmers is expected to be more viable than of edible oils, has not been found inside the program argument. Duty structure is meant to be designed in a way that the price of bio-diesel will be slightly lower than that of imported petro-diesel fuel.

Jatropha curcas is considered most suitable since it uses lands, which are largely unproductive for the time being and are located in poverty-stricken and watershed areas and degraded forests. *Jatropha* is planned as well to be planted under the poverty alleviation programmes that deal with land improvements.

For the planned 13 Mio ha *Jatropha*, 3 Mio ha are to be identified in 38 Mio ha under stocked forest, 3 Mio ha hedge equivalent from 140 Mio ha of agricultural land and 2 Mio ha for absentee landlords since, *Jatropha* does not require looking after and gives a net income of Rs 15000/ha". In addition, land comes from 2.4 Mio ha out of 24 Mb. ha of fallow lands; two Mio ha from integrated watershed development programmes; one Mio ha from stretches of public land along railway, roads/ canals and 4 Mio ha from "other waste lands".

As a by-product the oil cake and glycerol are to be sold to reduce the cost of processing biodiesel to par with the oil price. The sales cost of bio-diesel is expected to be very close to the cost of oil obtained for production, since the cost of trans-esterification is meant to be recoverable to a great extent from the income of oil cake (3-5 Rupees/kg) and glycerol (50 Rupees/kg). The cost of bio-diesel is expected to reach between 15 and 16.3 Rupees at an assumed price of RS 5 per kg of seed and at 3.2 kg of seed for 1 litre of oil. "Thus the plantation, oil extraction and production of bio-diesel are economically feasible". Overall oil bio-diesel recovery is expected to be 91% at an oil portion of 35%. There is a plant density of 2500 trees per ha assumed, in mixed forestry areas 2500 trees each are considered one ha. An average seed yield of 1.5kg/tree and 3.75 t/ha are expected corresponding to 1.2 t of oil /ha and 2.5 t of fertilizer. Bio-diesel is expected to be available on the market from

2005/2006 onwards. Work created of 300 "man" days /ha would allow 550.000 people to escape poverty in the first part of the program. A transesterification plant is meant to cost Rs75 Crores (5/Euro 12.5 Mio; 1 crore is equivalent to Rs 10 Mio.), and procurement and expeller centre Rs 80 lakh (S/Euro 160.000; one lakh is equivalent to Rs 100.000),)NEEDS AND RESPONSIBILITIES

A number of research and development needs have been defined by the program:

- Genetically improved tree species, to produce better quality and quantity of oil This includes tree improvement programs, identification of candidate plus trees, standardization of nursery raising techniques, (vegetative/seed/tissue culture) Scientific data for planting density, fertilization practices, planting procedures
- Technology practices for adoption at grass root level.
- Research on inter-cropping for agriculture, agro-forestry and forestry application
- Processing techniques including bio-diesel and uses of by-products
- Utilisation of different oils and oil blends including potential additives needed
- Blending, storage and transport of bio-diesel
- Engine development and modification
- Marketing and trade
- Watering techniques, water and irrigation needs and wastewater use are not part of the program

There are some "micro-missions" or task forces planned for the different tasks:

- Ministry of Forestry; JFMCs (planting on forest lands)
- Novod (planting on non-forest lands)
- Ministry of Rural Development (other land implementation);
- Khadi Village and Industries Commission ? KVIC (procurement of seeds and oil extraction)
- Ministry of Petroleum (trans-esterification) and
- Different Research Agencies (research and development),
- All R&D activities are to be coordinated by a committee under the Planning commission.

Some of the institutions presently involved in R&D activities are the following:

- Punjab Agricultural University (PAU)
- Coiabatore Horticultural University with 250 l/day bio-diesel production facility
- institute of Petroleum (IIP)
- Indian institute of Chemical Technology (IJCT)
- Indian Institute of Technology (Delhi, Madras)
- Indian Oil Corporation (bC) with 60 kg/day bio-diesel production facility at Fardabad
- Mahindra&Màhindra (works on tractors from Karanji bio-diesel; pilot plant in Mumbai)

(Courtesy " case study" jatropha curcas by GFU)
