"The Jatropha System"

Integrated Rural Development by Utilisation of Jatropha curcas L. (JCL) as Raw Material and as Renewable Energy

by Reinhard K. Henning, Rothkreuz 11, D-88138 Weissensberg, Germany

Tel: +49 8389 984129 , e-mail: henning@bagani.de, see also: www.jatropha.org

This presentation is divided in 5 points:

1. Introductory remarks
2. Description of the plant, distribution, ecology
3. Description of the Jatropha System
4. Economic Aspects
5. Strategies to disseminate the know how of the Jatropha System1.
6. Introductory remarks

This paper contains only some information concerning "the Jatropha System", just to

understand its potential to contribute to rural development by its utilization.

A lot of information can be found on the Jatropha website for downloading**: www.jatropha.org.**

The economic evaluation of the Jatropha activities in Tanzania are based on real data. In other countries the Jatropha activities also show positive economic results, as far as soap making is concerned. The economic use of Jatropha oil as fuel (direct or as biodiesel) depends very much on the level of rural labour costs, as well as on the price of diesel fuel, which is often substantially subsidized.

2. Description of the plant, distribution, ecology

Jatropha curcas L. (JCL) is a tall bush or small tree (up to 5 m hight) and belongs to the euphorbia family. The genus Jatropha contains approximately 170 known species. The genus name Jatropha derives from the Greek *jatrós* (doctor), *trophé* (food), which implies medicinal uses. The plant is planted as a hedge (living fence) by farmers all over the world around homesteads, gardens and fieldes, because it is not browsed by animals

2.1 Botanical description

Jatropha curcas L., or physic nut, has thick glabrous branchlets. The tree has a straight trunk and gray or reddish bark, masked by large white patches. It has green leaves with a length and width of 6 to 15 cm, with 5 to 7 shallow lobes. The leaves are arranged alternately**.**

2.2 Distribution

Jatropha curcas originates from Cental America.

From the Caribbean, Jatropha curcas was probably distributed by Portuguese seafarers via the Cape Verde Islands and former Portuguese Guinea (now Guinea Bissau) to other countries in Africa and Asia. Today it is cultivated in almost all tropical and subtropical countries as protection hedges around homesteads, gardens and fields, since it is not browsed by animals.

2.3 Ecology

Jatropha curcas L. is not a weed. It is not self propagating. It has to be planted.

It grows well on marginal land with more than 600 mm of rainfall per year, and it withstands

long drought periods. With less than 600 mm it cannot grow except in special conditions like

Dormancy is induced by fluctuations in rainfall and temperature/light. But not all trees respond simultainously. In a hedge you may have branches without leaves, and besides ones full of green leaves. The branches contain a whitish latex, which causes brown stains, which are very difficult to remove. Normally, five roots are formed from seeds: one tap root and 4 lateral roots. Plants from cuttings develop only lateral roots. Inflorescences are formed terminally on branches. The plant is monoecious and flowers are unisexual. Pollination is by insects. After pollination, a trilocular ellipsoidal fruit is formed. The exocarp remains fleshy until the seeds are mature. The seeds are black and in the average 18 mm long (11 ? 30) and 10 mm wide (7 ? 11). The seed weight (per 1000) is about 727 g, this are 1375 seeds per kg in the average. The life-span of the Jatropha curcas plant is more than 50 years.

Varieties

There are 3 varieties.The Cape Verde variety is the one which is spread all over the world.

A Jatropha variety in Nicaragua has fewer, but larger fruits. The yield per ha seems to be the same. A non-toxic variety exists in Mexico which is used for human consumption after roasting. It does not contain Phorbol esters. ("This non-toxic variety of Jatropha could be a potential source of oil for human consumption, and the seed cake can be a good protein source for humans as well as for livestock.", Becker et al, 1999).

3. Description of the Jatropha System

3.1 The Jatropha SystemThe Jatropha System is an integrated rural development approach. By

planting Jatropha hedges to protect gardens and fields against roaming animals, the oil from the seeds can be used for soap production, for lighting and cooking and as fuel in special diesel engines. In this way the Jatropha System covers 4 main aspects of rural development:

promotion of women (local soap production);

poverty reduction (protecting crops and selling seeds, oil and soap);

erosion control (planting hedges);

energy supply for the household and stationary engines in rural areas.

The obvious advantage of this "Jatropha System" is that all the processing procedure, and thus all added value, can be kept within the rural area or even within one village. No centralised processing (like in the cotton industry) is necessary.

3.2 Possible Uses of the Jatropha Plant

- The Jatropha plant is used as a medicinal plant:
- The seeds against constipation;
- The latex / sap for wound healing;
- The leaves as tea against malaria; etc.
- Jatropha is planted in the form of hedges around gardens or fields to protect the crops against roaming animals like cattle or goats;
- Jatropha hedges are planted to reduce erosion caused by water and/or wind;
- Jatropha is planted to demarcate the boundaries of fields and homesteads;
- Jatropha plants are used as a source of shade for coffee plants (on Cuba);
- In Comore islands, in Papua New Guinea and in Uganda Jatropha plants are used as a support plant for vanilla;

4. Economic Aspects

This is an example of a successful project in Tanzania. The Jatropha plant is already known by the population since a long time, but its utilization was limited to the use of the plant as protection hedge around homesteads and gardens. The seeds were not used.

The KAKUTE project convinced the Massai women as well as a women group in Mtu Wa Mbu, both near the Ngorongoro Crater, Arusha, Tanzania, of the interesting economic potential of this plant. Especially the medicinal property of the soap makes it interesting for the rural population. And KAKUTE was able to maintain the image of the soap to be a "medicinal soap".4.1 Economy of Small Scale Jatropha Utilization in Tanzania (data from KAKUTE, 2003)

Collection of seeds

Collection of seeds: 2 kg in 1 hour

Sale of seeds: 150 TZS per kgValue added for 1 hour work 300 TZS 0,29 USD per hour

Oil extraction

1,0 hours of work to extract 1 litre of oil

0,5 filtering of the oilInput: Purchase of 5 kg of seed 750 TZS 0,71 USD per litre

Depreciation/maintenance of ram press 0,04 USD / kg

for 5 kg: 210 TZS 0,20 USD per litre

Output: Sale of 1 litre of oil 2.000 TZS 1,90 USD

Total of revenues 1.040 TZS 0,99 USD

Value added for 1 hour work 693 TZS 0,66 USD per hour

Soap making

16 hours work for 252 bars of soap

10 hours for miscelenous work (organising purchase of oil, wrapping the soap, etc)

1 bar sold for 500 TZS

Purchase of 20 litres of oil à 2.000 TZS = 40.000

Purchase of 3 kg of Caustic Soda à 2.000 TZS = 6.000 TZS

Plasic for wrapping soap = 3.000 TZS

Input: 20 l oil à 2.000 TZS 40.000 TZS 38,10 USD

Plastic 3.000 TZS 2,86 USD

Caustic Soda 15.000 TZS 14,29 USD

Total input 58.000 TZS 55,24 USDOutput: 252 bars à 500 TZS 126.000 TZS 120,00 USD

Total input 38.000 TZS 35,24 USDOutput: 252 bars a 500 TZS 126.000 TZS 120,00 USD

Total of revenues for 26 hours work 68.000 TZS 64,76 USD

Value added for 1 hour of work 2.615 TZS 2,49 USD per hour

The added value by 1 hour of work of the utilization of the Jatropha plant can be summarized

as follows:

- Collection / harvesting of seeds 0,29 USD
- Extraction of Jatropha oil with hand press 0,66 USD
- Soap making 2,49 USD5

4.2 Economy of Small Scale Production of Jatropha Oil as Fuel in TanzaniaProduction and utilization of Jatropha oil as fuel (price for Diesel in Tanzania in Nov. 2003: 650 TZS) has a positive result in the economic anylysis, but only, if the raw material (Jatropha seeds) are not bought, but collected. If the revenues of the whole process are calculated in respect of the necessary working hours, an economic benefice is visible:

Extraction with hand press (Bielenberg ram press):

Labour costs:

In reality a rural worker gets about 10.000 TZS per month (technical assistant in a flower mill), but he will get some extras like housing, medicine, etc., which is difficult to calculate. Working 6 days a week and 8 hours a day, these are 190 hours a month. This gives a calculated salary on hour basis of 53 TZS.

Usually it is too much to calculate with 8 hours of work daily, so we take 6 and get a payment per hour of 70 TZS.

Officially the costs of labour is 1.200 TZS per day of 8 hours. So 1 hour is worth 150 TZS. To be on the secure side, we calculate also with 6 hours work per day and get 200 TZS per hour.

Depreciation of the hand press:

Price of the press: 150 USD, capacity: 5 kg seeds/h, lifespan: 5 years;

- Throughput in 5 years: 5 years x 10 hrs/day x 6 days/week x 50 weeks = 15.000 kg
- Depreciation: 150 USD / 15.000 kg = 1 cent / kg
- Costs of the handpress: Depreciation + maintenance = 1 + 1 = 0,02 USD per kg = 20TZS/kg;
- Collection / harvest of seeds: 3 kg of seeds can be harvested per hour (measured in Mali), 5 kg are needed for 1 litre of oil; i. e. the labour to collect/harvest 1 kg of seeds is:1,7 hours.
- Extraction of the oil: Per working hour 1 litre of oil can be extracted by one person with a hand press. Additionally ? hour is needed for purifying the raw oil (sedimentation,filtration);. i. e. 1,5 working hours for the extraction of 1 litre of oil.
- Cost factors of oil production: Harvesting/collecting seeds = 1,7 hours/litre

Extraction of the oil = 1,5 hours/litre

Depreciation/maintenance = 0,10 USD/litre

Summary of costs:

Low cost calculation: (10.000 TZS/month, 144 hrs.)3,2 hrs. at 70 TZS/hr = 224 TZS

costs of extraction (costs handpress): = 100 TZS

Total costs: = 324 TZS6

High cost calculation: (1.200 TZS/day, 6 hrs.)

3,2 hrs. at 200 TZS/hr = 640 TZS

costs of extraction (costs handpress): = 100 TZS

Total costs: = 740 TZS

Profit of oil production:

- High cost calculation: = 650 ? 740 = no feasibility
- Low cost calculation = 650 ? 324 = 276 TZS/litre
- Profit per working hour of oil production:
- Structure of the costs:
- Sale of 1 liter of oil: 650 TZS
- ./. costs of extraction (costs handpress): 100 TZS

Profit of the sale of 1 litre of oil at the price of diesel fuel 550 TZSProfit: 550 TZS for 3,2 working

Profit of the sale of 1 litre of oil at the price of diesel fuel 500 TZSProfit: 500 TZS for 1,7 working hours, this are 294 TZS per houror 0,28 USD per hour6??High cost calculation: (1.200 TZS/day, 6 hrs.)

3,2 hrs. at 200 TZS/hr = 640 TZS

costs of extraction (costs handpress): = 100 TZS

Total costs: = 740 TZS

Profit of oil production:High cost calculation: = 650 ? 740 = no feasibility

Low cost calculation = 650 ? 324 = 276 TZS/litre

Profit per working hour of oil production:

Structure of the costs:

Sale of 1 liter of oil: 650 TZS

% costs of extraction (costs handpress): 100 TZS

Profit of the sale of 1 litre of oil at the price of diesel fuel 550 TZSProfit: 550 TZS for 3,2 working hours, this are 172 TZS per houror 0,17 USD per hour

This is almost 3-times the real salary of a rural worker

or almost the official minimum salary of 1.200 TZS a day (which is about 200 TZS/hr (6 hours work per day).

Extraction with Sayari oil expeller:

Cost factors of oil production: Harvesting/collecting seeds = 1,7 hours

Extraction of the oil (Sayari) = 150 TZS/litre

High cost calculation: (1.200 TZS/day, 6 hrs.)

1,7 hrs. at 200 TZS/hr = 340 TZS

Extraction 150 TZS = 150 TZS

Total costs: = 490 TZS

Low cost calculation: (10.000 TZS/month, 144 hrs.)

1,7 hrs. at 70 TZS/hr = 120 TZS

Extraction 150 TZS = 150 TZS

Total costs: = 270 TZS

Profit of oil production:High cost calculation: = 650 ? 490 = 160 TZS per litre

Low cost calculation: = 650 ? 270 = 380 TZS per litre

Profit per working hour of oil production:

Structure of the costs:

Sale of 1 liter of oil: 650 TZS

./. costs of extraction (Sayari expeller): 150 TZS

Profit of the sale of 1 litre of oil at the price of diesel fuel 500 TZSProfit: 500 TZS for 1,7 working hours, this are 294 TZS per houror 0,28 USD per hour7

Conclusion:

The estimation (transport costs, storage etc. are not considered) shows, that the production and sale of Jatropha oil as diesel substitute is economically feasible.

Using the hand press the official labour costs of 1.200 TZS are too high to produce the oil at a price below the diesel price at the pump.

But if somebody declares himself an entrepreneur, who collects/harvests Jatropha seeds and extracts them with a ram press, she/he will get a payment of 172 TZS per working hour. Using a Sayari expeller, the profit will be higher. Even a high cost calculation shows some profit of 160 TZS per litre of oil, but if the calculation is done for a one person company, a payment of 294 TZS per working hour is calculated. This really seems to be a promising business.4.3 Central Hypothesis This above presented calculation might be different in other countries with lower wages for rural work. But it also shows clearly, that the added value of Jatropha oil utilization for soap making is very high and that this is a real possibility of creating rural income without big initial investments.

Therefor a central hypothesis of the Jatropha System can be formulated:The Jatropha System creates a positive reciprocity between raw material/energy

production and environment/food production.i. e. the more seeds/oil Jatropha hedges produce, the more food crops are protected from animals and erosion.

Also additional income is created, mainly for women.5. Strategies to disseminate the know how of the Jatropha System

A strategy to disseminate the know how of the Jatropha system should formulate different activities on 3 different levels:

- A local level, i. e. farmers who plant Jatropha hedges to protect their crops, women groups who look for income, NGOs which look for possible actions to support rural development.
- These local activities should be supported by know how centres on a national level.
- These centres are supported by a promotion centre which acts on an international level.

5.1 Local level:On a local level "Jatropha Project Modules" should be developed, which can be realized by development groups and/or small NGOs. The centre of such a module is an active women group, which is engaged to utilize the economic potential of the Jatropha System.

If Jatropha is not yet available, the project needs a preparatory time of 4 to 5 years to plant Jatropha and wait for the production.5.2 National level:

On a national level "Centres of Excellence" should be created in each country. They should play the role of a "know how centre" and support the implementation of Jatropha activities by

groups and organizations of rural development.

Such a "Centre of Excellence" is a number of persons who are familiar with all the aspects ofJatropha production, oil extraction, soap production and marketing. These persons have to be up to date with regional development in extraction technology and marketing techniques ("eco-label").

These persons can easily be invited by some organisations to start Jatropha projects in their region:

Support of the supply of material & chemicals to projects; list of suppliers;

Organisation of the exchange of information;

Creation of a national JCL network;Support of the marketing of products;

Facilitation of credits.

Organization of national workshops;

ooking for wholesale buyers for Jatropha soap and / or oil in national markets;

Presentation of Jatropha products on agricultural & bio-product exhibitions (national / international);

Approach of national / international trading companys of natural products.5.3 International level:

On an international level a "Jatropha Promotion Centre" should be created, which supports the different "Centres of Excellence" by various activities:

Publication of available and useful information concerning the application of the Jatropha know how into the internet. This internet presence will supply up to date information to all members of the "Centre of Excellence" and will facilitate the exchange of information between the "Centres of Excellence" in different countries.

Organization of a Q & A service;

Creation of a Jatropha network for mutual support and exchange of know how,including workshops,

seminars and visits of different projects with differentapproaches and in a different socio-economic environment (capacity building);Publication of Jatropha information

To keep the Jatropha network alive, regular workshops on regional level should be held, accompanied by some central seminars (capacity building);

Supply of tools & blueprints & contacts with experts;

The "Jatropha Promotion Centr" can also identify research topics and coordinate the work on these topics by different organisations / universities and distribute the results.

Such topics could be:

- Selection of high yield Jatropha plants (seeds, cuttings);
- Selection of high oil yield Jatropha plants;
- Selection of a pure line of the non toxic variety from Mexico (edible oil, press cake as animal feed);

Establishment of a seed bank to provide Jatropha projects / initiatives with high yield and / or non toxic seeds;

Conception of small scale projects, which can be financed by small donor agencies (modular project system) and executed even by small NGOs.

Looking for export / import possibilities on international markets; Presentation of Jatropha products on agricultural & bio-product exhibitions (national /international); Approach of national / international trading companys of natural products.

THE PLANT- PROFILE

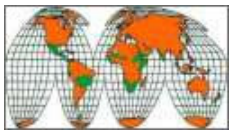
INTRODUCTION

Jatropha curcus is a drought-resistant perennial, growing well in marginal/poor soil. It is easy to establish, grows relatively quickly and lives, producing seeds for 50 years.
Jatropha the wonder plant produces seeds with an oil content of 37%. The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The by-products are press cake a good organic fertilizer, oil contains also insecticide.

It is found to be growing in many parts of the country, rugged in nature and can survive with minimum inputs and easy to propagate.

Medically it is used for diseases like cancer, piles, snakebite, paralysis, dropsy etc.
Jatropha grows wild in many areas of India and even thrives on infertile soil. A good crop can be obtained with little effort. Depending on soil quality and rainfall, oil can be extracted from the jatropha nuts after two to five years. The annual nut yield ranges from 0.5 to 12 tons. The kernels consist of oil to about 60 percent; this can be transformed into biodiesel fuel through esterification.
Family: Euphorbiaceae Synonyms: Curcas purgans Medic. Vernacular/common names: English- physic nut, purging nut; Hindi - Ratanjyot Jangli erandi; Malayalam - Katamanak; Tamil - Kattamanakku; Telugu - Pepalam; Kannada - Kadaharalu; Gujarathi - Jepal; Sanskrit - Kanana randa.

Distribution and habitat



It is still uncertain where the centre of origin is, but it is believed to be Mexico and Central America. It has been introduced to Africa and Asia and is now culti-vated world-wide. This highly drought-resistant spe-cies is adapted to arid and semi-arid conditions. The current distribution shows that introduction has been most successful in the drier regions of the tropics with annual rainfall of 300-1000 mm. It occurs mainly at lower altitudes (0-500 m) in areas with average an-nual temperatures well above 20°C but can grow at higher altitudes and tolerates slight frost. It grows on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content.

Botanical Features

It is a small tree or shrub with smooth gray bark, which exudes a whitish colored, watery, latex when cut. Normally, it grows between three and five meters in height, but can attain a height of up to eight or ten meters under favourable conditions.

Leaves

It has large green to pale-green leaves, alternate to sub-opposite, three-to five-lobed with a spiral phyllotaxis.

Flowers

The petiole length ranges between 6-23 mm. The inflorescence is formed in the leaf axil. Flowers are formed terminally, individually, with female flowers usually slightly larger and occurs in the hot seasons. In conditions where continuous growth occurs, an unbalance of pistillate or staminate flower production results in a higher number of female flowers.

Fruits

Fruits are produced in winter when the shrub is leafless, or it may produce several crops during the year if soil moisture is good and temperatures are sufficiently high. Each inflorescence yields a bunch of approximately 10 or more ovoid fruits. A three, bi-valved cocci is formed after the seeds mature and the fleshy exocarp dries.

Seeds

The seeds become mature when the capsule changes from green to yellow, after two to four months.

Flowering and fruiting habit

The trees are deciduous, shedding the leaves in the dry season. Flowering occurs during the wet season and two flowering peaks are often seen. In permanently hu-mid regions, flowering occurs throughout the year. The seeds mature about three months after flowering. Early growth is fast and with good rainfall conditions nursery plants may bear fruits after the first rainy season, direct sown plants after the second rainy season. The flowers are pollinated by insects especially honey bees.

Ecological Requirements

Jatropha curcas grows almost anywhere , even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks. The leaves shed during the winter months form mulch around the base of the plant. The organic matter from shed leaves enhance earth-worm activity in the soil around the root-zone of the plants, which improves the fertility of the soil.
Regarding climate, Jatropha curcas is found in the tropics and subtropics and likes heat, although it does well even in lower temperatures and can withstand a light frost. Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves to reduce transpiration loss. Jatropha is also suitable for preventing soil erosion and shifting of sand dunes.

Biophysical limits

Altitude: 0-500 m, Mean annual temperature: 20-28 deg. C, Mean annual rainfall: 300-1000 mm or more.

Soil type: Grows on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content. On heavy soils, root formation is reduced. Jatropha is a highly adaptable species, but its strength as a crop comes from its ability to grow on very poor and dry sites.

CULTIVATION TECHNOLOGY

THE PRODUCTIVE PLANTATION OF JATROPHA CURCAS

The practices being undertaken by the Jatropha growers currently need to be scientifically managed for better growth and production. The growth and yield of Jatropha could be improved through effective management practices.

The keyfactors that can influence the oil yield of Jatropha Curcas are:

1. Climate
2. Quality of the soil
3. Irrigation
4. Weeding
5. Use of fertilizer
6. Crop density
7. Genotype
8. Use of pesticide
9. Inter-cropping

PROPAGATION METHODS

GENERATIVE PROPAGATION	EFFECTING FACTORS
Direct seeding	▫ Quality of seeds ▫ Seding depth ▫ Date of sowing
Transplantation of precultivated plants Seeds beds(bare roots) Poly bags	▫ Type of precultivation ▫ Length of precultivation ▫ Age of precultivation
VEGETATIVE PROPAGATION(cuttings)	
Direct planting	▫ Right time
Transplanting of precultivated plants Seeds beds(bare roots) Poly bags	▫ Right size ▫ Right age ▫ Right strain ▫ Right source
SUCCESSFULL PRECULTIVATION IS CHARACTERIZED BY	▫ High germination rates of seeds ▫ High sprouting rates of cuttings ▫ High survival rates

Basing the propagation method on rainfall conditions plays a decisive role in the survival and properties of the plant in field.

- Method of cultivation should be chosen on the basis of
- Maximum survival rates

Intended utilization of the plantation

1. For quick establishment of hedges and plantation for erosion control, directly planted cuttings are best.
2. For long-lived plantations for vegetative oil production, plants propagated by seeds are better.
3. With better rainfall conditions, the plantations could also be established by direct seeding.

Direct seeding, precultivation of seedlings, easily propagates the Jatropha transplanting of spontaneous wild plants and direct planting of cuttings. Seed should be collected when capsules split open. Use of fresh seeds improves germination. Intervals of presoaking and drying, or partial removal of the testa, are more successful than presoaking alone. With good moisture conditions, germination takes 10 days. The seed shell splits, the radicula emerges and 4 small peripheral roots are formed. Soon after development of the 1st leaves, the cotyledons wither and fall off. Further growth is sympodial

Climate

Can withstand severe heat. Likes heating and doing well in warmer areas. When cold will drop its leaves. It can withstand light frost but not for prolonged periods. The older the tree the better it will withstand. Black frost will almost certainly kill young plants and severely damage older plants

Quality of the soil

Best in sandy well-drained soils. Can withstand very poor soils and grow in saline conditions All the actors in the Jatropha sector suggest, anyway, using organic fertilizer in order to obtain higher yield.

Irrigation

It handles dryness very well and it is possible to live almost entirely of humidity in the air. - See Cape Verde where rainfall is as low as 250 mm a year. Differences are expressed in what is optimum rainfall as some readings say 600 mm and some say 800 mm whilst some areas in India report good crops with rainfall of 1380 mm. Under irrigation 1 500 mm is given.

500 - 600 mm of rainfall is the limit. Below it the production depends on the local water condition in the ground

It will also stand for long periods without water - up to 2 years – and then grow again when rains occur again.

Weeding

Standard cultural practices are timely weeding (4 times a year), proper fertilization, surface ploughing and pruning. With these management practices a yield around 15-20 kg of fruit per tree can be obtained even if the plants did not reach full maturity.

Use of fertilizer

Although Jatropha is adapted to low fertility sites and alkaline soils, better yields seem to be obtained on poor quality soils if fertilizers containing small amounts of calcium, magnesium, and Sulfur are used. Mycorrhizal associations have been observed with Jatropha and are known to aid the plant's growth under conditions where phosphate is limiting It is recommended that 1 kg of farmyard manure/ plus 100 g of Neem waste for every seedling, with a recommendation of 2500 plants per ha this comes up to 2.5 t organic fertilizer per ha.Besides it after transplantation and the establishment of the plant fertilizer such as N, P and K should be applied. Twenty gram urea + 120 g SSP and 16 g MoP should be applied annually

The possibility to return the press-cake (or part of it) to Jatropha fields should be carefully considered.

Crop density

References recommend spacing for hedgerows or soil conservation is 15cm - 25cm x 15cm-25cm in one or two rows respectively and 2m x 1.5m to 3m x 3mm for plantations. Thus there will be between 4,000 to 6,700 plants per km for a single hedgerow and double that when two rows are planted.

Satisfactory planting widths are 2 x 2 m, 2.5 x 2.5 m, and 3 x 3 m. This is equivalent to crop densities of 2500, 1600 and 1111 plants/ha, respectively. Distance OF 2MX2M BE KEPT FOR COMMERCIAL CULTIVATION

Wider spacing is reported to give larger yields of fruit.

Genotype

Little genetic research seems to be performed, as Information related to the project seems to be rather restricted.

Pruning

Pruning – 1st prune
The plants need to produce side shoots for maximum sprouting and maximum flowers and seed. Between 90 and 120 Days top of all plants at 25 Cm. Cut the top off cleanly and cut top to produce 8 – 12 side branches.

It is considered good practice. In order to facilitate the harvesting, it is suggested to keep the tree less than 2 meters.

Inter-cropping

Specific intolerance with other crops was not detected. On the contrary the shade can be exploited by shade-loving herbal plants; vegetables such red and green peppers, tomatoes, etc. (SEE INTERCROPPING PAGE)

Picking

We have developed the harvest methodology between wet and dry seed crush costing applicable has been compared

been compared.

CROP YIELD

It appears very difficult to estimate unequivocally the yield of a plant that is able to grow in very different conditions.

Yield is a function of water, nutrients, heat and the age of the plant and other. Many different methods of establishment, farming and harvesting are possible. Yield can be enhanced with right balance of cost, yield, labor and finally cost per Mt

Seed production ranges from about 2 tons per hectare per year to over 12.5t/ha/year, after five years of growth. Although not clearly specified, this range in production may be attributable to low and high rainfall areas.

Without irrigation

MT/HA

DRY

	LOW	NORMAL	HIGH
Year 1	0.10	0.25	0.40
Year 2	0.50	1.00	1.50
Year 3	0.75	1.25	1.75
Year 4	0.90	1.75	2.25
Year 5	1.10	2.00	2.75

With irrigation

MT/HA

IRRIGATED

	LOW	NORMAL	HIGH
Year 1	0.75	1.25	2.50
Year 2	1.00	1.50	3.00
Year 3	4.25	5.00	5.00
Year 4	5.25	6.25	8.00
Year 5	5.25	8.00	12.50

Germplasm management

Seeds are oily and do not store for long. Seeds older than 15 months show viability below 50%. High levels of viability and low levels of germination shortly after harvest indicate innate (primary) dormancy.

Processing and handling

After collection the fruits are transported in open bags to the processing site. Here they are dried until all the fruits have opened. It has been reported that direct sun has a negative effect on seed viability and that seeds should be dried in the shade. When the seeds are dry they are separated from the fruits and cleaned.

Storage and viability

The seeds are orthodox and should be dried to low moisture content (5-7%) and stored in air-tight con-tainers. At room temperature the seeds can retain high viability for at least one year. However, because of the high oil content the seeds cannot be expected to store for as long as most orthodox species.

Dormancy and pretreatment

Freshly harvested seeds show dormancy and after-ripening is necessary before the seeds can germinate. Dry seed will normally germinate readily without pre-treatment. If this is the case, it is not recommended to remove the seedcoat before sowing. Although it speeds up germination there is a risk of getting abnormal seed-lings.

Uses Of Jatropha Curcas : A Petrocrop

Whole plant	Roots	Leaves	Latex	Seeds	Bark	Twig
*Planted to prevent water erosion and for conservation	* Used as ethnomedicine	* Used as ethnomedicine	*Resembles shellac	*Source of oil (30-40%) suitable as fuel for diesel engine	*Yields tannins (37%)	*Used as medicine
*Promising live fence		*Yield a dye used to give	*Used for making ink	*Useful as illumitant, lubricant, in soap		*Used as Dataun (Herbal

fence		tan & brown	making ink	and candle making		tooth brush)
*useful as green manure		*Useful as botanical	*Used as ethnomedicine	*Used as medicine both internally and externally		*Young one cooked and eaten
*useful in controlling sand drift						
*possess Allelopathic properties						

For successful plantation we have developed Jatropha Production Technology for which our TOTAL CULTIVATION PACKAGE can be had.

JATROPHA INTER - CROPPING TECHNOLOGY

When two or more crops are grown simultaneously in the same field, this is called intercropping.

According to the topography, soil profile and prevailing agroclimatic conditions in an area, Jatropha can be combined with other suitable species comprising the agricultural, horticultural, herbs, pastoral and/or silvicultural components to result in an ecologically viable, economically profitable and socially acceptable agroforestry system. By evolving, promoting and adopting Jatropha based intercropping systems it is possible to improve the socioeconomic conditions in rural areas and to transform the National energy scenario and the ecological landscape.

Social & economic advantages of multiple cropping systems:

- Dependence on only crop is avoided.
- Less needs to import energy.
- Reduction in the outlay for fertilizers.
- There is much greater flexibility of the distribution of labor.
- Possible to recover investments in much less time.
- Availability of harvest over a much longer period of time.
- Can occupy much more labor.
- The farmer of little economic resources can produce a large variety of useful products.
- Promote a return to the land.
- Components can constitute a type of "savings" for the future.

SRIPHL has tried, applied and developed Some inter croping systems for both wastelands and cultivable lands as outlined below:

FOR WASTELANDS:

- Model (i) Hedgerows of Jatropha with Glyricidia and Subabul
- Model (ii) Jatropha intercropped with grasses, tubers and vegetables
- Model (iii) Jatropha mixed with fruit trees
- Model (iv) Jatropha in mixed plantation with Teak / Neem / Karanj / Subabul
- FOR CULTIVABLE LANDS
- On irrigated farmlands

Model (i) mixed with one or more of the following species, grown at the spacing indicated against each species:-

Gmelina arborea (Gamhar) 8mX8m, Dalbergia sissoo (Sheesham) 5m X 4m, Azadirachta indica (Neem) 7m X 5m, Tectona grandis (Teak) 4m X 4m, Emblica officinalis (Aonla) 5m X 3m, Eucalyptus camaldulensis 3.5m X 2m and Moringa oleifera (Munga) 3m X 3m

Model (ii) intercropping vegetables such as red and green peppers, tomatoes water melon etc. that would provide additional income for the farmers.

Model (iii) intercropping with important medicinal plants

For this purpose Jatropha curcus is the ideal plant to give shade to shade loving plants and provide a base for the climbers

Selection of the climber is done according to the climatic condition of the regions. Mainly, the following climbers are common for every/region:

- Kounch - Mucuna prurita
- Kalihari - Gloriosa superba
- Pippali - Piper longum
- Karela - Momordica charantia

Selection of shade crops:

- Sweth musli - Chlorophytum boriviliamum
- Sarpagandha - Rauwolfia serprntina
- Haridra - Curcuma longa
- Adrak - Zingiber officinales
- Ashwagandha - Withania somnifera

Model (iv) Jatropha can be intercropped with medicinal plants like Asparagus racemosus (Shatawar) and Commiphora mukul (Gugul)

Model (v) Shankhpushpi are effective in promoting the growth of Jatropha curca Intercropping

Model (vi) Patchouli and coleus are suitable and successful intercrop

In Madagascar, the plant is used as a support for vanilla

On drier farmlands

Interplanting of Jatropha can done with Mulberry.

Combined with the petroplant - Jatropha, Ber and Lac constitute a profitable planting model.

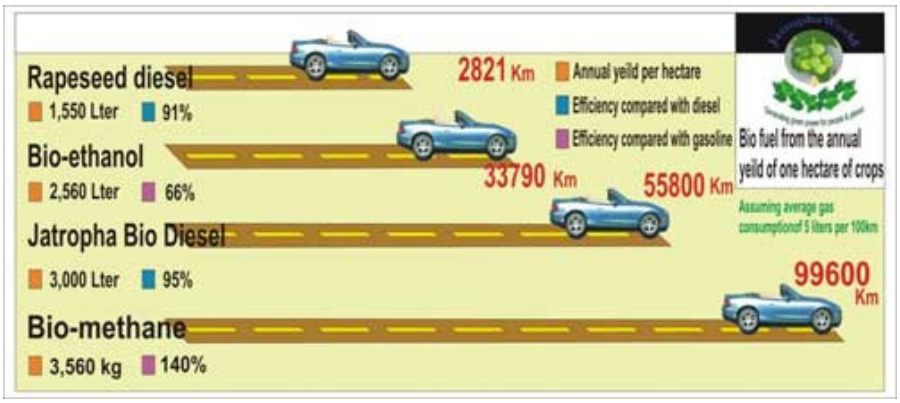
For Biofencing

- AGAVE SISALANA (FOR ROPE FIBER +PROTECTION)
- EUPHORBIA SP. (FOR PROTECTION)
- ERYTHRINA INDICA (FOR PLANT-BASED DYE +PROTECTION)
- IPOMOEA SP. (FOR BOUNDARY)
- PROSOPIS JULIFLORA (FOR PROTECTION +FUELWOOD + CHARCOAL)
- GLYRICIDIA (FOR BOUNDARY + GLYRICIDIA AS NITROGEN FIXING FODDER SPECIES)

{Our Book On Our "Jatropha Intercropping Technology" May Be Obtained For Details}

JATROPHA BIODIESEL

OVERVIEW



The Biodiesel industry is still young and relatively small, so as it grows to a larger scale and when an infrastructure is developed, the costs of producing and marketing biodiesel may decline. New cost-saving technologies will likely be developed to help producers use energy more efficiently, increase conversion yields and convert cheaper feedstocks into high-quality biodiesel. However, in the longer term, the biggest challenge may be the ability of the feedstock supply to keep up with growing demand. The supply of soybeans, rapeseeds and other feedstocks available for biodiesel production will be limited by competition from other uses and land constraints.

As such the key to the future of Biodiesel is finding inexpensive feed stocks that can be grown by farmers on marginal agricultural land, and Jatropha is one of many plants that hold a great deal of promise. Jatropha proves to be a promising Bio Fuel plantation and could emerge as a major alternative to Diesel thus reducing our dependence on Oil imports and saving the precious Foreign Exchange besides providing the much needed Energy Security. Jatropha oil displacing conventional fossil fuel makes the project fully eligible as a CDM project, i.e. recipient of CO2 credits.

Jatropha stacks up nicely compared with other feedstocks, as soybeans and rapeseed have a relatively low oil yield compared with Jatropha — 375 kilograms per hectare for soybeans in the United States (280 gallons per acre) and 1,000 kilograms per hectare of rapeseed in Europe (740 gallons per acre) to 3,000 kilograms per hectare of Jatropha (2,226 gallons per acre) in India. Good planning, quality planting material, standardized agronomy practices and good crop management could increase yields

COST BENEFITS SCENARIO

Cost benefits scenario will depend on various factors such as seed yield, area of Production, its gestation period, and raw oil yield during various stages of bio-diesel production-plantation, extraction, and transesterification.

An integrated Jatropha Biodiesel Project has three stages:

1. The first stage of the production process of bio-diesel from the seeds of Jatropha is the plantation stage.
2. Extraction stage of bio-diesel production
3. The final stage of bio-diesel production is the transesterification stage in which raw oil is transesterified to bio-diesel.

The combination of three stages of bio-diesel production and the role of each player in these stages have to be objectively defined as they can affect the economics of bio-diesel production
Therefore, we have carried out Economic analysis considering all above three stages as separate entities.

- **ECONOMICS: FARMING**
- **ECONOMICS: EXTRACTION**
- **ECONOMICS: BIODIESEL**

Kindly visit relevant page for complete information
For further enquiry kindly contact:

Director
Business Development, C J P
jatrophac

he Next Generation Sustainable Fuel

What is Bio Diesel?

The concept dates back to 1885 when Dr. Rudolf Diesel built the first diesel engine with the full intention of running it on vegetative source.

He first displayed his engine at the Paris show of 1900 and astounded everyone when he ran the patented engine on any hydrocarbon fuel available - which included gasoline and peanut oil. In 1912 he stated " … *the use of vegetable oils for engine fuels may seem insignificant today. But such oils may in the course of time become as important as petroleum and the coal tar products of present time."*

Scientists discovered that the viscosity (thicKness) of vegetable oils could be reduced in a simple chemical process In 1970 and that it could work well as diesel fuel in modern engine.

This fuel is called Bio- Diesel.

Since than the technical developments have largely been completed. Plant oil is highly valued as Bio fuel "Diesel" and transformed into Bio Diesel in most industrialised

Please note!!!

- This vegetable oil can be used as it is crushed – ie - unrefined in the engines of cars
- This vegetable oil can be blended with normal diesel and used in cars.
- This vegetable oil can be refined and sold as pure diesel
- Refined it can be exported as a clean fuel to anywhere in the world.

Bio Diesel is asubstitute for, or an additive to, diesel fuel that is derived from the oils and fats of plants, like Sunflower, Canola or Jatropha.

It is an alternative fuel that can be used in diesel engines and provides power similar to conventional diesel fuel.

Bio Diesel is arenewable domestically produced liquid fuel that can help reduce the countries dependence on foreign oil imports.

Recent environmental and economic concerns (Kyoto Protocol) have prompted resurgence in the use of biodiesel throughout the world. In 1991, the European Community, (EC) Proposed a 90% tax reduction for the use of biofuels, including biodiesel.

Today, 21 countries worldwide, produce Biodiesel.

The Advantages of Bio Diesel

- Bio Diesel is the most valuable form of renewable energy that can be used directly in any existing, unmodified diesel engine.
- **Energy Independence:** Considering that oil priced at $60 per barrel has had a disproportionate impact on the poorest countries, 38 of which are net importers and 25 of Which import all of their oil; the question of trying to achieve greater energy independence one day through the development of biofuels has become one of 'when' rather than 'if,' and, now on a near daily basis, a biofuels programme is being launched somewhere in the developing world.
- **Smaller Trade Deficit:** Rather than importing other countries' ancient natural resources, we could be using our own living resources to power our development and enhance our economies. Instead of looking to the Mideast for oil, the world could look to the tropics for biofuels. producing more biofuels will save foreign exchange and reduce energy expenditures and allow developing countries to put more of their resources into health, education and other services for their neediest citizens.
- **Economic Growth:** Biofuels create new markets for agricultural products and stimulate rural development because biofuels are generated from crops; they hold enormous potential for farmers. In the near future—especially for the two-thirds of the people in the developing world who derive their incomes from agriculture.

  Today, many of these farmers are too small to compete in the global market, especially with the playing field tilted against them through trade distorting agricultural subsidies. They are mostly subsistence farmers who, in a good year, produce enough to feed their families, and in a bad year, grow even poorer or starve. But biofuels have enormous potential to change this situation for the better.

  At the community level, farmers that produce dedicated energy crops can grow their incomes and grow their own supply of affordable and reliable energy.

  At the national level, producing more biofuels will generate new industries, new technologies, new jobs and new markets.
- **Cleaner Air:** Biofuels burn more cleanly than gasoline and diesel. Using biofuels means producing fewer emissions of carbon monoxide, particulates, and toxic chemicals that cause smog, aggravate respiratory and heart disease, and contribute to thousands of premature deaths each year.
- **Less Global Warming:** Biofuels contain carbon that was taken out of the atmosphere by plants and trees as they grew. The Fossil fuels are adding huge amounts of stored carbon

dioxide (CO2) to the atmosphere, where it traps the Earth's heat like a heavy blanket and causes the world to warm. Studies show that biodiesel reduces CO2 emissions to a considerable extent and in some cases all most nearly to zero.

In Nut-shell:

- Bio Diesel is the most valuable form of renewable energy that can be used directly in any existing, unmodified diesel engine.
- Bio Diesel fuel and can be produced from oilseed plants such as rape seeds, sunflower, canola and or JATROPHA CURCAS.
- Bio Diesel is environmental friendly and ideal for heavily polluted cities.
- Bio Diesel is as biodegradable as salt
- Bio Diesel produces 80% less carbon dioxide and 100% less sulfur dioxide emissions. It provides a 90% reduction in cancer risks.
- Bio Diesel can be used alone or mixed in any ratio with mineral oil diesel fuel. The preferred ratio if mixture ranges between 5 and 20% (B5 - B20)
- Bio Diesel extends the live of diesel engines
- Bio Diesel is cheaper then mineral oil diesel
- Bio Diesel is conserving natural resources

The Process

The process of converting vegetable oil into biodiesel fuel is called Transesterification and is luckily less complex then it sounds.

Chemically, Transesterification means taking a triglyceride molecule, or a complex fatty acid, neutralizing the free fatty acids, removing the glycerin, and creating an alcohol ester. This is accomplished by mixing methanol with sodium hydroxide to make sodium methoxide. This liquid is then mixed into the vegetable oil. After the mixture has settled, Glycerin is left on the bottom and methyl esters, or biodiesel is left on top and is washed and filtered.

The final product Bio Diesel fuel, when used directly in a Diesel Engine will burn up to 75% cleaner then mineral oil Diesel fuel.

The Technology

The technology is mature and proven

Presently, the indigenously designed bio-fuel plant for 250 lt./day is in operation. We have to design and develop bio-fuel plants of 3 to 10 tones per day capacity for installation in different parts of the country. Effective marketing chain needs to be planned for enabling farmers to reap the benefits directly. Bio-fuel mission will provide technological and employment generation focuses for the rural sector. Use of eleven million hectares of wasteland for Jetropha cultivation can lead to generation of minimum twelve million jobs

The Cost

The cost of Bio Diesel is largely dependent on the choice of feedstock and the size of the production facility.

If Jatropha feedstock is used, the fuel will cost depending on the country approximately US $ 0,40 per liter plus tax when applicable.

FEED STOCK PRODUCTION PER HECTARE & COST THEREOF

FEEDSTOCK	Country	Yield/hectare (kg)	Rate Per Barrel(US$)
SOYA OIL	USA	375	73
RAPESEED OIL	Europe	1000	78
JATROPHA OIL	INDIA	3000	43
PALM OIL	Malaysia	5000	46

International Laws and regulation

Several countries have active Biodiesel programmes. Such countries also have given legislative support and have drawn up national polices on biodiesel development. Wide variety of motives for action taken can observe like

- Increase of energy supply security
- Reduction of dependence on fossil energy forms
- Reduction of harmful locally acting emissions.
- Protection of soil by biodegradable products
- Reduction of health hazard by using non-toxic products.

Biodiesel Scenario In India

As India is deficient in edible oils, non-edible oil is the main choice for producing biodiesel. According to Indian government policy and Indian technology effects. Some development works have been carried out with regards to the production of transesterfied non edible oil and its use in biodiesel by units such as Indian Institute of Science, Bangalore, Tamilnadu Agriculture University Coimbatore and Kumaraguru College of Technology in association with Pan horti consultants. Coimbatore. Generally a Blend of 5% to 20% is used in India (B5 to B20). Indian Oil Corporation has taken up Research and development work to establish the parameters of the production of tranesterified Jatropha Vegetable oil and use of bio diesel in its R&D center at Faridabad. Research is carried out in Kumaraguru College of Technology for marginally altering the engine parameters to suit the Indian Jatropha seeds and to minimize the cost of transesterification.

Area Coverage vs. Blending Requirements

Year	Diesel Demand MMT	Bio-Diesel @ 5% MMT	Area For 5% Mha	Bio-Diesel @10% MMT	Area For 10% Mha	Bio-Diesel @20% MMT	Area For 20% Mha
2005-06	49.56	2.48	2.07	4.96	4.14	9.91	8.28
2006-07	52.33	2.62	2.19	5.23	4.38	10.47	8.76
2011-12	66.90	3.35	2.79	6.69	5.58	13.38	11.19

Bio Diesel Experiments

Initially 5% of the bio diesel was blended with High-speed diesel and later increased to 20%. The railway and Indian oil corporation has successfully used 10% blended biodiesel fuel in train running between Amritsar and New Delhi in the month of Feb 2003. At Kumaraguru College of Technology an auto rickshaw was run on pure biodiesel (B100) prepared from Jatropha oil.

Conclusion

As a substitute for fast depleting fossil fuel. Bio diesel had come to stay. In future, it should also serve to reduce and maintain the price of automobile fuel. The under exploited and un exploited vegetable oils are good sources of biofuel. Our country is endowed with many such plants. Research is being carried out now to convert vegetable oils into biodiesel through biotechnological processes using biodiesel. With a concentrated and coordinated effort. Wide use of bio diesel in our country is going to be a reality in the days to come.

A national mission on Bio-Diesel has already been proposed by the committee comprising six micro missions covering all aspects of plantation, procurement of seed, extraction of oil, trans-esterification, blending & trade, and research and development. Diesel forms nearly 40% of the energy consumed in the form of hydrocarbon fuels, and its demand is estimated at 40 million tons.

Therefore blending becomes the important National Issue which apart from giving the dividends , it saves the country's exchequer. India has vast stretches of degraded land, mostly in areas with adverse agro- climatic conditions, where species of Jatropha , Mahua etc can be grown easily.

Even 30 million hectares planted for bio- diesel can completely replace the current use of biofuels. The production of Bio fuels will also boost the rural economy which will bring more enthusiasm in more than one billion lives in the area