Jatropha curcas—A Fence Against Energy Crisis

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Jatropha curcas (Euphorbiacaca), native to tropical America, has become naturalised throughout the semi-arid Asia and Africa. In India, it is variously known as Moglaierand, Baghierand, Chandrajyoti, Chandraprabha or Nepalam. This species solely or in combination with another important latex plant *Euphorbia tirucalli*, is planted to fence the farm land and farm houses. Being quick growing and non-palatable to the browse animals, *J. curcas* forms a thick live fence in a short period of 6-9 months and grows up to 4 m high with thick branchlets around in about 3 years. Quite a few Jatropha species are grown as ornamental plants in gardens and parks and as hedge rows. Notable among these are *J. pandurifolia*, *J. multifida* and *J. podagrica*.

The latex of *J. curcas* has been used in local Ayurvedic pharmacopoeia. According to Botany Laboratory, BARC-East Beltsville, Maryland, USA, the active principle in its latex, jatrophone, has shown anticancer properties. The green tender leaves are a useful feed for tasar silk worms and the plant holds promise to sustain a small-scale silk industry in rural India.

Jatropha Seed Oil

J. curcas bushes flower and bear fruit only after 4-5 months and can live up to 50 years or so. The plant flowers profusely every year between November and December and sometimes later in May or June. However, when put on supplement (protective) irrigation, it remains green and sets flowers and fruit round the year. Each fruit contains 2 or 3 seeds weighing 600-700 mg per seed. The mean yield of air dry seeds from a five year old tree is reported to be 4-6 kg. Seeds contain a semi-drying oil (40-50% at 7% moisture) extractable by solvent extraction or mechanically by using the hydraulic press or simple screw press. With the process evaluated at the Thei Farm Machinery Training Centre, a yield of about 25% oil from whole seed is obtainable (Fig 1). However, using improved methods of oil extraction, 34.96% oil is obtained from whole seed; the oil yield from the kernel alone is 54.68%. According to the Industrate of Osaka Municipal Industry, Japan, the oil contains 21% saturated fatty acids and 79% unsaturated fatty acids (Table 1).

Fig 1—Process for production of *Jatropha curcas* oil : Flow diagram

Table 1—Chemical Analysis of *Jatropha curcas* Oil

Item	Value
Acid value	38.2
Saponification value	195.0
Iodine value	101.7
Viscosity (31°C) (Fatty acid), cP	40.4
Palmitic acid, %	14.2
Stearic acid, %	6.9
Oleic acid, %	43.1
Linoleic acid, %	34.3
Other acids, %	1.4

Table 2—Nitrogen, Phosphorus and Potassium Contents of *Jatropha curcas* Oilcake Compared to Other Fertilizers

Fertilizer	Moisture content %	Nitrogen %	Phosphorus %	Potassium %
Jatropha curcas oilcake	4.58	4.44	2.09	1.68
Cow manure	9.70	0.97	0.69	1.66
Chicken manure	10.19	3.04	6.27	2.08
Duck manure	17.57	2.37	2.10	1.09
Compost of raw straw	—	0.81	0.18	0.68
Compost of water hyacinth	—	1.43	0.46	0.48
Compost of municipal wastes	—	1.25	0.25	0.65

Jatropha Oilcake

The oilcake is rich in nitrogen compared to other commonly available organic manures (Table 2). However, because of its toxicity, it cannot be used as an animal feed, but it is a good fertilizer.

Diesel Engine Test for Jatropha Oil

A Kubota four-stroke cycle diesel engine (7 hp/2200 rpm, with a simple horizontal piston, a cylinder volume of 400 cc, and a water cooling system) and Yanmar diesel engine (Horizontal 4 cycle, 7 hp/2400 rpm of pre-combustion type) usually run on LPG and diesel respectively were tested for comparative performance against running on jatropha oil.

Table 3—Comparison of Engine Performance of a Yanmar Engine Run on *Jatropha curcas* Oil as Opposed to the Use of Diesel Oil

Continuous rating output	Diesel oil	Jatropha oil
Output/speed, ps/rpm	6.5/2,200	6.5/2,200
Fuel consumption, kg/h	1.294	1.506
Fuel specific, g/psh	199	232
Exhaust gas temperature, °C	473	508
Exhaust gas colour, sd	2.4	2.8
Maximum rating output		
Output/seed, ps/rpm	7.5/2400	7.5/2400
Fuel consumption, kg/h	1.513	2.652
Fuel specific, g/psh	201	274
Exhaust gas temperature, °C	513	599
Exhaust gas colour, sd	3.0	5.6

The engine performance and fuel consumption were favourable (Tables 3 and 4 and Fig 2). The results of inspection of Kubota diesel engine parts when run on jatropha oil for 1000 hours are also satisfactory. When compared with diesel oil for exhaust gas tests, differences in smoke and carbon monoxide content were not only negligible but the values were also

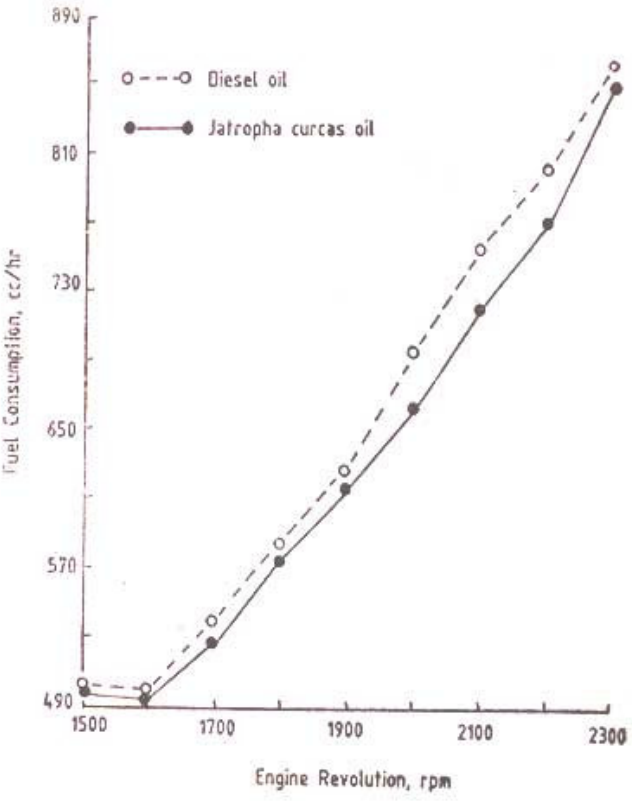

Fig. 2—Comparison of engine performance with jatropha and diesel oils

Table 4 – Properties of Jatropha and Diesel Oils

Specification	Jatropha oil	Standard specification of diesel oil (Japan)
Specific gravity	0.9186	0.82-0.84
Flash point	240/110°C*	50°C up
Carbon residue	0.64	0.15 less
Cetane value	51.0	50 up
Distillation point	295°C	350°C less
Kinematic viscosity	50.73 cs	2.7 cs up
Sulphur, %	0.13%	1.2% less
Calorific value	9,470 kcal/kg	10,170 kcal/kg
Pour point	8°C*	10°C less**
Colour	4.0*	4 less*

* Analysed by the Petroleum Authority of Thailand
** Standard specification of diesel oil.

lower than the accepted values as per the standard specifications of the Environment Board. Similarly, no sulphur dioxide was found in the exhaust gas of the diesel engine run on jatropha oil as against 125 ppm sulphur dioxide found in the exhaust gas of the diesel engine run on diesel oil.

Jatropha Husbandry

J. curcas is adapted to arid and semi-arid conditions, has low fertility and moisture demand and can come up on stony, gravelly or shallow and even calcareous soils. It can be propagated from seeds as well as cuttings. Since it is an open-pollinated species, the latter method may be more desirable to establish a uniform plantation for anticipated yields. While good quality seeds give up to 100% germination on adequate moisture in the soil, the best period to raise the plantation is from stem cuttings in the rainy season, particularly July.

The ideal spacing of its bushes to obtain good seed bearing plants appears to be 2 m between the rows and 2 m within the rows to have 2,000 plants per ha. However, the number of plants can be further increased to 3,125 per ha without any loss in seed yield by having a staggered design of 2m × 2m and filling the interspace as well as by giving a hexagonal form to the design. The maximum number of plants per ha could be 5555 with 1.5 m × 1.5 m spacing with the interspace filled by a staggered hexagonal design of planting. On the other hand, for erecting a productive live fence, a minimum of 3 rows may be planted in alternate rows at a spacing of 1 m × 1 m.

Economic Feasibility

Anticipated Profits from a Ten Hectare Plantation with 3125 Trees per Hectare

Expenditure Statement

First year

	Rupees
Land preparation	4,000
Cost of planting material	8,000
Cost of planting	1,000
Cost of fertilizer application	2,000
Cost of weeding	4,000
Cost of watering	1,000
Cost of seed collection	500
Supervision cost	1,000
Total	21,500
Interest on the total amount	1,075
Total for the first year planting	22,575
Income in the first year when each plant bears @ 70 g seeds/ plant with 1 kg of seed at the rate of Re 1 per kg	+2,200
Net balance after 1 year	−20,355

Second year

Expenditure during 2nd year	−2,000
Total (deficit) towards the end of 2nd year	−22,355
Income in the second year	+9,400
Net balance after 2 years	−12,955

Third year	
Expenditure during 3rd year	—3,000
Total (deficit towards the end of the 3rd year)	—15,955
Income in the 3rd year	+25,000
Net balance after 3rd year	+9,045
Fourth year	
Expenditure in 4th year	—3,000
Total surplus amount towards the 4th year	+6,045
Income in the 4th year	+37,500
Net balance after 4 years	+43,545
Fifth year	
Expenditure in the 5th year	—4,000
Total surplus towards the end of the 5th year	+39,545
Income in the 5th year	+47,000
Net balance after 5th year	+86,545
Net yearly inome anticipated after 5th year	5,000 per hectare per year

Additional income up to Rs 2,000 per ha per year from the plantation could be generated by raising tasar silk worms. Nominal income could also be expected from the plantation by tapping it for latex. However, economic feasibility as well as effectiveness on crop yield tapping remain to be studied.

While preparing the economic feasibility report, very low market price for the seed has been considered keeping in mind the eventuality of having lesser processing facilities and also the possible difficulty in producing the seeds at a centralised place, if the plantation is raised in remote areas with little transport facilities. Again, with a price range of seed around Re 1 per kg and with a recoverable oil of 33% (leaving enough margin for the extraction losses), the price of jatropha oil seems to be competitive even against the present diesel oil price in the country. The extraction and processing cost can easily be recovered from the sale of oilcake.