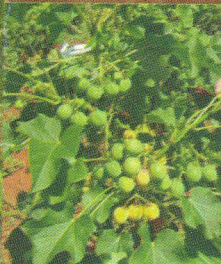
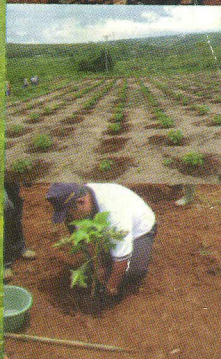


CULTIVATION OF

Jatropha curcas L.

IN INDONESIA



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INTRODUCTION

Jatropha is recognized widely as hedge crop; most portions of this plant are locally utilized for their medicinal properties. Jatropha produces latex and inedible seeds which is known to have toxic and purgative properties. Jatropha's seed yields a slow drying oil which is utilized as an industrial raw material such as soap, cosmetic, furniture varnish, etc.

The physical and chemical properties give it potential to be used for a petroleum-substituting fuel. Research results indicated that this oil is renewable fuel source to substitute for diesel-oil.

With the recent increase of international oil price, Indonesia has to look for alternative, renewable and sustainable source of energy to reduce the amount of the imported oil and a heavy burden of subsidy. Since 2006, the Indonesia's Government has set a National Energy Policy that diversify the energy sources including biofuel development.

Jatropha is one of potential resource due to its ability to grow in hostile environments, produce inedible oil that compatible with diesel-fuel; establishment of plantations will provide employment opportunities in the rural area, protection of land through revegetation and reduction the levels of pollution from engine emissions using curcas oil.

CLIMATE AND SOIL REQUIREMENTS

Jatropha can tolerate a wide range of growing conditions; it grows well in humid to semi arid/arid tropical environments, where average annual rainfall varies between 480 to 2.380 mm, at 0 to 700 m above sea level and annual temperature of 18 to 28°C. In area where moisture is not a limiting factor, jatropha can bloom and produce fruit all year.

Jatropha is known to grow on almost any soil except clay soil; on severely eroded lands, its growth form may be stunted. Although jatropha is adapted to low fertility sites, better yields are obtained if fertilizers or manures are used. Mycorrhizal associations are known to aid the plant's growth under conditions where phosphate is limiting. It has been experienced that the land where the soil depth is less than 45 cm, plantation of jatropha should not be taken up as a commercial crop as the expected returns shall not be profitable from such sites.

This crop is tolerant to acid alkaline soils and grow best at pH 5.5 to 6.5. The Indonesian Center for Estate Crops Research and Development (ICECRD) has issued a land suitability map for jatropha planting where 14.2 million hectare are highly suitable and 5.5. million hectare are suitable (Table 1).

Table 1. Distribution of land suitable for *Jatropha* development in Indonesia (ha)

PROVINCE	Highly Suitable	Suitable	Poorly Suitable	TOTAL
Nanggroe Aceh Darussalam	180,139	160,764	836,001	1,176,904
North Sumatera	215,393	-	1,390,475	1,605,868
West Sumatera	4,269	-	781,189	785,458
Riau	80,718	-	1,600,844	1,681,562
Jambi	218,284	-	993,134	1,211,418
South Sumatera	530,207	-	3,229,784	3,759,991
Bengkulu	-	-	602,022	602,022
Lampung	718,823	66,023	706,931	1,491,777
Bangka and Belitung	156,319	-	947,881	1,104,200
West Java	231,011	445,022	306,989	983,022
Central Java	494,630	74,416	338,824	907,870
DIY	35,227	33,999	8,454	77,680
East Java	960,595	574,121	255,722	1,790,438
Banten	134,484	116,576	36,646	287,706
Bali	19,892	51,423	24,265	95,580
West Nusa Tenggara	37,877	428,539	124,466	590,882
East Nusa Tenggara	595,421	833,293	322,174	1,750,888
West Kalimantan	67,463	984,340	3,897,005	4,948,808
Central Kalimantan	171,063	-	3,632,324	3,803,387
South Kalimantan	833,745	48,559	623,326	1,505,630
East Kalimantan	3,643,059	680,468	2,878,161	7,201,688
North Sulawesi	143,760	-	538,555	682,315
Central Sulawesi	506,887	-	373,638	880,525
South Sulawesi	435,483	122,407	613,780	1,171,670
Southeast Sulawesi	1,015,825	27,248	177,833	1,220,906
Gorontalo	290,146	13,701	-	303,847
Molucca	766,888	162,982	316,223	1,246,093
North Molucca	809,470	-	716,909	1,526,379
Papua	980,457	711,030	3,445,699	5,137,186
TOTAL	14,277,535	5,534,911	29,719,254	49,531,700

PROPAGATION OF JATROPHA

Propagation is commonly practiced using either cuttings or seeds. Use of cuttings is easy and results in rapid growth and the plants can be expected to start bearing fruit within 4 to 8 month after planting. The planting raised from seed are not generally uniform, because *jatropha* is a cross-pollinated species. Propagation by cuttings will help in multiplication of superior and uniform phenotypes that contains high seed yield.

1. Nursery

Similar to other crops, grading of seeds help in screening of quality seeds to separate filled seeds against the unfilled ones to have higher germination percentage from the seed lots. Nursery provides necessary control of moisture, light, soil and allows healthy development of seedlings. The nursery soil should have good structure, porosity, rich in organic matter and good water holding capacity. The polythene bags of 15 x 25 cm size have been found suitable for three months nursery.

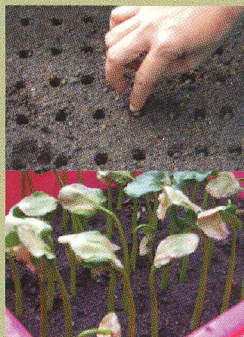
The seedlings are normally ready for transplanting 45 days after seeding; this will allow tap roots to grow straight in the field.



Elimination of weak and abnormal seedlings will establish good uniform plantation.

2. Propagation through seeds

Jatropha can be propagated by seeds. The seeds are picked from physiological mature capsule and dried under shade. Seeds are sown in the nursery beds or polybags with the seed depth of 4 cm. Germination is fast and under favorable conditions it is completed in 10 days. The overnight soaking of seeds in water, improves the germination percentage. In dry season regular irrigation is needed to enhance germination.



Transplanting should be done in the beginning of rainy-season when the seedlings are 6 - 8 weeks old. The field should be prepared by digging small pits of 40 x 40 x 40 cm at recommended spacing (depend on cropping system used); the pits are filled with 5 kg of farm-yard manure or compost. For the protection of termites, 50 gram malathion dust (10%) should be mixed with soil in each pit. For long lived plantations and oil production plants, propagation by seeds are better. Plants from seed develop a typical tap root and four lateral roots.

3. Propagation by stem cuttings

Propagation by cuttings is the cheapest and economical methods of propagation. Cuttings are taken from juvenile plants (2 - 3 year old plants) during rainy season that will give a better rooting than those derived from mature trees. Cuttings are selected from strong shoots; the size of 20 ± 5 cm long with diameter of 2.0 ± 0.5 cm is the most ideal that normally give nearly 80 - 90% rooting.

Cuttings should be free of pests and diseases; the cuttings are planted in raised beds of 3 - 5 m long and 1.5 m width and irrigate when required. The rooting media like mixture of compost, sand and soil should be used. The beds are watered regularly; for the quick establishment of hedges and plantation for erosion control, directly planted cuttings are recommended.



PRODUCTION TECHNOLOGY

1. Varieties

The Indonesia Center for Estate Crops Research and Development (ICECRD) have released three improved populations, viz. IP-1A, IP-1M and IP-1P in 2006; those are composite of superior genotypes selected on three provenances based on capsule-count per shrub. Estimated yield on year-1 is 0.7 - 0.8 tons of dry seeds per hectare or 4.0 - 4.5 tons on year-5 on. Improvement will be continued to produce IP-2 populations with the expected yield of 0.9 - 1.2 tons on year-1 or 7 - 8 tons on year-5 and stabilized thereafter. Future improvement will depend on the amount of genetic viabilities left within and between those provenances. The developing of hybrid varieties is planned when its components are available.



2. Field Preparation

Jatropha curcas is a hardy plant, well adapted to arid land or semi arid conditions. However, the crops grows well in fertile soil with good drainage. Land preparation for jatropha planting is very simple i.e. cleaning, leveling and digging of pits without tillage. The pits should be dug in with proper layout to mechanically manage plantations. The planting density in fertile soils should be lower than in soils with low fertility.

The sandy or gravelly soils should be dug in the size of 45 cm³ to provide more of rich soil with compost for initial establishment of the seedlings. Initial growth is very important, hence nutrients should be applied in the initial year of plantation.



3. Digging of pits

Pits of 30 cm³ (30 x 30 x 30 cm) is ideal for plantation in soils fairly rich in nutrients. Pits are dug, based on the slope of land, availability of water and soil fertility. The pits should be dug prior to rainy season when sufficient moisture is available in the soil. Refilling of pits is done by mixing with mixture of soil, sand, compost/organic mixture and 40 gram methyl parathion per pit to protect the plants against termite.

4. Transplanting

For better establishment of seedlings, transplanting should be done in the early rainy season (October - November in Indonesia); transplanting should be done preferably in the evening and irrigation is given especially during the first 2 - 3 months.



5. Manure and Fertilizers

Better yield is obtained if manure and fertilizers with small amounts of calcium, magnesium and sulphur are used. In general application of 5 ton of cattle manure in combination of with 150 kg of urea, 200 kg of super phosphate and 100 kg of KCl per hectare is observed to improve the yield. The application should coincide with rainy season or followed by proper irrigation immediately after application of fertilizer. The doses may be lowered for rainfed conditions.

6. Irrigation

Jatropha requires irrigation or high rainfall during the first 2 - 3 months of planting; the amount of water needed is contingent upon soil and climate conditions. During dry season, the sandy soil should be irrigated every 5 - 6 days; the time interval might be lengthened to every 10 or 12 days in fertile soils. Mulching method has been found very effective to conserve moisture and reduce the cost for irrigation. It is recommended to build embung (water pond) to harvest rain water to be used during the dry season.

7. Weeding

The plant spacing should be made to give optimal space for movement of tractors drawing rotavator. The area close to the shrub should be kept free from weeds using herbicides, hand weeding or hoeing, mainly in the first two year. After year-3, the cost for weeding will be decline as plant canopy covered the field.



8. Plant Protection

As the provenances use in Indonesia are poisonous type, jatropha has no serious pest or disease problem at present. This will change when it is grown in commercial plantations with irrigation and fertilization.

Pests and disease which are found causing damage on jatropha in Indonesia are tabulated in Table 2.



Table 2. Pest and disease of jatropha in Indonesia

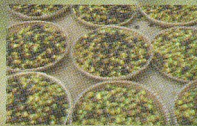
Pest / Disease	Damage
<i>Julus</i> sp (milipede)	death of seedlings
<i>Oedalues senegalensis</i> (locust)	damage of leaves and seedlings
<i>Lepidopterae</i> larvae	holes on leaves
<i>Pinnaspis strachani</i> (cushion scale)	death of branches
<i>Ferrisia virgata</i> (wooly aphid)	death of branches
<i>Calidea dregei</i> (blue bug)	suck capsule/fruit
<i>Nezara viridula</i> (green stink bug)	suck capsule/fruit
<i>Spodoptera litura</i>	damage leaves
<i>Phytophthora</i> spp., <i>Phytium</i> spp., <i>Fusarium</i> spp., etc.	damping off death of seedlings, root, rot
<i>Helminthosporium tetramera</i>	leaf spots
<i>Pestalotiopsis paraguarensis</i>	leaf spots
<i>Pestalotiopsis versicolor</i>	leaf spots
<i>Cercospora jatropha-curcas</i>	leaf spots
<i>Macrophomina phaseolina</i>	collar rot

Insects such as beetles, hoppers and leaf minor larvae feeding (*Spodoptera litura*) lepidopteran larvae, die back of branches (*Pinnaspis strachani*), blue bug sucking on capsules (*Calidea dregei*), locust feeding on leaves of seedlings (*Oedalues senegalensis*), green stink bug sucking on fruit (*Nezara viridula*) are observed on jatropha in Indonesia. It is recommended to control by botanical pesticides; application of synthetic insecticides will kill beneficial insects that help jatropha pollination.

The collar rot caused by *Macrophomina phaseolina* or *Rhizoctania bataticola*; it can be controlled with 0.2% Copper Oxchloride or 1% Bordeaux drenching. The rooting has been observed in the soils saturated with moisture for a long period of time. The *Cercospora Jatropha-curcas* leaf spots are reported to be associated with this species. The rot can be controlled by application of 1% Bordeaux drenching. Minor disease such as root-rot (*Fusarium moniliforme*), damping off (*Phytophthora* sp) and leaf spots are reported to be caused by *Helminthosporium tetramera* and *Pestalotiopsis* sp.

9. Harvesting

For oil production the seeds are harvested at maturity when majority of capsules turn yellow and brown. Picking of green capsules should be avoided. The capsules are collected manually and seeds are separated manually or using seed decorticator. The seeds for planting purposes are picked from yellow capsules (physiological maturity stage) and are dried under shade to 7-9% moisture content before packaging.



The seeds for oil production should be dried in sun for-5 days until moisture level of 6 - 10%. Poor post-harvest management will bring down the quality of seeds that determines the refining process.

10. Pruning and canopy management

Crop architecture plays an important role in a plant like jatropha; proper pruning will produce more branches, healthy inflorescence to exchange good capsule set and ultimately the yield. The experiments reveal that pruning at 30 cm height is ideal to manage.

Pruning at the end of the 1st and 2nd-year will induce formation of 9 - 12 branches and 27 - 36 branches. Each branch should be pruned up to 2/3rd top portion and retaining 1/3rd of branch. Pruning will keep the plant short to manage flowering and fruiting and also provides ease during picking of mature capsules.

The entire plant has to be cut to ground level leaving 45 cm stump once in 10 years. The regrowth is quick and starts yielding in about a year. It induces new growth and helps stabilize yield.



11. Intercropping

Jatropha is a perennial that can be intercropped with annual crops primarily during the first two years; shade loving crops such as medicinal and aromatic plants as intercrop will add to farmers' income until the jatropha plantation attains productive and profitable phase. Several leguminous crop i.e ground nut, mungbean could be grown as intercrop, which will supply soil with nitrogen, that available to the plantation.

Economic return, suitability to climatic conditions, technological development, policies of the government will affect the cropping system to some extent. In initial stage jatropha have been used in agroforestry program particularly reclamation of mining area. Those are the combination of 2 - 3 major crops, trees, jatropha and annual crops with additional components such as honeybees, silkworm etc.

The inclusion of leguminous crops/trees on poor soil will result in marked improvement in soil fertility by increasing soil organic matter, efficient biological nitrogen fixation, little erosion run off, improvement in soil physical condition, etc.

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