

Jatropha Oilseed Production: A Realistic Approach

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1. Introduction

Non-edible oils extracted from tree seeds are considered an important source of energy for the future. Among the species producing oilseeds, *Jatropha* (*Jatropha curcas*) is the frontrunner as a species for commercial cultivation because of its several advantages over others in this category. In the wake of the interest being generated about *Jatropha*, a large number of people have entered the scene as stakeholders. Unfortunately, not many of them are well informed about its actual potential as an oilseed bearer for biodiesel production. The current situation is one where overenthusiastic or unscrupulous promoters are misleading a majority of the prospective *Jatropha* producers. Tall claims are being made of varieties and vegetative planting material that start producing seed in the first year itself, and have the potential to eventually yield 10 tons of *Jatropha* seed per ha annually. In reality, however, there does not appear to be a single plantation in India that can substantiate such claims.

BAIF Development Research Foundation in Pune has been conducting research on the cultivation aspects of *Jatropha* for the past six years on its farm in Tiptur in Karnataka. It also organised a National Workshop on the subject in 2003. Since then, BAIF has been serving as an information network centre for those interested in tree-borne oilseed species. The current paper combines the research experience with information gathered through interaction and from literature on oilseeds for biodiesel production.

2. Advantages of Jatropha

Apart from *Jatropha*, the category of tree-borne oilseed species includes Karanj (*Pongamia pinnata*), Mahua (*Madhuca latifolia* and *M. indica*), Undi (*Calophyllum inophyllum*), Neem (*Azadirachta indica*) and Simarouba (*Simarouba glauca*). *Jatropha* has an advantage over others in many ways. It is at a higher stage of domestication than others and hence considerable research has been carried out already to understand the species and its cultivation.

Unlike most other perennial species, *Jatropha* has a shorter gestation period and regular seed harvests are possible within four years of establishment. Being a small tree with a lax canopy, it is ideally suited for small farm agroforestry systems. Its natural distribution throughout India is indicative of its adaptation to diverse agro-climatic conditions. Moreover, farmers are familiar with *Jatropha* as a hardy fence plant that can survive with very little inputs or management. These advantages notwithstanding, it should not be assumed that *Jatropha* can succeed under any condition.

Another advantage of *Jatropha* is the properties of its oil for biodiesel production. Its very low Free Fatty Acid content, almost similar to edible oils, makes it ideal for transesterification and the oil to biodiesel conversion ratio is higher than in other non-edible oils. A higher ratio means better profit margins and hence *Jatropha* oil is a more desirable raw material than the oils of other tree seeds. Combustion studies have also shown *Jatropha* biodiesel to be superior to others as its emissions are less polluting than that of others.

3. Beliefs and Facts

Whenever a crop species or agricultural practice is in the limelight, a lot of information is circulated to highlight its merits. Not all of it is necessarily based on hard evidence.

Common beliefs, distorted claims and wishful thinking are all part of the information dissemination that *Jatropha* is going through at present.

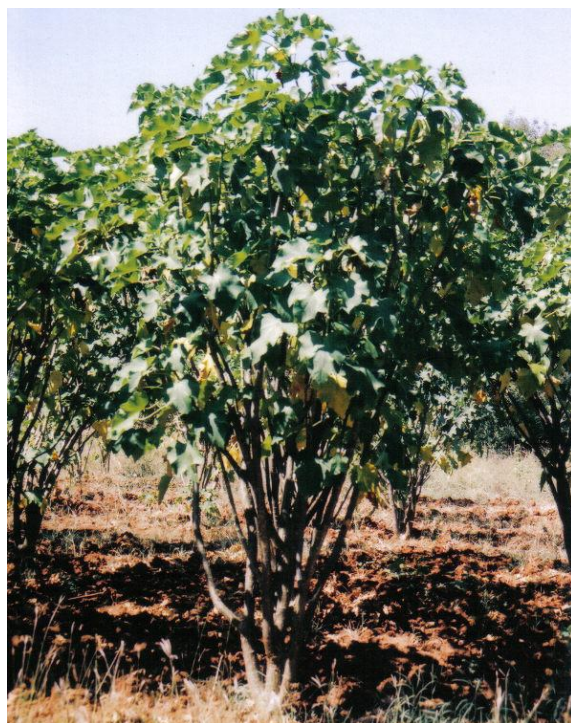
3.1 Hardy species

The commercial success of any species depends on its potential (as a plant) getting realised (as a crop). The experiences of many who make unrealistic claims are based on observations of *Jatropha* as a plant and not in a cropping situation. It is common knowledge that *Jatropha* is a hardy species that survives under extremely harsh environmental conditions with little or no external inputs and management. But mere survival is not what is expected of a crop when it is cultivated commercially. Moreover, in most farms where it is found, *Jatropha* is planted as a single row fence plant or on bunds. Performance of a species in terms of growth, susceptibility to pests or diseases and seed yield in block plantations will not be the same as that obtained in linear plantings.

3.2 Planting material

The upsurge in interest in *Jatropha* has resulted in the growing demand for its planting material. A natural extension of this demand is the emergence of planting material suppliers who claim to have elite varieties. It is not known whether these so-called varieties have undergone any performance testing under diverse agro-climatic conditions. Studies conducted by BAIF in Karnataka showed pronounced differences among genotypes and the genotype collected locally outperformed that from Maharashtra and Nicaragua (Figure 1). However, in the absence of multi-locational evaluation, it cannot be concluded that this genotype is superior to others.

Figure 1. *Jatropha* stand of Karnataka genotype at four years.



Seed oil content is another parameter where inflated claims are made. Generally, oil content of *Jatropha* kernel is around 25%, but some researchers have reported twice as much

in seed collections from natural stands. It is too early to say whether such high oil contents can be achieved in large-scale cultivation. Moreover, if the trait of seed oil content is not combined with seed-yielding ability, it is only of academic interest.

Another trend is to encourage the use of vegetative propagules of *Jatropha* as planting material. There are nurseries that sell propagules at exorbitant rates with the promise that they will come into seed production early. It is an established fact that propagules from cuttings or grafts start bearing early and show uniform growth. Vegetative propagation has been very successful in plantation crops like tea and rubber, but the recommended clones of those species have undergone testing for long periods under biotic and abiotic stresses. The suitability of vegetative propagation for *Jatropha* is untested. Until studies are conducted on this aspect, *Jatropha* seedlings that have a tap root system may be a safer option for wastelands than propagules with adventitious roots.

3.3 Seed yield

Enthusiastic promoters of *Jatropha* often claim that a seed yield can be had in the first year itself, and the yield can be as high as 8.0-10 tons per ha per year when the trees mature in 3-4 years. These are highly optimistic projections. Although it is a perennial, *Jatropha* starts flowering in the first year itself and may produce some seeds. Harvesting these seeds is undesirable because the priority for the first three years of establishment of a commercial plantation is to develop the tree structure. This is achieved by periodic pruning and thinning of branches. During this juvenile phase, flowers that appear should be removed at the bud stage so that vegetative growth continues unaffected.

Another over-estimation is the yield projection based on the yield of a single tree or few trees. For example, a vigorously growing six-year old *Jatropha* tree growing on a bund in BAIFF's Karnataka farm produced more than 3.0 kg of seed. It will be unrealistic, however, if the per ha seed production is estimated based on the unusually high seed yield of this single tree.

3.4 Inputs

The belief that *Jatropha* grows with little or no inputs is also a generalised one that does not hold good for commercial cultivation. Repeated harvest of seed in substantial quantities will drain the soil as well as the plant of nutrients and moisture. Unless these are replenished through fertiliser or manure application and irrigation, seed production cannot continue. If the goal is to produce seed on a commercial scale, input application has to match the crop requirements. Such requirements are usually much higher for trees grown for the purpose of production than those serving the function of live fencing.

3.5 Multipurpose species

Jatropha has several other uses besides the seed oil. Almost all its parts have medicinal properties and are used in native medicinal preparations. Extracts of its bark can be made into a wax. Tannin or dye can be extracted from leaf and root of *Jatropha*. These characteristics are projected as additional benefits from the multipurpose *Jatropha* tree. In reality, if plant parts are harvested for other purposes, seed yield will be adversely affected. Therefore, commercial cultivation should focus on the seed and the periodically pruned branches and fallen leaf litter should be considered as by-products.

Table 1. Beliefs / claims and facts associated with Jatropha.

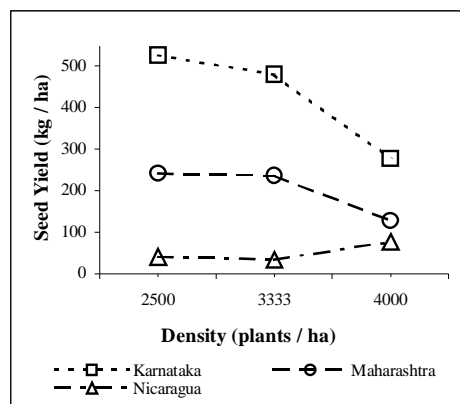
Property	Belief / Claim	Fact
Soil and climate	Grows anywhere	Grows, but very low seed yield
Fertiliser application	Not required	Seed production will be low
Irrigation	Hardy, needs no water	Survives, but seed yield very low
Gestation period	Seed yield from first year	Small quantities for first 2-3 years
Seed yield potential	8.0-10 tons per ha per year	Not under average conditions
Oil content	As high as 50% or more	Usually about 25%
Multipurpose species	Bark, leaf, root and latex have uses	If these parts are harvested, seed yield will be low or absent
Varieties & genotypes	High-yielding varieties and propagules	Not certified or tested under diverse conditions

4. Realistic Targets

The manner in which Jatropha is promoted at present with exaggerated claims is fraught with the possibility of growers losing interest in this species if their very high expectations are not met. This has happened in several other crops in the past. It is not that these crops failed altogether, but their potential was blown out of proportion and farmers were unhappy with what they eventually realised. Even Jatropha went through such an experience when farmers discontinued its commercial cultivation in parts of Maharashtra a few years ago. However, the current situation and the purpose for which it is promoted now are totally different, so the chances of its success are greater this time around.

The potential seed yield of Jatropha, according to technical literature, is up to 10 tons per ha. In India, apparently, the recorded yields have been less than 2.0 tons per ha. BAIF investigated seed production of three genotypes of Jatropha under three plant densities in Tiptur district of Karnataka. This aim of this study was to examine the productivity of Jatropha under average resource conditions. Therefore, it was conducted on a marginal land with limited fertilisation and management. The field received life-saving watering during the summer seasons of the first two years; no other irrigation was given. Under such resource-limited conditions, the highest seed yield was about 500 kg per ha in the fifth year (Figure 2).

Figure 2. Seed yields of Jatropha genotypes from Maharashtra, Karnataka and Nicaragua under different plant densities at five years (Source: BAIF Institute for Rural Development-Karnataka, Unpublished data).



Regular irrigation was introduced in the next year and this resulted in luxuriant vegetative growth, followed by a longer flowering period and increased number of fruit

pickings. The seed yield in the sixth year, when all the pickings are completed, is expected to be about 1.2 tons per ha per year. This yield is achieved under less than average conditions. Therefore, a seed yield of 2.0 tons per ha appears to be an achievable target with average levels of fertilisation, irrigation and management (although this author is yet to personally see a plantation of this level of productivity). Intensive *Jatropha* production on good agricultural land with drip irrigation, high levels of fertilisers or manures and adoption of management practices such as regular pruning may yield 5.0 tons or more. However, this target has to be treated rather cautiously because plantations of this intensive kind have been established only within the past two years in India and they have not yet come into seed production.

The seed yield range for *Jatropha*, quoted above, is from 0.5 tons to 10 tons per ha. A farmer getting into *Jatropha* production cannot start off with an expectation of 5.0 or more tons. At the same time, a very conservative yield of less than 1.0 ton does not hold out any promise for a prospective grower to enter the field. A modest target that has a high probability of attainment is 2.0 tons per ha. The price at which *Jatropha* seed can be sold for oil extraction is generally Rs. 5/- per kg. Thus, a safe gross income target is Rs. 10,000 per ha. Setting this as the income potential, the establishment cost has to be kept to less than Rs. 7000/- and that on aftercare to Rs. 2000/- annually. The break even in such a situation would be in about six years and thereafter a net income of Rs. 8000/- per year can be expected.

5. Production Strategies

5.1 Farm land

The economics of *Jatropha* cultivation, described above, may not appear appealing enough to attract would-be growers in large numbers. This initial hunch, however, is likely to get less intense on closer examination of facts. The actual income from vast areas of wasteland in the country is lower than what is possible with *Jatropha* cultivation. Most of these lands belong to small marginal farmers in dry areas who routinely take up cultivation of some crop during the rainy season. *Jatropha* is a suitable option for them. There are others who raise crops on a part of their land while the other part, usually the less fertile one, remains barren. Such land can be brought under *Jatropha* as it requires very little management after establishment and will not be a constraint on farmer's time and resources.

It is also possible to enhance the role of *Jatropha* in existing production systems. A single row of *Jatropha* as live fencing is a common practice. This can be increased to 2-3 rows in a strip of 3.0 m along the farm boundary. In a farm of 1.0 ha, this would amount to devoting 0.10 ha (0.25 acre) for *Jatropha*. Besides the service function of protecting the farm, this strip of *Jatropha* will produce about 200 kg of seed with very little additional resource commitment.

Studies conducted at BAIF to examine the suitability of *Jatropha* for agroforestry purposes have also yielded promising results. When it was grown as the upper storey species, yield reduction on the annual crops horse gram and finger millet was negligible during the first four years. In fact, the annual crops seemed to benefit from the sheltering effect of *Jatropha* when there were strong dry winds. Being a small tree, *Jatropha* may also fit in as the under storey species with taller trees if the shade is not too heavy.

Figure 3. Finger millet in an agroforestry system with *Jatropha* at three years.



5.2 Common land

Large-scale *Jatropha* seed production on common wastelands has been highlighted extensively in popular articles. There have been limited attempts by the Indian Railways to raise *Jatropha* on land owned by it. Leasing of government land for the specific purpose of non-edible oilseed production is another suggestion put forward. The fertility status of common wastelands is such that intensive production with high levels of inputs may not be a viable option. At least until the soil fertility is improved, the cultivation approach has to be extensive on larger areas with modest levels of inputs. In such a scenario, the aim should be maximum returns and not maximum yields. This will require a systematic approach to establish and manage the large plantations. The target seed yield in extensively managed plantations on wastelands should be about 1.0 ton per ha.

6. Concluding Remarks

Presently, tree-borne oilseed species, *Jatropha* in particular, find themselves in a rare situation where several factors are in their favour. Those of significance are: the record high prices of petroleum products and the rapid depletion of their global reserves; worsening environmental problems and the emerging stringency in the emission standards of fast-growing economies; the expanse of degraded barren land in India that has to be brought under vegetation for the future common good; an opportunity to earn carbon credits through Clean Development Mechanism while creating rural employment and a non-conventional energy system. Opportunities such as this with so many factors in favour do not come up that often.

Considering the prevailing favourable situation, the biodiesel programme based on *Jatropha* and other tree-borne oilseeds should not be allowed to falter at this stage. A lot is heard about government programmes for their promotion, but there appears to be a lull at implementation level. The non-government efforts tend to be driven by overly optimistic or deliberately exaggerated production levels. *Jatropha* can succeed if it is promoted through a systematic programme with realistic targets.