THE JATROPHA HANDBOOK

CHAPTER 1

1. General Data on Jatropha

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1.1. Introduction

Jatropha curcas L. (Latin name) is often referred to as 'jatropha'. It is a plant that produces seeds with high oil content. The seeds are toxic and in principle non-edible.

Jatropha grows under (sub) tropical conditions and can withstand conditions of severe drought and low soil fertility. Because jatropha is capable of growing in marginal soil, it can also help to reclaim problematic lands and restore eroded areas. As it is not a food or forage crop, it plays an important role in deterring cattle, and thereby protects other valuable food or cash crops.

Current interest by investors, farmers and NGOs in jatropha is mainly due to its potential as an energy crop. Jatropha seeds can be pressed into bio-oil that has good characteristics for direct combustion in compressed ignition engines or for the production of biodiesel. The bio-oil can also be the basis for soap-making. The pressed residue of the seeds (presscake) is a good fertilizer and can also be used for biogas production.

Jatropha is a promising crop with many applications. The technology is in its infancy and on the verge of commercialisation. Expectations are high. The first developments are underway, but not much has been realised so far. FACT (Fuels from Agriculture in Communal Technology) is gaining experience in several pilot projects and has encountered many initial obstacles and problems. In several projects it has tried to tackle these problems. The objective of this handbook is to share the most recent knowledge on all aspects of jatropha with practitioners and other people involved in making use of jatropha for local development, with bio-fuel as the most interesting option.

Within this context, the primary focus of this book will be on the start up of plantations, the processing of fruit, seeds, oil and the use of oil for local development. Each topic is discussed in more detail in the appropriate chapters.

This introductory chapter describes the basic and global characteristics of jatropha. It includes the botanical description, ecology, geographical distribution, applications of jatropha and its oil, sustainability issues and report outline.

1.2. Botanical description

Jatropha curcas L. has many local names, including bagani/ (Ivory Coast-Mali), pourghère (French), physic nut (English), tabanani (Senegal), makaen/ mmbono (Tanzania), piñon (Latin America), purgeernoot (Dutch), sketnoto (Surinamese).

In all cases *Jatropha curcas* L. is a tall bush/ shrub or small tree that can grow up to 6 meters tall, belonging to the Euphorbiaceae family. Its lifespan is in the range of 50 years. The tree is a deciduous wood type with leaves falling off under conditions of stress.

The plant has green leaves with a length and width of 6 to 15 centimetres. Jatropha plants show different plant architecture, ranging from a main stem with no or few branches to a plant that is branched from below. The branches of the jatropha plant contain a white, sticky latex that leaves

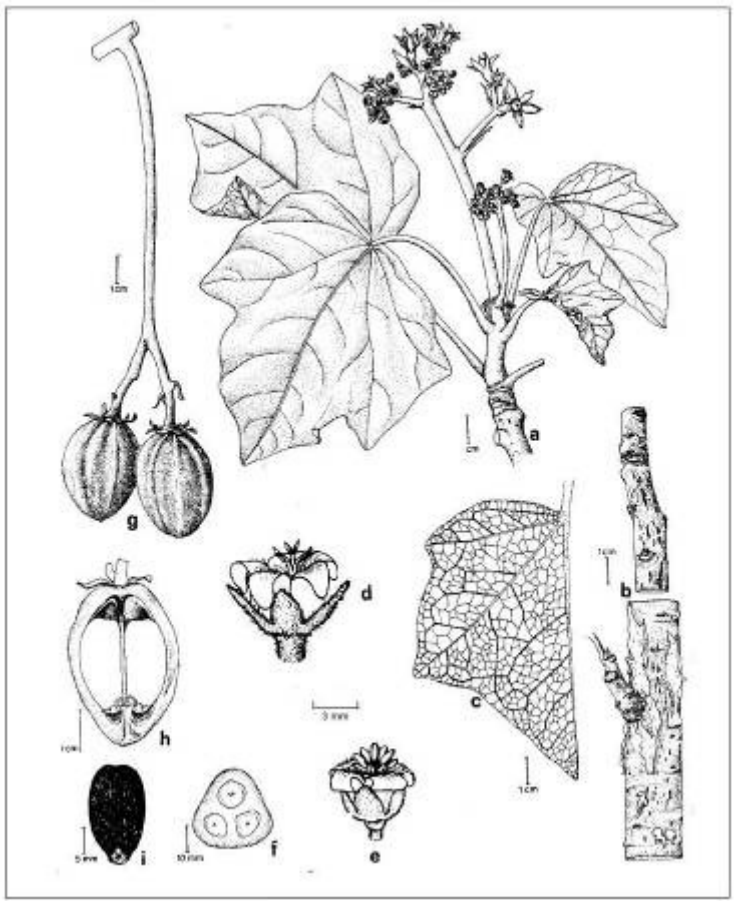
brown stains, which are hard to wash out. The root system from natural jatropha plants is well developed, with roots growing both laterally and vertically into deeper soil layers.

Figure 1 – Pictures of the Jatropha plant (Photo Mauricio Moller) .

The plant is monoecious, with male and female flowers on the same plant. Fruit forms at the end of branches in bunches of 5 – 20, have a shape resembling an "American football" and are about 40 mm. long. Each fruit contains 3 seeds, though occasionally one may have 4 or 5 seeds.

Figure 2 – Pictures of the Jatropha fruits (photo Arthur Riedacker).

Jatropha seeds look like black beans and are on average 18 mm long and 12 mm wide and 10 mm thick. These dimension vary within seeds from the same plant or provenance and between seeds from different provenances. Seed weigh between 0.5 and 0.8 gram, with an average of 1333 seeds per kilogram. Seeds contain various toxic components (phorbol esters, curcin, trypsin inhibitors, lectins and phytates) and are non-edible. Seeds consist of a hard shell that makes up around 37% by weight on average and soft white kernel that makes up 63% by weight. The dry seeds have a moisture content of around 7% and contain between 32 and 40% of oil, with an average of 34%. Virtually all the oil is present in the kernel.



a) flowering branch,
b) bark,
c) leaf veinature,
d) pistillate flower,
e) staminate flower,
f) cross-cut of immature fruit
g) fruit,
h) longitudinal cut of fruit

Figure 3 - Nomenclature from [3]

1.3. Ecology

Some consider jatropha to be a weed. However, it is definitely not an invasive species since it hardly propagates by itself. Seeds from fruits that are left on the ground surrounding the mother plant seldom germinate and develop. The fruit and seeds are poisonous and not eaten or collected by animals, Jatropha, therefore, is not naturally dispersed.

Jatropha is a resilient plant that can adapt to many ecological conditions. Its survival mechanism enables it to withstand periods of stress (cold weather/ severe drought/ low radiation). It is able to retrieve the nutrients from its leaves and store them in the plant stem and root system. The leaves then turn yellow and are subsequently shed by the plant. The stem remains green and photosynthetically active. In this dormant state the plant can survive periods of more than a year without rain.

In some cases jatropha naturally forms a symbiosis with soil mycorrhiza (a specific kind of fungus) that increases the plant's uptake of nutrients and water from the soil. The presence of mycorrhiza increases the plant's tolerance to drought and low levels of nutrients. This symbiosis occurs sometimes under natural conditions but never occurs in plantations, unless artificially introduced.

1.4. Geographical distribution

Jatropha historically originates from Central America and the northern parts of South America. Jatropha has been distributed to other tropical regions by European seafarers and explorers from the 16th century onwards. Presently it grows in tropical areas worldwide (Sub-Saharan African countries, Southeast Asia, India).

Figure 4 - indication of the most suitable climate conditions for the growth of Jatropha curcas L (30°N, 35 °S) and Oil palm (Elaeis guinensis Jacq. (4°N, 8 °S). [3]

1.5. Jatropha historical and current uses

Historical records show that jatropha was used by native Indians of Central America and perhaps South America, where it was traditionally used in herbal medicine. Jatropha seeds were commercially produced on the Cabo Verde Islands already in 1836. The seeds were exported to Portugal and France and the oil was used for street lighting and soap production [3]. Due to the toxicity of the leaves and its fast growth and resilience, jatropha is often used as a hedge or living fence since it is not browsed by cattle. There are many other current uses for jatropha. Figure 5 gives an overview of the several applications of jatropha and its products.

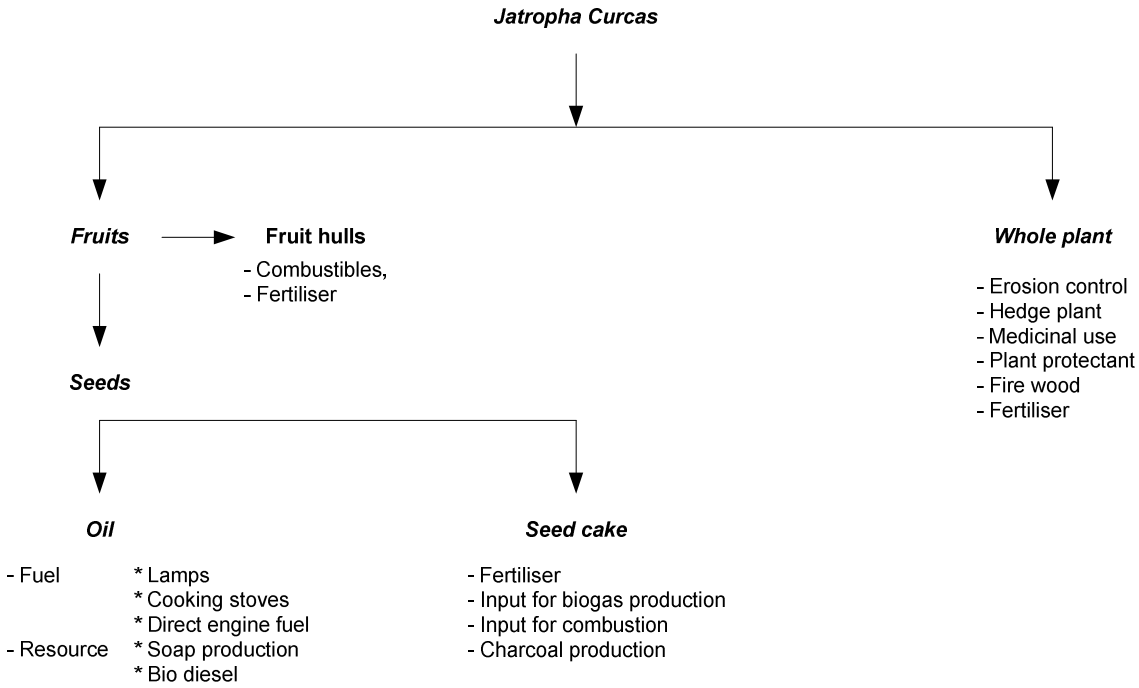


Figure 5 - Uses of the jatropha plant and products.

Figure 6: Left: Pongamia seeds (another oil containing tree seed), middle jatropha seeds from Tanzania, right top: soap from Kakute Tanz, below, Oil from Diligent

Figure 6: Right: Pieces of presscake, pressed by a strainer type of press. (Photo Rural Biodiesel – Brazil)

1.6. Fact sheet

Parameter	Unit	Minimum	Average	Maximum	Source
Seed yield	dry Tonne/ Hectare	0.3	1,5	6	Position Paper on Jatropha Large Scale Project Development, FACT June 2007
Rainfall requirements for seed production	mm/year	600	1000	1500	Position Paper on Jatropha Large Scale Project Development, FACT June 2007
Oil content of seeds	% of mass	-	34%	40%	Jatropha bio-diesel production and use, W. Achten et al, 2008
Oil yield after pressing	% of mass of seed input	-	20%	25%	various sources
Energy content kg of oil	MJ/kg		37		

1.7. Jatropha and local development

Jatropha can be integrated into traditional farming systems in developing countries. It can be planted as a living fence around agricultural fields or on marginal soils to control erosion. When the presscake is returned to the fields there is a sustainable recycling of nutrients and the soil remains productive. The production of seeds and processing into biofuel provide extra job opportunities. Jatropha biofuel can be used for both transport and electricity production, and can give local communities energy independence. Any excess biofuel that is produced can be sold. The oil can also be used for soap production, providing a profitable rural village activity.

Jatropha production should only take place when there is sufficient land for local food production. Intercropping jatropha with food crops is also a good option; the extra investments in agriculture will increase food production as well.

1.8. Jatropha handbook outline

This handbook describes the jatropha oil production process step by step, as in figure 7.

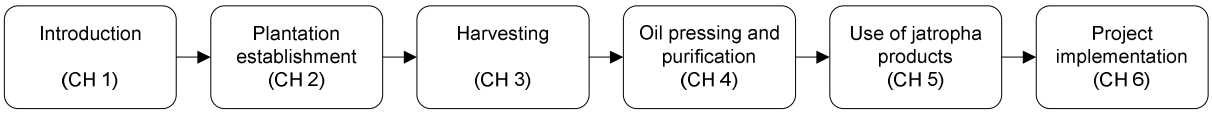


Figure 7 - Jatropha handbook outline.

Plantation establishment (Ch 2) discusses the aspects of the establishment and management of a jatropha plantation on a small scale (0.5 to 5 ha.). It elaborates on soil sampling, field preparation and planting. Furthermore the chapter highlights the dangers and hazards on a plantation, including pests and diseases. At the end, there is a discussion of various dry seed yields of the plantation.

Harvesting (Ch 3) discusses the harvesting and drying of fruit, and the dehulling and storage of seeds. It provides insight into the major issues of the harvesting process of the jatropha seeds.

Oil pressing and purification (Ch 4) discusses the mechanical oil extraction methods and oil quality aspects for jatropha oil production. Multiple technologies are available for oil extraction. The selection is mainly a trade-off between the acceptable complexity, costs of technology and the required oil quality. Production scale is an important limiting factor in the choice of technology. Oil extraction is one aspect of oil production. After pressing, the jatropha oil needs further purification before it can be used. Cleaning methods, handling guidelines and storage conditions are therefore discussed.

Use of jatropha products (Ch 5) discusses the potential applications of jatropha and its products. Jatropha is first of all cultivated for the oil and its several applications are discussed. During the process many by-products are created which can be used as well. However, until now only a few applications have been realized on a reasonable and large scale. This chapter elaborates further on the technical details and concepts needed to modify and adapt existing technologies for the use of jatropha oil and by-products.

Project implementation (Ch 6) focuses on the implementation phase, which requires several strategic decisions about who will own the production facilities, what products to include in the chain and how to finance the different components of the enterprise. These decisions determine to a large degree the social impact and sustainability of the production chain. This chapter also aims to describe the most important options, with its respective advantages and disadvantages.

Sustainability is another important topic of the implementation phase. Conformation with the Cramer Criteria, for example, is obligatory if one wants to sell its products in the Netherlands. Other sustainability issues, namely environmental, social and economic subjects (people, profit, planet) are also important for the long-term acceptance and success of any project.

1.9. References

[3] Heller (1996) - Physic nut - underutilized species
[1] a – c and f –h (Aponte Hernandez 1978);
[2] d and e from Dehgan 1984 (in Physic nut, Joachim Heller, IPGRI -1996)
[3] Jongschaap et al., 2007