

# Identification, selection and multiplication of high yielding *Jatropha curcas* L. plants and economic key points for viable *Jatropha* oil production costs

## 1) Identification/selection of high yielding plants

Up to now, in many countries *Jatropha* is well known under different names, but it was mostly used by the farmers as living fences around their homesteads and gardens, sometimes also around their fields, to protect crops against roaming animals. The seeds did not play any important role. Therefore the farmers cannot tell, which are good yielding plants.



Mr. Hak of Cambodia with the tip of a branch of his high yielding plant

The first task to start a *Jatropha* oil production is therefore to identify such high yielding plants. This can be done by watching plants during the fruiting time (during the rainy season), because one can recognize the ability of a plant to produce fruits/seeds by regarding the plant itself and the details of the branches.

Since flowers of the *Jatropha* plant are only developed terminally, only plants with many branches, i. e. with a good ramification, can produce many fruits. A good plant should have bunches of *Jatropha* fruits at every end of a branch. We saw bunches of 18 fruits, and even some flowers at the top of the branch.

The picture above shows the end of a branch of such a high yielding plant. Until the middle of the rainy season, the plant (about 3 years old) produced already 2.8 kg of seed. So the total yearly yield of this plant can be estimated at about 5 kg (more than 4 kg). With a density of about 1,300 plants per ha (2.5 m distance between the plants in a row, and 3 m distance between the rows), this amounts to about 5 tonnes of *Jatropha* seed per ha, a value; which



Male (left) and female flowers of an *Jatropha* inflorescence

is very high and is not yet confirmed by other *Jatropha* growers. It is a value at the upper end of a scale, defined by *Jatropha* experts during a conference in Wageningen, Netherlands, in March 2007

The cuttings of this plant show also a very good root development in the first 3 weeks after planting them in polybags.

Such plants should be chosen to take cuttings and to plant them. In a second step, these plants from different cuttings can be screened in detail. The best plants in respect of seed production,



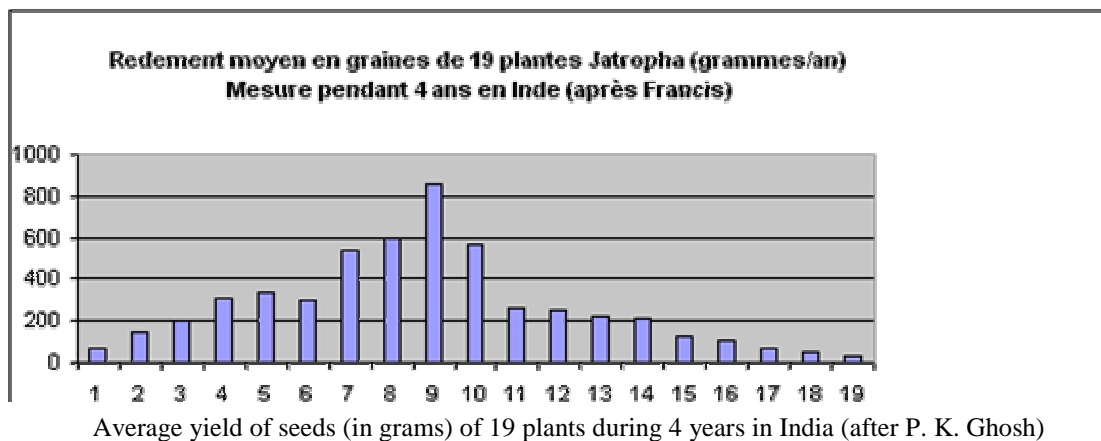
The root system of cuttings of the high yielding plant of Mr. Hak after 3 weeks in polybag.

oil content of the seeds and ratio of female and male flowers should be identified and multiplied. Unfortunately, up to now, the *Jatropha* plants have been used mainly as protective hedges (living fences) around gardens, and the farmers don't have any idea, which ones might be high yielding plants. Mr. Hak of Sisopon identified such a plant within his plantation and tries to multiply it.

An important effect on the yield of a plant has the ratio between female and male flowers within an inflorescence. Usually a ratio of about 1 female to 10 male flowers is observed. If this figure can be improved, more fruits will be developed within an inflorescence.

## 2) Multiplication of high yielding plants

Usually *Jatropha* plants are multiplied by cuttings, because this kind of multiplication is faster than multiplication by seeds, because the cuttings are already part of adult plants and inflorescences are developed during the first rainy season.



The plants growing from cuttings have the same genetic information as the mother plants. So if the yields of the mother plants are not known (because the cuttings are from various plants), the plants from these cuttings will follow the biological variation rule and we will find about 5 % high yielding plants, and the rest will show lower yields (see graphic above).

It is not predictable, which plants will be high yielding, unless the yields of the mother trees are known. Therefore a very exact screening of the potential mother plants is important. The best plants can be multiplied vegetatively (by cuttings or tissue culture). Up to now (August 2007) no working method of tissue culture for *Jatropha* is known. To the knowledge of the author, 2 laboratories are working on multiplication of *Jatropha*: a) at Jains in Jalgaon, India, and b) at the University of Mozambique in Maputo.

## 3) Yield of plantations

The yields of plantations have not been carefully measured up to now. This is partly due to the fact, that plantations in full production don't exist up to now, because the *Jatropha* hype started 2 years ago (in the middle of 2005), and the *Jatropha* bushes need about 4 to 5 years until full production.

And it is not allowed to extrapolate the yields of a single plant to a plantation of 1,300 or more plants. A single plant has a different access to minerals and other plant important substances than a plant within a plantation.

During a Jatropha conference in Wageningen in the Netherlands (March 2007), the Jatropha experts of different countries around the world agreed to a yield of 4 to 5 tonnes of seed per ha and year.



Quite high yielding plants from seeds in Cambodia (Canada Bank plantation)

5 tonnes per ha and year represents a yield per plant of 3.8 kg per year (1,300 plants per ha, i. e. 2.5 m between the plants in a row, and 3 m between the rows). Not many plants with such a yield can be found. It seems, that Mr. Hak of Cambodia has such a plant within his plantation. He measured 2.8 kg of seed in half of the production period (half of the rainy season) (see photo under point 1).

The plantation of Mr. Torres in Brazil seems to be quite homogenous and good yielding. But this plantation (13 ha) is only 14 months old and no screening of the yield of the single plants has been made.

The plants of his plantation seem very homogenous with a good yield. One reason for this high yield might be the good and early ramification of these plants. An early and good ramification is important, for the yield of a plant, because inflorescences are only developed terminally, i. e. at the end of branches. The more branches a plant has, the more fruits it can produce. See at right the photo of a Jatropha bush of Sr. Torres in Brazil, which seem very good, because it shows a good ramification right above the ground. This can be improved, if the new shoots will be pruned during the first 3 years just after they reached a length of about 60 cm. 50 cm should be cut off, 10 cm will stay to develop new shoots. The photo underneath shows such a young plant which was already pruned twice during the first 6 months grown in the field.



Early ramification of plants of Mr. Torres in Brazil



Twice pruned young Jatropha plant with many branches

The idea is, that the pruning of the plants will keep them low enough to facilitate the harvest of the fruits, because the time needed to harvest a certain number of kg of seeds, is a very important factor of the economic feasibility of Jatropha oil production (see next point Nr. 4).

#### 4) Economic key-points of Jatropha oil production

The following Excel spread sheet shows, how the amount of seeds harvested within 1 hour, influences the production costs of Jatropha oil: The doubling of the harvest (6 kg instead of 3 kg) reduces the production costs from 0.28 to 0.16 USD, that is almost half of the cost (57 %).

If the costs of the expeller are doubled, from 1,500 USD to 3,000 USD, the production costs of the Jatropha oil stay at 0.28 USD (they mount from 1,104 to 1,122 Riel).

This shows clearly, that it is very important to look for high yielding plants right from the beginning and to look for good expellers, even if they are more expensive. An improvement in the extraction rate of 22 % (3.55 instead of 4.55 kg of seed for 1 liter of oil) reduces the production costs also by 22 % (0.22 instead of 0.28 USD per liter of oil).

<b>Economic estimation of JCL oil production in Cambodia</b>			
<b>(Mr. Hak, Banteay Meanchey)</b>			
Installation costs of plantation as well as storage and transport are not considered			
<b>Basic data</b>			
Working hours per day:			8 hours/day
Working days per week:			5 days/week
Working weeks per year:			45 weeks
Working days per year:			225 days/year
Minimal wage per day:			5000 Riel
Minimal wage per hour:			625 Riel
Exchange rate for 1 USD:			4000 Riel
National currency:			Riel Riel
Amount of seed harvested in 1 hour:			3 kg
Time needed to harvest the seed for 1 liter of oil:			2 hours
Extraction rate with mechanical expeller: (kg seeds for 1 liter of oil):			4,55 kg of seed / l of oil
Diesel consumption of expeller:			2,00 liter per hour
Extraction capacity of expeller:			250 kg seed per hour
Extraction rate of expeller:			22 %
Production rate of expeller:			55,00 liters oil per hour
Working time to extract 1 liter of oil with expeller:			0,04 hours
Persons working with the expeller:			2 persons
Misc. time for oil extr. (buying spare parts, transport of seed & oil, etc):			0,25 hours/liter
Local price of expeller (1500 USD, Hak bought from nephew):			6000000 Riel
Depreciation of the expeller per 1 liter of oil:			135 Riel
Actual diesel price:			3200 Riel
Life time of expeller:			10 years
<b>Cost of oil production with expeller (without plantation, storage &amp; transport):</b>			
Harvest of seeds + cost of working time for extraction 1 l oil + depreciation:			<b>1104,24 Riel</b>
			<b>0,28 USD</b>

## 5) Bibliography

- a) **Joachim Heller**, Physic nut *Jatropha curcas L.*, IPGRI 1996, for download: [www.Jatropha.de/documents/heller.pdf](http://www.Jatropha.de/documents/heller.pdf)
- b) **Münch/Kiefer**: Diploma work on Jatropha, 1986, University of Stuttgart-Hohenheim, Germany, download (only German and French versions are available): [www.Jatropha.de/documents/Muench-Kiefer-Jatropha-Diplomarbeit-de.pdf](http://www.Jatropha.de/documents/Muench-Kiefer-Jatropha-Diplomarbeit-de.pdf)
- c) **Reinhard K. Henning**, The Jatropha Booklet (version for different countries), for download in the Jatropha website: [www.Jatropha.de/documents/jcl-booklet.pdf](http://www.Jatropha.de/documents/jcl-booklet.pdf)
- d) **Reinhard K. Henning**, The Jatropha Manual (a simplified version of the Jatropha booklet for decision makers): [www.Jatropha.de/documents/jcl-manual.pdf](http://www.Jatropha.de/documents/jcl-manual.pdf)
- e) **Reinhard K. Henning**: The Jatropha Website: [www.Jatropha.de](http://www.Jatropha.de) (since 1998).
- f) **Swan Fauveaud**, GERES, Phnom Penh, Cambodia: Economic evaluation of Jatropha Oil Production by Mr. Hak, REE = Rural Energy Enterprise Mongkol Borei, near Siopon, Banteay Meanchey Province.
- g) **P. K. Ghosh**, DaimlerChrysler presentation at Environment Conference Magdeburg, Germany, 2001