

# “The Jatropha System”

## Integrated Rural Development by Utilisation of *Jatropha curcas* L. (JCL) as Raw Material and as Renewable Energy

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### 1. Introductory remarks

This paper contains only some information concerning “the Jatropha System”, just to understand its potential to contribute to rural development by its utilization.

A lot of information can be found on the Jatropha website for downloading:  
[www.jatropha.org](http://www.jatropha.org).

The economic evaluation of the Jatropha activities in Tanzania are based on real data. In other countries the Jatropha activities also show positive economic results, as far as soap making is concerned. The economic use of Jatropha oil as fuel (direct or as biodiesel) depends very much on the level of rural labour costs, as well as on the price of diesel fuel, which is often substantially subsidized.

### 2. Description of the plant, distribution, ecology

*Jatropha curcas* L. (JCL) is a tall bush or small tree (up to 5 m high) and belongs to the euphorbia family. The genus *Jatropha* contains approximately 170 known species. The genus name *Jatropha* derives from the Greek *jatrós* (doctor), *trophé* (food), which implies medicinal uses.

The plant is planted as a hedge (living fence) by farmers all over the world around homesteads, gardens and fields, because it is not browsed by animals

#### 2.1 Botanical description

*Jatropha curcas* L., or physic nut, has thick glabrous branchlets. The tree has a straight trunk and gray or reddish bark, masked by large white patches. It has green leaves with a length and width of 6 to 15 cm, with 5 to 7 shallow lobes. The leaves are arranged alternately.

Dormancy is induced by fluctuations in rainfall and temperature/light. But not all trees respond simultaneously. In a hedge you may have branches without leaves, and besides ones full of green leaves.

The branches contain a whitish latex, which causes brown stains, which are very difficult to remove.

Normally, five roots are formed from seeds: one tap root and 4 lateral roots. Plants from cuttings develop only lateral roots.

Inflorescences are formed terminally on branches. The plant is monoecious and flowers are unisexual. Pollination is by insects.

After pollination, a trilobular ellipsoidal fruit is formed. The exocarp remains fleshy until the seeds are mature. The seeds are black and in the average 18 mm long (11 – 30) and 10 mm wide (7 – 11). The seed weight (per 1000) is about 727 g, this are 1375 seeds per kg in the average.

The life-span of the *Jatropha curcas* plant is more than 50 years.

### Varieties (there are 3)

The Cape Verde variety is the one which is spread all over the world.

A *Jatropha* variety in Nicaragua has fewer, but larger fruits. The yield per ha seems to be the same.

A non-toxic variety exists in Mexico which is used for human consumption after roasting. It does not contain Phorbol esters. (“This non-toxic variety of *Jatropha* could be a potential source of oil for human consumption, and the seed cake can be a good protein source for humans as well as for livestock.”, Becker et al, 1999).

## 2.2 Distribution

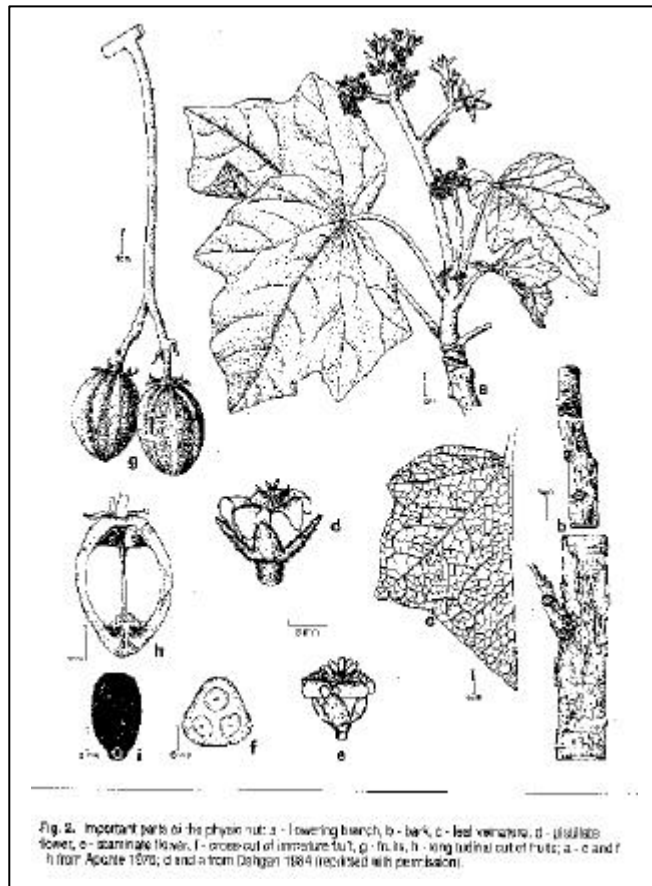
*Jatropha curcas* originates from Central America.

From the Caribbean, *Jatropha curcas* was probably distributed by Portuguese seafarers via the Cape Verde Islands and former Portuguese Guinea (now Guinea Bissau) to other countries in Africa and Asia. Today it is cultivated in almost all tropical and subtropical countries as protection hedges around homesteads, gardens and fields, since it is not browsed by animals.

## 2.3 Ecology

*Jatropha curcas* L. is not a weed. It is not self propagating. It has to be planted.

It grows well on marginal land with more than 600 mm of rainfall per year, and it withstands long drought periods. With less than 600 mm it cannot grow except in special conditions like



on Cape Verde Islands, where the rainfall is only 250 mm, but the humidity of the air is very high (rain harvesting).

It cannot stand frost. It survives a very light frost, but it loses all leaves. The production of seeds will drop sharply.

### 3. Description of the Jatropha System

#### 3.1 The Jatropha System

The Jatropha System is an integrated rural development approach. By planting Jatropha hedges to protect gardens and fields against roaming animals, the oil from the seeds can be used for soap production, for lighting and cooking and as fuel in special diesel engines. In this way the Jatropha System covers 4 main aspects of rural development:

- ?? promotion of women (local soap production);
- ?? poverty reduction (protecting crops and selling seeds, oil and soap);
- ?? erosion control (planting hedges);
- ?? energy supply for the household and stationary engines in rural areas.

The obvious advantage of this “Jatropha System” is that all the processing procedure, and thus all added value, can be kept within the rural area or even within one village. No centralised processing (like in the cotton industry) is necessary.

#### 3.2 Possible Uses of the Jatropha Plant

~~///~~ The Jatropha plant is used as a medicinal plant:

- The seeds against constipation;
- The latex / sap for wound healing;
- The leaves as tea against malaria; etc.

~~///~~ Jatropha is planted in the form of hedges around gardens or fields to protect the crops against roaming animals like cattle or goats;

~~///~~ Jatropha hedges are planted to reduce erosion caused by water and/or wind;

~~///~~ Jatropha is planted to demarcate the boundaries of fields and homesteads;

~~///~~ Jatropha plants are used as a source of shade for coffee plants (on Cuba);

~~///~~ In Comore islands, in Papua New Guinea and in Uganda Jatropha plants are used as a support plant for vanilla;

### 4. Economic Aspects

This is an example of a successful project in Tanzania. The Jatropha plant is already known by the population since a long time, but its utilization was limited to the use of the plant as protection hedge around homesteads and gardens. The seeds were not used.

The KAKUTE project convinced the Massai women as well as a women group in Mtu Wa Mbu, both near the Ngorongoro Crater, Arusha, Tanzania, of the interesting economic potential of this plant. Especially the medicinal property of the soap makes it interesting for

the rural population. And KAKUTE was able to maintain the image of the soap to be a “medicinal soap”.

#### 4.1 Economy of Small Scale Jatropha Utilization in Tanzania (data from KAKUTE, 2003)

<b>Collection of seeds</b>		
	Collection of seeds: 2 kg in 1 hour	
	Sale of seeds: 150 TZS per kg	
<b>Value added for 1 hour work</b>	<b>300 TZS</b>	<b>0,29 USD per hour</b>

<b>Oil extraction</b>		
	1,0 hours of work to extract 1 litre of oil	
	0,5 filtering of the oil	
<b>Input:</b>	Purchase of 5 kg of seed	750 TZS 0,71 USD per litre
	Depreciation/maintenance of ram press 0,04 USD / kg for 5 kg:	210 TZS 0,20 USD per litre
<b>Output:</b>	Sale of 1 litre of oil	2.000 TZS 1,90 USD
	Total of revenues	1.040 TZS 0,99 USD
<b>Value added for 1 hour work</b>	<b>693 TZS</b>	<b>0,66 USD per hour</b>

<b>Soap making</b>		
	16 hours work for 252 bars of soap	
	10 hours for miscelenous work (organising purchase of oil, wrapping the soap, etc)	
	1 bar sold for 500 TZS	
	Purchase of 20 litres of oil à 2.000 TZS = 40.000	
	Purchase of 3 kg of Caustic Soda à 2.000 TZS = 6.000 TZS	
	Plasic for wrapping soap = 3.000 TZS	
<b>Input:</b>	20 l oil à 2.000 TZS	40.000 TZS 38,10 USD
	Plastic	3.000 TZS 2,86 USD
	Caustic Soda	15.000 TZS 14,29 USD
	Total input	58.000 TZS 55,24 USD
<b>Output:</b>	252 bars à 500 TZS	126.000 TZS 120,00 USD
	Total of revenues for 26 hours work	68.000 TZS 64,76 USD
<b>Value added for 1 hour of work</b>	<b>2.615 TZS</b>	<b>2,49 USD per hour</b>

The added value by 1 hour of work of the utilization of the Jatropha plant can be summarized as follows:

?? Collection / harvesting of seeds	0,29 USD
?? Extraction of Jatropha oil with hand press	0,66 USD
?? Soap making	2,49 USD

## 4.2 Economy of Small Scale Production of Jatropha Oil as Fuel in Tanzania

Production and utilization of Jatropha oil as fuel (price for Diesel in Tanzania in Nov. 2003: 650 TZS) has a positive result in the economic analysis, but only, if the raw material (Jatropha seeds) are not bought, but collected. If the revenues of the whole process are calculated in respect of the necessary working hours, an economic benefit is visible:

### Extraction with hand press (Bielenberg ram press):

#### ~~✍~~ Labour costs:

- ~~✍~~ In reality a rural worker gets about 10.000 TZS per month (technical assistant in a flower mill), but he will get some extras like housing, medicine, etc., which is difficult to calculate. Working 6 days a week and 8 hours a day, these are 190 hours a month. This gives a calculated salary on hour basis of 53 TZS.
- ~~✍~~ Usually it is too much to calculate with 8 hours of work daily, so we take 6 and get a payment per hour of 70 TZS.
- ~~✍~~ Officially the costs of labour is 1.200 TZS per day of 8 hours. So 1 hour is worth 150 TZS. To be on the secure side, we calculate also with 6 hours work per day and get 200 TZS per hour.

#### ~~✍~~ Depreciation of the hand press:

- ~~✍~~ Price of the press: 150 USD, capacity: 5 kg seeds/h, lifespan: 5 years;
- ~~✍~~ Throughput in 5 years: 5 years x 10 hrs/day x 6 days/week x 50 weeks = 15.000 kg
- ~~✍~~ Depreciation: 150 USD / 15.000 kg = 1 cent / kg
- ~~✍~~ **Costs of the handpress:** Depreciation + maintenance = 1 + 1 = **0,02 USD per kg = 20 TZS/kg;**

- ~~✍~~ **Collection / harvest of seeds:** 3 kg of seeds can be harvested per hour (measured in Mali), 5 kg are needed for 1 litre of oil; i. e. the labour to collect/harvest 1 kg of seeds is: 1,7 hours.

- ~~✍~~ **Extraction of the oil:** Per working hour 1 litre of oil can be extracted by one person with a hand press. Additionally ½ hour is needed for purifying the raw oil (sedimentation, filtration); i. e. 1,5 working hours for the extraction of 1 litre of oil.

- ~~✍~~ **Cost factors of oil production:**

Harvesting/collecting seeds	= 1,7 hours/litre
Extraction of the oil	= 1,5 hours/litre
Depreciation/maintenance	= 0,10 USD/litre

#### ~~✍~~ Summary of costs:

- ~~✍~~ **Low cost calculation:** (10.000 TZS/month, 144 hrs.)

3,2 hrs. at 70 TZS/hr	= 224 TZS
costs of extraction (costs handpress):	= 100 TZS
Total costs:	= 324 TZS

~~///~~ **High cost calculation:** (1.200 TZS/day, 6 hrs.)  
 3,2 hrs. at 200 TZS/hr = 640 TZS  
 costs of extraction (costs handpress): = 100 TZS  
 Total costs: = 740 TZS

~~///~~ **Profit of oil production:**  
~~///~~ High cost calculation: = 650 – 740 = no feasibility  
~~///~~ Low cost calculation = 650 – 324 = 276 TZS/litre

~~///~~ **Profit per working hour of oil production:**

~~///~~ **Structure of the costs:**  
~~///~~ Sale of 1 liter of oil: 650 TZS  
~~///~~ ./ costs of extraction (costs handpress): 100 TZS  
~~///~~ Profit of the sale of 1 litre of oil at the price of diesel fuel 550 TZS

**Profit:** 550 TZS for 3,2 working hours, this are **172 TZS per hour**  
 or **0,17 USD per hour**

**This is almost 3-times the real salary of a rural worker  
 or almost the official minimum salary of 1.200 TZS a day (which is about 200 TZS/hr (6  
 hours work per day).**

**Extraction with Sayari oil expeller:**

**Cost factors of oil production:** Harvesting/collecting seeds = 1,7 hours  
 Extraction of the oil (Sayari) = 150 TZS/litre

~~///~~ **High cost calculation:** (1.200 TZS/day, 6 hrs.)  
 1,7 hrs. at 200 TZS/hr = 340 TZS  
 Extraction 150 TZS = 150 TZS  
 Total costs: = 490 TZS

~~///~~ **Low cost calculation:** (10.000 TZS/month, 144 hrs.)  
 1,7 hrs. at 70 TZS/hr = 120 TZS  
 Extraction 150 TZS = 150 TZS  
 Total costs: = 270 TZS

~~///~~ **Profit of oil production:**  
~~///~~ High cost calculation: = 650 – 490 = 160 TZS per litre  
~~///~~ Low cost calculation: = 650 – 270 = 380 TZS per litre

~~///~~ **Profit per working hour of oil production:**

~~///~~ **Structure of the costs:**  
~~///~~ Sale of 1 liter of oil: 650 TZS  
~~///~~ ./ costs of extraction (Sayari expeller): 150 TZS  
~~///~~ Profit of the sale of 1 litre of oil at the price of diesel fuel 500 TZS

**Profit:** 500 TZS for 1,7 working hours, this are **294 TZS per hour**  
 or **0,28 USD per hour**

## Conclusion:

The estimation (transport costs, storage etc. are not considered) shows, that the production and sale of Jatropha oil as diesel substitute is economically feasible.

Using the hand press the official labour costs of 1.200 TZS are too high to produce the oil at a price below the diesel price at the pump.

But if somebody declares himself an entrepreneur, who collects/harvests Jatropha seeds and extracts them with a ram press, she/he will get a payment of 172 TZS per working hour.

Using a Sayari expeller, the profit will be higher. Even a high cost calculation shows some profit of 160 TZS per litre of oil, but if the calculation is done for a one person company, a payment of 294 TZS per working hour is calculated. This really seems to be a promising business.

### 4.3 Central Hypothesis

This above presented calculation might be different in other countries with lower wages for rural work. But it also shows clearly, that the added value of Jatropha oil utilization for soap making is very high and that this is a real possibility of creating rural income without big initial investments.

Therefor a central hypothesis of the Jatropha System can be formulated:

**The Jatropha System creates a positive reciprocity between raw material/energy production and environment/food production.**

i. e. the more seeds/oil Jatropha hedges produce, the more food crops are protected from animals and erosion.  
Also additional income is created, mainly for women.

## 5. Strategies to disseminate the know how of the Jatropha System

A strategy to disseminate the know how of the Jatropha system should formulate different activities on 3 different levels:

- ?? a **local level**, i. e. farmers who plant Jatropha hedges to protect their crops, women groups who look for income, NGOs which look for possible actions to support rural development.
- ?? These local activities should be supported by know how centres on a **national level**.
- ?? These centres are supported by a promotion centre which acts on an **international level**.

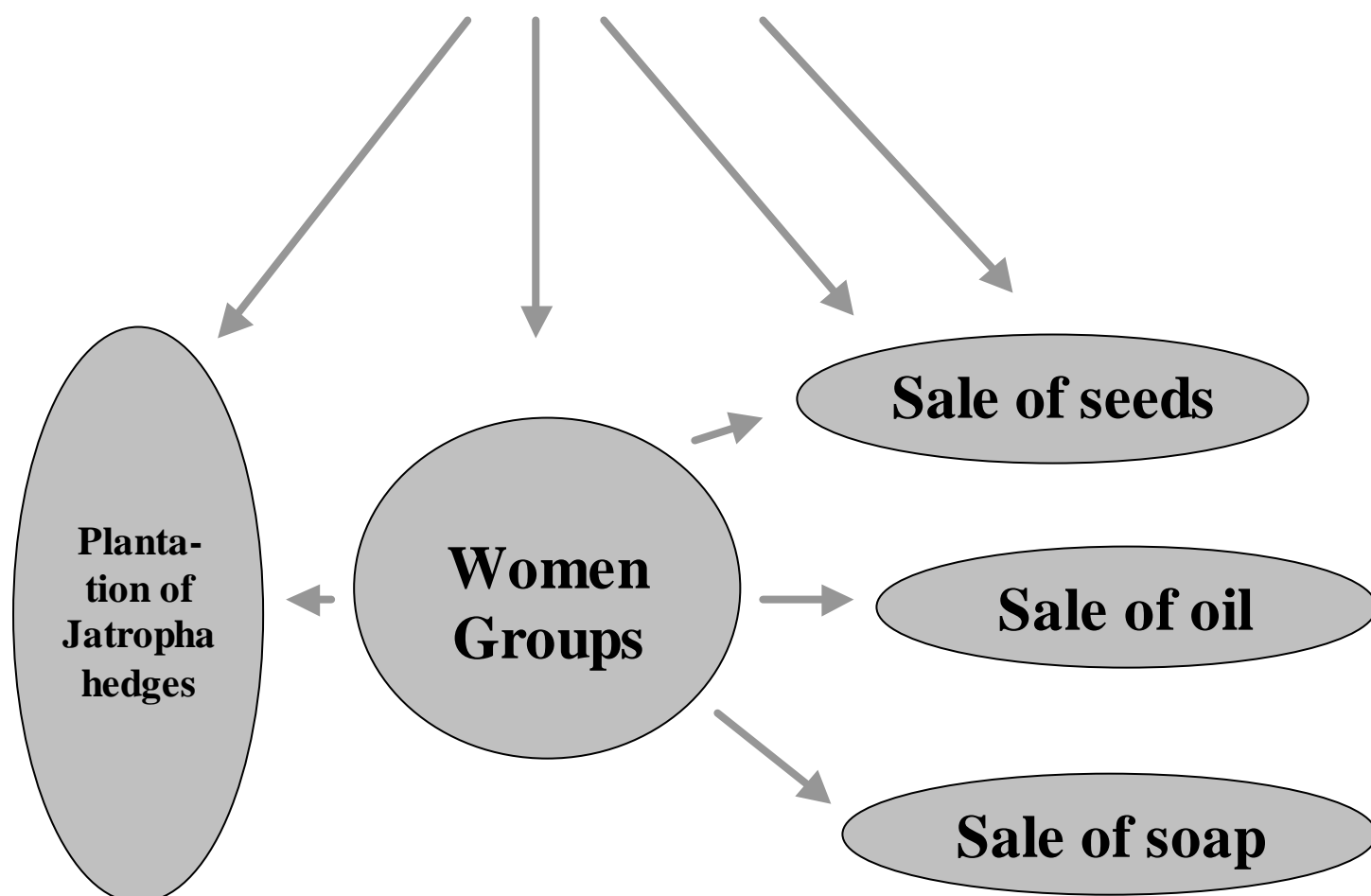


### **5.1 Local level:**

On a local level “Jatropha Project Modules” should be developed, which can be realized by development groups and/or small NGOs. The centre of such a module is an active women group, which is engaged to utilize the economic potential of the Jatropha System.

If Jatropha is not yet available, the project needs a preparatory time of 4 to 5 years to plant Jatropha and wait for the production.

## Support by the Centre of Excellence



### 5.2 National level:

On a national level “Centres of Excellence” should be created in each country. They should play the role of a “know how centre” and support the implementation of Jatropha activities by groups and organizations of rural development.

Such a “Centre of Excellence” is a number of persons who are familiar with all the aspects of Jatropha production, oil extraction, soap production and marketing. These persons have to be up to date with regional development in extraction technology and marketing techniques (“eco-label”).

These persons can easily be invited by some organisations to start Jatropha projects in their region:

- ?? Support of the supply of material & chemicals to projects; list of suppliers; Organisation of the exchange of information;
- ?? Creation of a national JCL network; Support of the marketing of products; Facilitation of credits.
- ?? Organization of national workshops;
- ?? Looking for wholesale buyers for Jatropha soap and / or oil in national markets;

- ?? Presentation of Jatropha products on agricultural & bio-product exhibitions (national / international);
- ?? Approach of national / international trading companies of natural products.

### **5.3 International level:**

On an international level a “Jatropha Promotion Centre” should be created, which supports the different “Centres of Excellence” by various activities:

- ?? Publication of available and useful information concerning the application of the Jatropha know how into the internet. This internet presence will supply up to date information to all members of the “Centre of Excellence” and will facilitate the exchange of information between the “Centres of Excellence” in different countries.
- ?? Organization of a Q & A service;
- ?? Creation of a Jatropha network for mutual support and exchange of know how, including workshops, seminars and visits of different projects with different approaches and in a different socio-economic environment (capacity building);
- ?? Publication of Jatropha information
- ?? To keep the Jatropha network alive, regular workshops on regional level should be held, accompanied by some central seminars (capacity building);
- ?? Supply of tools & blueprints & contacts with experts;
- ?? The “Jatropha Promotion Centre” can also identify research topics and coordinate the work on these topics by different organisations / universities and distribute the results. Such topics could be:
  - Selection of high yield Jatropha plants (seeds, cuttings);
  - Selection of high oil yield Jatropha plants;
  - Selection of a pure line of the non toxic variety from Mexico (edible oil, press cake as animal feed);
- ?? Establishment of a seed bank to provide Jatropha projects / initiatives with high yield and / or non toxic seeds;
- ?? Conception of small scale projects, which can be financed by small donor agencies (modular project system) and executed even by small NGOs.
- ?? Looking for export / import possibilities on international markets;
- ?? Presentation of Jatropha products on agricultural & bio-product exhibitions (national / international);
- ?? Approach of national / international trading companies of natural products.