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Using the Indigenous Knowledge of *Jatropha*

The use of *Jatropha curcas* oil as raw material and fuel

Mali is a landlocked country in the middle of West Africa, just at the southern edge of the Sahara desert. The country's average annual rainfall ranges from 200 mm in the north to 1200 mm in the south. For generations, farmers have protected their gardens with hedges of *Jatropha curcas*, or physic nut, which is not eaten by animals and thus protects the food crops as a living fence.

Jatropha curcas is a plant of Latin American origin which is now widespread throughout arid and semiarid tropical regions of the world. A member of the *Euphorbiaceae* family, it is a drought-resistant perennial, living up to 50 years and growing on marginal soils. A close relative to the castor plant, its oil has the same medical properties. Jatropha seeds contain about 35% of non-edible oil. The production of seeds is about 0.8 kg per meter of hedge per year, with an oil yield of 0,17 l [1]. Currently, Mali has about 10.000 km of Jatropha hedges with a growth rate of 2.000 km per year, which represents a potential of 1.700.000 liters of oil per year. The average length of these hedges, in those areas of Mali where they are most prevalent, is between 2 and 15 km per village, with a maximum of up to 40 km per village [2].

Jatropha curcas is generally well-known among the populations of Mali and has long been recognized as a plant of many uses. If carefully planted, Jatropha hedges not only protect gardens from hungry livestock but also reduce damage and erosion from wind and water. Traditionally the seeds were harvested by women and used for medical treatments and local soap production.

As far back as at the end of the 1930's the oil's potential as a fuel source was also recognized [3]. Currently, it can be used to substitute for the "gazoil" mixture used in the Indian type diesel engines that drive grain mills and water pumps in rural areas of Mali. The high-quality oil extracted by engine-driven expellers or by manual Bielenberg-ram-presses or the sedi-

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ment of the oil purification process may be used for larger-scale soap making in rural areas, giving local women the chance to gain additional income and thus strengthen their economic position. The press-cake as another extraction by-product can be used as a high-grade organic fertilizer.

The Jatropha activities were initiated in Mali in 1987 by German Technical Assistance (GTZ) in the framework of a renewable energy programme. The Jatropha Project itself started 1993 and ended in 1997. It worked to combine the above mentioned and other factors into the « Jatropha System ». This system focuses not simply on the use of Jatropha oil as fuel, but rather on the use of this oil as a crucial element to activate a circular system combining ecologic, economic, and income-generating effects, the latter specifically for women [4].

Thus, the Jatropha system promotes four main aspects of development, which combine to help assure a sustainable way of life for village farmers and the land that supports them:

- Erosion control and soil improvement
- Promotion of women
- Poverty reduction
- Renewable energy

Erosion control and soil improvement

Jatropha "living fences" in Mali not only control unwanted animal access to the fields; they also reduce wind erosion and, if planted parallel to slopes to fix small earth or stone dams, they help control water erosion. The plant's roots grow close to the ground surface, anchoring the soil like miniature dikes or earthen bunds. These dikes effectively slow surface runoff during intensive downpours, which are common, thus causing more water to penetrate into the soil and boosting harvests.

The press cake which remains after oil extraction by the expellers is a very good organic fertilizer, with mineral composition comparable to that of chicken manure. This has great value for agriculture in the Sahelian countries, since soils there are rapidly depleted of humus and chemical fertilizers are very expensive.

The Malian cotton-growing company, CMDT (Compagnie Malienne de Développement Textile), uses Jatropha hedges to assure a program of improved fallow: the cotton fields are protected with Jatropha hedges to keep out cattle, while the fields are sown with legumes to improve soil fertility.

Promotion of women

Many government and non-government organizations provide rural Malian women with engine-driven grainmills to ease their work of food preparation. However, these grainmills need external resources of fuel, lubrication oil, spare parts and maintenance. Consequently, the introduction of such a grainmill tends to lead to an impoverishment of the village because of the cash required both to buy and to transport these external resources to the village. By using locally produced Jatropha oil as fuel and lubrication oil, some of this cash outflow from the village can be stopped.

Traditionally, rural women used Jatropha cureas for medicine (seeds as a laxative, latex to stop bleeding and against infections, leaves against malaria) and for soap production. The traditional soap-making process is very labor-intensive, producing small amounts of relatively poor-quality soap. When Jatropha oil is used, either alone or in combination with other local plant oils such as shea butter, larger amounts of a more refined soap are produced. The women can easily sell this soap in local markets and nearby towns, increasing their possibilities of earning income with local resources.

Some details of the economy of soap production with the means of the Bielenberg hand press are shown in the following table (prices in US$, 500 FCFA = 1 US$):

Description	Quantity	Unity	Price per unity US$	Amount in US$
Inputs				
Seeds (give 3 l of oil with handpress)	12	kg	0,1	1,20
Caustic soda	0,5	kg	1,2	0,60
Labour (4 h for pressing, 1 h soap production)	5	h	0,2	1,00
Depreciation/maintenance (5 years, 10 t/a, 240,-)		US$/kg	0,02	0,24
Total expenses				**3,04**
Revenues				
Presscake	9	kg	0,03	0,27
White soap	28	pieces (170 g)	0,15	4,20
Total revenues				**4,47**
Net Profit				**1,43**
Profit per liter of oil			**0,48**	
Profit per kg of soap			**0,31**	
Price per kg of soap			**0,89**	

Poverty reduction

By promoting the integrated utilization of the Jatropha plant, the Jatropha System can provide direct financial benefits to the rural economy. To illustrate this with a rough calculation, assume the average village of the pilot area has 15 km of Jatropha hedges, which represents 12 tons of seeds.

These 12 tons of seeds may generate 1.800 US$ of cash income when the oil is extracted and the products are sold:

- 9.000 kg of presscake for 0.03 = US$270
- 2.400 liters of oil for 0.60 = US$1.440
- 600 kg of sediment for 0.15 = US$90

Total *US$1.800US$*

If we take the real example of an entrepreneur in a small village near Bamako, who buys the seeds for soap production and hires people for the production process (extraction with Bielenberg ram press, soap production, see table above), the cash income for the village population, including the entrepreneur, amounts to 3.630 US$:

- 12.000 kg of seeds for 0.10 US$1.200
- 5.000 hours of labor for 0.20 US$1.000
- profit of the entrepreneur US$1.430

Total *US$3.630*

If these figures are extrapolated to Jatropha plantations, a profit in the range of cotton farming is within reach.

The "Jatropha System" also helps reduce poverty by:

- Reducing crop losses caused by wandering livestock or wind damage;
- Increasing rainfall infiltration, resulting in less work/irrigation water needed for local gardens;
- Increasing soil fertility by use of presscake as fertilizer;
- Increasing use of inexpensive local resources rather than expensive external resources;
- Reducing disputes between farmers and livestock owners regarding crop damage, as well as among farmers themselves regarding the boundaries of their fields;
- Providing local jobs, lessening the need for local villagers to migrate to cities to find employment.

Because of its economic value the rural people are planting new Jatropha hedges in a large extent. In Kita, one of the pilot regions of the Jatropha project, the average length of hedges went up from 5 km to 15 km in the last 8 years.

Renewable energy

In the rural areas in Mali, Lister-type engines are used to drive grainmills and waterpumps. These inexpensive precombustion chamber diesel engines of Indian origin require only the addition of a fuel filter to be able to run on pure Jatropha oil, thus eliminating the need for gazoil entirely. Furthermore, at maximal load conditions the Jatropha oil.gives even better results than gazoil because of its high oxygen content [5]. Based on tests conducted by the Jatropha Project, the oil can also be successfully used as a lubricant in these engines[6].

In equivalent terms, the energy needed to produce Jatropha oil in mechanical presses amounts to about 10% of the oil obtained. Because Jatropha oil can be produced inexpensively [7], it can also be sold at prices lower than gazoil's official price at the petrol stations. Even more important than the price is the possibility of local energy production, because of the periodic unavailability of gazoil in the rural areas caused by lack of road access during rainy season.

The technology for using natural pure Jatropha oil as substitute for paraffin oil for lamps and cookers is not yet available. Different research centers are working on it.

Conclusions

The results of the Jatropha Project to date show that the chances of this system being successfully implemented are high, provided that a cautious approach is taken. Above all, care must be taken to ensure that women retain their traditional responsibilities for harvesting and processing the seeds.

Furthermore, Mali is a typical Sahelian country; its large geographic expanse and climatic variations mirror the ecological conditions found throughout the Sahel. Because of this, the efforts already being made in Mali to derive value from oil-bearing plants can be taken as representative and used to elaborate a "concept for production and use of plant oils as fuel" that is valid for the Sahel region as a whole, and even for other African countries.

To summarize, the Jatropha system is characterized by the many positive ecological, energetic and economic aspects which are attached with the commercial exploitation of this plant. The more this plant is exploited, the better for the environment and for food production.

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This article was written by Reinhard K. Henning, e-mail: henning@bagani.de, internet: www.bagani.de. For more information on the Jatropha System see also: www.jatropha.org