

A green oil for the world



Robust and requiring very little maintenance: the bushes of the purging nut (jatropha) – up to 8 m in height

Jatropha is a magic word in many parts of the world where the people are suffering because of the rapidly increasing diesel prices. Robust and requiring very little maintenance, this bush even prospers on wasteland. However, there are still some questions to be answered as regards the processing and combustion in engines.

Making successful small entrepreneurs from impoverished small farmers – that is the aim of professor Klaus Becker from German University of Hohenheim. For years the specialist in tropical agriculture has been working on how to »make people's life in the countryside worth living so that they don't migrate to the towns«. The professor is placing a lot of hope in a plant to achieve this aim: The purging nut (*Jatropha curcas*), a bush of up to 8 m in height from the Spurge family, should help satisfy the hunger for energy of developing countries with its fruit which contains oil.

This bush originates from the American continent. Portuguese and Dutch mariners brought the plant to Asia and Africa. It is used around the world in the tropics and subtropics as a hedge in order to protect useful plants and settlements because animals don't eat it. Yet jatropha also seems ideal for recultivating previous agricultural areas that have been abandoned because the soil has dried out or because of drought. For the purging nut is very robust and requires very little maintenance. Because of this it even thrives on wasteland and can even survive long periods of drought. It is not

»The transesterified jatropha oil from India already fulfils the EU standard relating to the quality of biodiesel although it hasn't yet been perfected«, says professor Rudolf Maly (Daimlerchrysler AG).

very susceptible to diseases although it is not hardy to frost. The bush produces seeds as early as the first year. Notable yields can be expected after three to five years and then will continue for around 30 years. The plum-sized fruit consists of a peel and three kernels, which contain approximately 60 % oil – and substances which have a burning, acrid taste, a drastic laxative effect and cause vomiting. Therefore the oil is not edible; it is used traditionally as lamp oil or for cooking and processed to make soap and candles. The residues that remain after cold pressing, the so-called press cake, are used as fertiliser.

India: quality biodiesel from jatropha oil

»80,000 hectare of jatropha grow in Myanmar, previously known as Burma,« Becker reports. »That is more than in the rest of the whole world put together.« Yet more and more countries along the Equator are becoming interested in the purging nut. Professor Pushpito Gosh, director of the Central Salt and Marine Chemicals Research Institute (CSMCRI) in the Indian city of Bhavnagar in Gujarat, for example, examined the characteristics of all domestic, non-edible vegetable oils – and then decided on jatropha. Together with Becker, Gosh is now accompanying the first jatropha project on the subcontinent. It is being supported by the German DEG (German Investment and Development Company). Trial fields were set up in an area of 10 hectare on stony, dry ground all round Chorvadla, a community with a population of 1,500 in the federal state of Gujarat. A further 20 hectare were planted in the significantly moister east Indian state of Orissa. While the small bushes are growing bigger on the former wasteland, Gosh's team has bought 8,000 kg of jatropha kernels that the farmers in various regions of India have gathered from wild plants. For, the scientists aren't just looking for high-yield plants and optimum conditions for cultivation, but also a sim-



Fuel of the future: the oily purging nuts

Photos (7): Energiebau Köln

Pilot project in Tanzania: pressing the jatropha nuts into pure oil for running the gensets of the twelve building complex of the Vincentian Sisters in Mbinga.

Parameters	Diesel	Jatropha oil
Energy content (MJ/kg)	42.6 to 45.0	39.6 to 41.8
Liquid up to (C°)	-14.0	2.0
Flash point (C°)	80	110 to 240
Cetane number	47.8	51.0
Sulphur content (%)	1.0 to 1.2	0.13

Comparison jatropha oil and diesel *source: www.jatropha.de*

ple and economical technology to turn the harvest into quality biodiesel. For this they have installed pilot plants in their institute.

Vegetable oils consist above all of so-called triglycerides, fatty acid glycerol ethers. They are more or less viscous and are inclined to resinify – therefore not exactly the best qualities for its use as a fuel. For this reason, the Indian experts have decided to produce biodiesel from the cold pressed jatropha oil. For this purpose the glycerine is being replaced for the time being by methanol during transesterification. The resulting raw product is then purified. During this process, excess methanol, the glycerine as well as any impurities are separated off.

Fuel specialists from Daimlerchrysler AG tested the jatropha biodiesel and seemed to be surprised: »The fuel is not quite at its best but it already fulfils the EU standard relating to the quality of biodiesel«, says professor Rudolf Maly. »In consideration of the simple production process that is very significant.« Test vehicles from Daimlerchrysler India covered thousands of kilometres with this fuel, without breaking down or any other problems. Advertising for the motorcar group was also included – for the modified C-Class Mercedes was observed by the public with a lot of interest during its tour of India. In future, jatropha plantations on wasteland could help to satisfy the hunger for energy of the seventh-largest country in the world. India is already consuming now more than 50 million tonnes of diesel a year. The country has to import most of its crude oil. In general, the energy supply isn't keeping up with the

The German company, Energiebau Köln, has developed a technology with which the generators can be operated using either diesel or vegetable oil.

boom. In many places, when people use mains electricity, they have to accept that there will be power cuts for several hours a day.

Tanzania: nuns plant 30,000 jatropha bushes

In other Asian countries, including China, and on the African continent the situation isn't any better. »The lack of electricity supply, which is often the case in the rural regions of Africa, is a cause for the inadequate economic development in these countries,« confirms Ulrich L. Schnepfel, spokesman for the German Energiebau Solarsysteme GmbH. The Cologne-based company has already been supplying systems for the decentralised provision of power since 1994 – for example, for hospitals, schools or for supplying water. These specialists have turned to solar energy for the base load. If more electricity is needed a generator is also used. Schnepfel: »We have developed technology with which the generators can be operated using either diesel or vegetable oil.« Similar systems have already been installed in Ghana, Mali and Indonesia. Now German expertise is also being used in the Tanzanian district of Mbinga. Energiebau Solarstromsysteme GmbH, together with Inwent (Capacity Building International) and the German Energy Agency (Dena) completed a reference project there last year: A hybrid solar system, which so far has been the biggest and most extensive system of its kind, is producing electricity for the twelve building complex of the Vincentian Sisters.

»The nuns started cultivating jatropha as early as two years ago in Mbinga,« says Schnepfel. The Vincentians are teaching their pupils how to cultivate this energy crop in their agricultural schools. So far the nuns have planted 30,000 jatropha bushes. The same amount again should follow. Sister Kaya explains their aim: »With a stock of 50,000 jatropha plants we will be completely



Cultivating jatropha bushes can be a way to create successful entrepreneurs from small farmers.

»Because of its chemical composition it is relatively possible to put jatropha oil straight into the engine,« points out Ralf Werkmeister, a qualified engineer from the German Weihenstephan Science Centre. »There is, however, a lack of simple, cost-effective processes to purify the oil. Furthermore, no mass-produced vegetable oil engines are in existence yet.«

independent of diesel fuel all year round and will produce the electricity ourselves for all of the facilities here in our convent in Mbinga.«

That could also be a sensible solution for other locations: »There are 500 million smallholders worldwide,« explains professor Becker. »And a good 30% of the areas managed by them is so degraded that the farmers no longer take the risk of planting seeds in this soil. It's all about providing these people with an income.« According to the scientist, the jatropha kernels are now already a bestseller in India: »When we began we had to pay 2 rupees/kg – that has since become 15 rupees.«

And the yield? »Here we are talking about a wild plant that is 70 million years old and its cultivation has never been managed or selected,« emphasises Becker. The professor warns against the crazy examples calculated with exaggerated yields that are going around the Internet and printed publications. »With our randomised seeds and if the crops receive the necessary nutrients and sufficient water then one can expect about 500 kg oil per hectare wasteland.« The press cake that is left after the oil is extracted contains up to another 60% crude protein. At present there is, however, no practicable process yet which would remove the poisonous substances from the cake so that it could be used as feed, the professor says with regret.

China: jatropha protects against bilharzia

The constituents which make the purging nut unpleasant to eat don't just protect the plant from being eaten by animals. They can also be of significance in a completely different way for the future, explains the professor, as phorbolsters are very efficient in tackling bilharzia. The second-most common tropical disease is caused by

parasites that need water snails as an intermediate host to multiply. Becker has observed: »They are extremely sensitive to this active ingredient – the smallest concentrations of just 0.15 ppm are enough to clear the river courses of snails. In China, farmers cultivate jatropha all around the rice fields on the banks.« Tiny amounts of phorbolsters are released from the roots of the bushes. Even that is sufficient to keep the fields free of snails – and save the people from an excruciating illness.

In Mexico, scientists found a type of jatropha that contains hardly any phorbolsters. »As a wild version it seems to yield more,« believes the professor. If jatropha flour could replace soya as an animal feed then this would mean an additional income of 325 to 370 US\$/hectare for the farmers. The disadvantage: The poison-free crop is no longer protected against being eaten by animals. According to Becker, this causes problems when cultivating: »Who on earth fences in wasteland?!«

If the jatropha system is to work the farmers will have to receive support from the buyer. That's why the German Bioking Deutschland Arndt GmbH, a supplier of systems for producing biodiesel, considers its so called African green cooperative to be so important. The jatropha bushes can be planted in commercial cultivations or also as protective hedges – »living fences«. The company publicises: »You have the land and we supply everything else, including biodiesel system, jatropha seedlings, conventional growth fertiliser and all the necessary cultivation and harvesting accessories.«

Cold pressed oil or biodiesel?

There are different opinions as to whether the jatropha oil or rather the biodiesel produced from it should be put in the fuel tank. »Because of its chemical composition it is relatively possible to put jatropha oil straight into the engine,« says Ralf Werkmeister, a qualified engineer from the Weihenstephan Science Centre at Munich Technical University. According to Werkmeister, there is, however, a lack of simple, cost-effective processes to purify the oil. »And furthermore, no mass-produced vegetable oil engines are in existence yet.« The infrastructure for the modification and continuous maintenance of the vehicles is lacking. »For the time being, cold pressed oil seems to be the simplest way,« says professor Becker. »It's very doubtful whether fuel can actually be produced locally from it with the required purity.« According to the professor, this is because cold pressing oil

is technically extremely demanding if acceptable yields are to be attained. »The technical side of biodiesel production has been clarified,« underlines Becker. »High-value biodiesel can also be produced by small systems.«

»Our simplest system costs altogether € 25,000 including oil press, filters and tanks. That's how 4,000 metric tons (MT) of biodiesel can be produced each year,« says Volker Arndt from Bioking. »That is simple technology and so robust that it is also suitable for use in the Third World.«

»In India the jatropha kernels are already a bestseller. When we began we had to pay 2 rupees/kg – that has since become 15 rupees/kg,« says professor Klaus Becker of the German University of Hohenheim.



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Sorting out the nuts before they are pressed to oil



In the jatropha fields: local labour and added value

»The cultivation of the purging nut only makes sense if two conditions are fulfilled. Using wasteland and manual labour to create jobs,« says professor Becker.

According to Arndt, using cold pressed jatropha oil in stationary machines doesn't present much of a problem: »Generators are operated at a constant number of revolutions. They are much more robust than modern diesel engines,« says Arndt. The problem is that when the engine is cold the vegetable oil doesn't burn completely which causes a lot of sooting. There is a risk of coking and the resulting damage to the engine – particularly if the oil contains impurities. That's why Arndt advocates transesterifying the jatropha oil: »Adapting the fuel seems to us to be the better way. In this way it can be ensured that someone knows what they are doing and does it correctly.« »The production of biodiesel goes hand in hand with a purification process,« confirms Becker. However, alcohol is needed for this which therefore requires a particular infrastructure. »But the result is indeed high-value fuel that can be burnt in normal engines.« And even the glycerine that results from the production of the biodiesel is highly welcome in Africa – for producing soap, says Becker.

Werkmeister is of the opinion that jatropha might not have any relevance for the European market in the coming years. There aren't any large areas joined together for cultivation but a multitude of decentralised projects. »It's a matter of building up the value chain in the particular country and covering the market there,« the scientist emphasises. According to Werkmeister, jatropha mustn't end up like palm oil – that has justifiably gained the bad reputation of being »woodcutter's diesel.« He continues: »That has little to do with »renewable.« The cultivation of the purging nut only makes real sense if two conditions are fulfilled, confirms Becker: »Using wasteland and manual labour to create jobs.«

India, Peru: industry discovers jatropha

Of course it's now not just researchers and volunteer workers in developing countries that are interested in the plant. Industry has also discovered jatropha. The

Germany-based systems manufacturer, Lurgi, and the Indian company, Chemical Construction International, for example, have constructed a biodiesel system with an annual capacity of 10,000 tonnes in India in the federal state of Andra Pradesh for just under € 3 million. The project is a Public Private Partnership together with the German GTZ (German Agency for Technical Cooperation). The system is operated by Southern Online Bio Technology Inc. A bus company from Hyderabad is going to buy the whole amount produced.

According to information from the German Office for Foreign Trade, the British oil concern, BP, and the Japanese car manufacturer, Toyota, also want to cultivate 16,000 hectare of jatropha in the federal state of Andra Pradesh and produce biodiesel from it in their own systems. The Indian Energy and Resources Institute (TERI) is also taking part in the project.

The state-run railway company, Indian Railways, has already been mixing 5 % biodiesel with its fuel for its locomotives since 2002. In the medium term the company would like to increase the proportion of biodiesel to 20 % and wants to cultivate, for this purpose, 30 million hectare of wasteland where jatropha can be grown.

In Lima, the capital of Peru, the GTZ, in conjunction with the German Development Service (DED) and the United Workshops for Vegetable Oil Technology, is currently adapting 200 buses of the company California so that they can be fuelled with jatropha oil. Other bus operators are also showing great interest in the project as diesel is becoming more and more expensive – but not vegetable oil, apparently.

Anke Müller

Further information:

de.wikipedia.org/wiki/Purgiernuss
www.uni-hohenheim.de
www.daimlerchrysler.com
www.jatropha.de
www.bioking-deutschland.com