Jatropha in Haiti: Opportunities and Challenges

[June 2009] - Poverty has been - and still is - one of the biggest problems in Haiti for many generations. Another problem the country has to face is the massive deforestation. These problems are highly related to one another: The majority of the population is poor and uses charcoal as their source of fuel, especially for cooking. Although it is far from the best solution, they do not have the money for electricity or gas, which are much more expensive. On the other hand the deforestation (caused by the massive demand for charcoal) indirectly caused the loss of many lives during storms or heavy rainfall: entire villages succumbed to massive mud streams, leaving many Haitians homeless and hopeless behind. Finding a solution to the deforestation seems to be the best way to fight poverty in Haiti and give its inhabitants new hope for their future.

In October 2008 a group of students from the Netherlands started on a new project in collaboration with a small NGO in Haiti. The objective: Finding a sustainable alternative for the use of charcoal in Haiti. Being new to both Haiti and its difficult problem, the research was divided into several parts. First of all the focus was set on orientation: learning more about Haiti, its culture, geography, history, demography and economy. Following that several alternative sources of energy were researched - some in more detail than others. This publication will start with a quick look at both *oil palm* as well as *biogas* and the focus will then shift to Jatropha and the implementation of Jatropha in Haiti.

Oil palm

The first of three alternative sources of fuel that was investigated was oil palm. It is a strong tree which can grow up to 30 meters in height. Originating from West-Africa it can nowadays be found anywhere near the equator - Indonesia is well-known for the production of palm oil. The palm tree produces oil which can be used as a biofuel but is more often used as edible oil: oil to cook *in* rather than to cook *on*.

Initially the oil palm seemed to be a feasible alternative for charcoal. There are many advantages to it such as extremely high yields and a strong tree which will not succumb at the first sign of rain. However, eventually it became clear that there are even more disadvantages to it: making the seeds sprout is difficult, the ground needs to be extremely fertile and above all: oil palm needs a lot of water. Circa 1500-2000 millimeters of rainfall annually is a minimum - far above the average rainfall in Haiti. Considering the above (and more requirements, such as high humidity) it became clear that oil palm is not a feasible alternative for charcoal for the poor population of Haiti.

Biogas

The second alternative was slightly unconventional in comparison with *oil palm* and *Jatropha*: the concept of biogas is not based on growing a specific plant such as Jatropha and oil palm or yielding oil at all. Although the word 'biogas' is used in many different contexts, the one discussed in this publication is a *biogas installation.* It basically consists of a tank/reservoir in which manure (from animals and/or humans) is collected. Before being added to the reservoir it is manually mixed with water to make the manure fluid. In the reservoir the organic waste is broken down by bacteria. These bacteria convert the organic material combined with CO^2 into methane gas. This gas is transferred through a copper tube to a small stove and can be cooked on just like normal gas.

Although the concept sounds nice there are several disadvantages, especially for biogas in Haiti, to bear in mind. First of all the people are not used to dealing with their manure in the way required for the biogas installation. A second problem would be the use of the installation: who is going to insert the organic waste? Who can and cannot use the biogas? It takes several households to produce enough biogas for daily usage, but who is given access to the connected stove and for how long? The third issue is the lack of expertise in Haiti. Building the installation takes great precision, and a local needs to be trained to maintain the installation when necessary. Taking all this into consideration it is clear that just like oil palm, biogas is not suited as an alternative for charcoal for the poor local population. However, biogas could prove to be of good use in another way: if connected to the sewerage of a company or factory it could be an easy way to produce gas to - for example - power the kitchen of the building or other gas-dependant parts of the building.

Jatropha, an introduction

And here it is, the alternative for charcoal that proved to be most suitable and usable in Haiti: Jatropha. The *Jatropha Curcas* is a plant that grows natively in Haiti and you are likely to have already encountered more than once. It looks a lot like succulents that some people have at home. It can grow up to 5-8 meters in height, has green leaves and is highly toxic. The toxic element of the Jatropha plant is comparable with *ricin* (a protein) which is known to be lethal when consumed, even in relatively small quantities.

The unique selling point of Jatropha are its seeds: they contain up to 40% oil, with an average of 30%. The oil can be yielded and used for several things: the oil can be used to produce soap as well as medicine, but is mostly known for use as fuel. Another significant advantage of Jatropha is its strength: the plant will grow virtually anywhere and can survive for several months without rainfall. Haiti's climate is perfectly fit for growing Jatropha, the fact that the plant already grows natively in the country is a great testimony to that.

When one decides on growing Jatropha, it will prove to be fairly easy when one is familiar with cultivating normal crops. Although the plant can practically survive in the most rocky landscape, this will unconditionally influence the yield. Therefore it is highly recommended to use fertilizers. Luckily, the plant's own organic waste appears to be a very good fertilizer for Jatropha. Aside from that, growing Jatropha is just like growing most other crops: using basic instruments such as a shovel to maintain the plants, harvesting the seeds at the right moment, removing and replacing any dead plants etcetera.

There is yet another great thing about Jatropha: due to its toxic nature a goat (or any animal) will think twice before eating from the plant. Thanks to this a field full of Jatropha will not succumb to the mouth of a hungry goat. When living a normal lifespan, the Jatropha plant survives for approximately 30 to 50 years.

Processing the seeds

After the harvest a farmer is likely to have a lot of Jatropha seeds. The exact yield depends on several things (such as: ground fertility, Jatropha species, etcetera) but one hectare of Jatropha produces approximately 4 to 7 metric tons of seeds a year, resulting in 1 to 2 metric tons of oil every year (4 kilograms of seed produce 1 kilogram of oil). Before one has oil however, the seeds need to be processed. This happens with an *oil press*, available from easy to use hand presses to extremely efficient but extremely expensive mechanical expellers. The *oil press* produces two very useful things: crude (not yet purified) Jatropha oil and *press cake* which basically is a substance that consists of Jatropha seeds without oil. The press cake can be used to multiple extends, such as usage as fuel or as fertilizer.

For this research a Jatropha hand press has been used to simulate the conditions under which the seeds would be processed in Haiti by the local farmers. The results of several oil pressing sessions were as following: one (1) kilogram of Jatropha seeds results in ca. 660 grams of press cake, 330 milliliters of crude oil, 260 milliliters of PPO (Pure Plant Oil) and 245 milliliters of biodiesel. These figures are based on the use of a hand press with an efficiency of 77%.

Using the oil

As mentioned, the oil which is produced is *crude oil* which means it is not clear and still filled with waste. To be of any use the oil needs to be purified through a process of *decantation* which is fairly simple: when one leaves the crude oil in place for several days the waste will sink to the bottom and what remains is relatively clear oil that can easily be separated from the waste on the bottom. At this point, one has created *PPO, Pure Plant Oil*. From here there are several ways to use the oil. It can be used to create medicine or soap, but the focus in the research was put on fuel: creating biodiesel from the PPO.

At this point one may wonder why the PPO cannot be used as normal oil to, like lamp oil for example, light an oil lamp or petroleum burner. There is one clear answer to this: PPO from Jatropha seeds is literally too *thick* to be used like normal oil. There is in fact only one cooker in the world that is able to run on Jatropha oil called the *Protos* burner, but it has a great disadvantage: it is designed for cooking under high pressure and for a short period of time, which is common in for example Asia. In Haiti the people are used to cooking for a longer period of time and the Protos cookers would break down after a short while because they are not fit for long cooking sessions. Therefore the best usage of the PPO is to use it as a fuel, preferably converting it to biodiesel.

Creating biodiesel is a relatively easy process, yet requires some knowledge on how to do it and cannot be done by a local farmer. In short, creating biodiesel is done by combining the Jatropha PPO with methanol or ethanol in specific quantities (a 9:1 ratio for PPO:methanol) at a specific temperature. Although both biodiesel and PPO can be used as fuel, biodiesel has some advantages worth the extra step. The most important advantages will be outlined in the following paragraph.

Biodiesel works in every engine that runs on diesel. That means that with biodiesel, not only all the diesel cars in Haiti can be powered but the many diesel generators, that are located all over the country, as well. To use PPO you first have to convert the engine to be compatible with PPO, which does not only cost money but also requires expertise. Therefore it is somewhat essential to convert Jatropha PPO into biodiesel if you want to make it attractive for people to use and pay for.

Using the press cake

The press cake however has much to offer as well. During the research two forms of usage were considered: using it as a fertilizer or as an alternative for charcoal. Using the press cake as a fertilizer speaks for itself: the press cake looks remotely like human waste but can easily be crushed into smaller parts to be used like fertilizer. It can be used as fertilizer for the Jatropha plants themselves but should also work great with other crops.

However, using the press cake as an alternative for charcoal seemed like a much better idea: it resembles charcoal in size and looks and in theory it should be usable as such. As part of the research this theory was put into practice. After several tests the conclusions were as following:

- Just like charcoal, the press cake does not burn easily. It needs a catalyst, such as wood or perhaps charcoal.
- When the press cake did successfully ignite it remained very hot (180 degrees Celsius) for a long period of time.
- The smell that was released in the process was very strong and certainly did not smell good or healthy in any way.

The last conclusion was a very important one. We are uncertain what caused the smell but as said it did not smell good or healthy and therefore we decided that cooking directly on the press cake was not a good idea. An alternative was developed: carbonizing the press cake.

Carbonization of the press cake is nothing more than making charcoal but this time using press cake rather than wood. The press cake is first ignited and then buried in the sand. Theoretically the toxic element, *ricin,* will be destroyed in the process (proteins cannot survive such high temperatures).

Unfortunately there has not yet been an opportunity to test the carbonization in practice - that is scheduled for a later moment. However, the expectations are as following: when using carbonization (which requires another catalyst such as wood) the total chain of conversions from seed to end product has become so long that the majority of the energy will have been lost. And it is important to keep in mind that it remains unclear if carbonization works at all *until further experiments on this are conducted*. Therefore the current advice is to use press cake as a fertilizer rather than as a fuel.

Jatropha in Haiti

Up until now, the focus of this article has mainly been on Jatropha (and earlier on biogas and oil palm) but not necessarily on the implementation of Haiti. During the research one of the main goals was to find an alternative that can be used by the local population rather than by massive companies. The plan we have developed has a bit of both. In our plan, we have operated under the assumption that the small NGO we have worked with so far will initiate the project, but not have full control over it to ensure the local population's support.

The idea: Jatrophaiti

First of all a pilot needs to be set up. This needs to be done in a region where the NGO is currently active and is familiar with. A small area needs to be set up for the cultivation of Jatropha, at least one hectare. The purpose of this pilot is simple: Finding out the yields of Jatropha seeds (and with that PPO, biodiesel and press cake) under the same conditions that future 'Jatropha farmers' in Haiti will work: the same climate, temperature, Jatropha species

etcetera. These numbers are currently unavailable for Haiti and depending on the outcome of the pilot it can be determined whether a wide scale Jatropha effort is profitable and feasible or not.

Assuming the pilot succeeds, the next step needs to be made: a small company (local NGO!) needs to be founded, from here to be named 'Company X'. Company X will have several functions: coordinating the Jatropha effort, processing the crude Jatropha oil into PPO and then into biodiesel in a small factory and the company has to actively encourage locals to start cultivating Jatropha.

The 'Jatropha cultivation' part of the project will work as following. If a local farmer decides to (or is encouraged to) start cultivating Jatropha, he has to register at Company X. Company X will supply the farmer with Jatropha seeds and an employee of Company X will advise the farmer on cultivating Jatropha. After circa 1.5 years, when the seeds have grown into plants and the farmer prepares for the first harvest, Company X will send an employee to see if the farmer has indeed actually been cultivating Jatropha. If so, he can purchase a hand press (largely subsidized by Company X).

After the harvest, he can use the press cake as a fertilizer. Some of it for his Jatropha plants, and some of it for other crops he grows. This way the press cake gives him the opportunity to cultivate other crops that would normally not survive the barren soil. The crude oil he has produced will not be processed by the local farmer himself. Instead, he will sell it to Company X. At this point the contribution and role of the local farmer ends: he gains both fertile ground as well as hard money which he would normally not earn.

In the ideal situation Company X will have many of these local farmers as 'partners', all cultivating Jatropha. At this point, Company X has invested a lot of money: supplying farmers with seeds, hiring employees to guide and train local farmers for Jatropha cultivation, subsidizing the purchase of a hand oil press and even buying the crude oil from the farmers. However, aside from coordinating the Jatropha effort in Haiti, Company X is also to have a small factory segment which processes the crude oil. The crude oil has to be processed into PPO first, and following that into biodiesel. When this biodiesel is produced, the possibilities are endless: biodiesel works just like normal diesel. Some possibilities:

- Reselling biodiesel to diesel filling stations in the more remote parts of the country
- Reselling biodiesel to companies that want to be 'Green' and use only eco-friendly fuel
- Reselling biodiesel to people who run diesel generators, such as the elite of the country
- Contracting companies or individual people who demand a constant supply of biodiesel

In order for this concept to succeed, however, the biodiesel price needs to be lower than or at least highly competitive with the prices for normal diesel. That is why a pilot is needed: to get an in-depth view on the actual yields. After all, the actual profit from selling biodiesel is determined by the yielding of the Jatropha plants. One thing that needs to be kept in mind: 'Company X' is to become a local NGO. That means that the goal is not to make any profit; just keeping expenses and incomes balanced would be a great achievement.

If it is possible to create the system as described above, it will open up many possibilities. Involved farmers will gain perfect fertilizers for, for example, food crops and earn a financial profit from reselling crude Jatropha oil to Company X. And above all: they will have a job. The same goes for Company X: even if they make no profit, they are still a winner for many jobs will be created and Company X will need employees to coordinate everything, employees to train local farmers on Jatropha and employees to work in the factory where the biodiesel is created.

It is very important that Company X will be a Haitian organization. Initially there will be several investments necessary to get the organization running, but after that it should be Haitians who run Company X with a 'By Haitians, For Haitians' mentality. And in the end it may have proven to be too difficult to find a direct alternative to charcoal, but increasing the wealth, economy and employment rate is another way to contribute to Haiti's development. To quote an old Chinese proverb: *"It is better to take many small steps in the right direction than to make a great leap forward only to stumble backward."*