

Environmental Comparisons of *Croton Megalocarpus* vs. Other Tropical Feedstocks

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Aren't All Biofuels By Definition "Green"?

By no means can all biofuels be considered "green," or environmentally benign. There are three aspects to consider: (1) What was the land use/land cover prior to the planting of the biofuel feedstock; (2) How much fossil fuel is used during the growing of the feedstock, and in the production of the final biofuel; and (3), Linkages to and/or competition with food stocks. An example of each of the above points will prove illustrative.

Biodiesel from palm oil is the worst infraction for point (1), in that oil palm plantations are supplanting what remains of tropical rainforests, particularly in the lowlands, across Indonesia and Malaysia. While the palm oil lobby claims that carbon stored in the palm trees is equivalent to the carbon content of a standing rainforest, not only is this difficult to substantiate but it is also a specious argument, in that it omits any mention of the crucial role vis-à-vis biodiversity in extant rainforests.

For point (2), carbon accounting procedures have to be in place in order to determine net savings, if any, in the production of biofuel. For example, castor can be grown as a biodiesel feedstock, but it's a plant that requires a good deal of irrigation to achieve optimal yields. Is this irrigation from groundwater? If so, is it mining the aquifer (i.e., removing more water than is recharged), and are the pumps running on fossil fuel? Is the harvesting mechanized, and if so, what fuel do the machines use? How much greenhouse gas was released to the atmosphere in the mining of the ore to produce the machines, and in their subsequent manufacture? How much fossil fuel may be burned in order to produce the fertilizers, pesticides, and herbicides required in the growing of the castor crop, and how much in the production and transport of the chemical catalysts needed to convert castor oil to biodiesel?

Ethanol production in the U.S. is a good basis for discussing point (3). Currently, most ethanol in that country derives from a maize feedstock. The demand for ethanol has had consequences on consumer prices, for many processed foods contain corn syrup; meat prices too have risen substantially, since maize is an important component in animal feeds. In developing countries, the fear among development practitioners is that farmers may opt for growing a biofuel feedstock for export versus growing food for their own consumption and for the national grain reserve. True, this last contention may not be universally negative, for household incomes may rise substantially, and in many cases indigenous food production is far less efficient than the mechanized agriculture common in food exporting countries. Nevertheless, it is a factor to be considered in the overall evaluation of feedstock alternatives.

Introduction

Much work has already been done globally on the production of biofuels – and in particular, biodiesel for motive power – using a variety of feedstock as inputs. In Africa and Asia, three of the most popular feedstocks now being discussed are jatropha, castor, and palm oil. Each of these has significant issues that ought to be considered before embarking on any plans to use them widely, but unfortunately project promoters are not very likely to reveal these. The remainder of this document outlines the various factors that mitigate against the use of these three feedstocks; we conclude the argument with a comparison to *Croton megalocarpus*, the indigenous tree and superior feedstock for East African uplands that the Company wishes to plant in northwest Tanzania. Finally, we attach a recent Associated Press news article that



reiterates several of the environmental issues raised herein, then outlines how EU countries are beginning to consider biofuel production in a comprehensive, holistic manner.

Jatropha:

1. This tree is endemic to India, and because it's a source of non-edible oil suitable for use in large, stationary engines (such as generators, pumps, etc.) as well as conversion to biodiesel, many companies are proposing to plant it in various locations across Africa.
2. Because it is non-native, and out of fear that it may spread uncontrolled, Australia has banned it; we have also heard, although it's as-yet unsubstantiated, that so too has South Africa. We can well understand Australia's position, for there have been so many ecological disasters on that continent because of introduced, alien species. This is potentially a significant problem in Africa. The mature tree produces chemicals that dissuade other plants from growing underneath or near it, and its seeds are toxic. If it were to run wild, its effect on ecology might be significant, and eradication efforts very expensive indeed.
3. Jatropha seeds must be picked at optimum ripeness, after the oil content has reached its peak but before the oil oxidizes. If left on its own, Jatropha trees will ripen their seedpods at variable times, meaning that the trees must be inspected daily during the harvest season. Given the planting density (recommended as 1200 trees/hectare), this constitutes a huge amount of work.
4. An Indian company with significant experience growing Jatropha informed us that the way to overcome the staggered ripening of the seedpod is through intensive cultivation during the trees' first three years. This implies a large labor force, irrigation, fertilizers, herbicides, and mycorrhizal injection. We're unconvinced that all proponents of Jatropha in Africa are aware of this – certainly this level of input cannot yet be seen in Tanzania.
5. While it's true that Jatropha has been used as a dune stabilizer in anti-desertification efforts, seed yields under these conditions are very low indeed. To achieve the “advertised” yield, irrigation is generally necessary. In Africa, the question of the water source is highly relevant. Will it be in competition with water currently used for irrigating food crops, or water that would otherwise fill hydroelectric reservoirs? Or from sources critical to wetlands? If from groundwater, will it be mining the resource (i.e., withdrawing more each year than can be replenished)? Is the water carrying salts - that is, will irrigation ultimately cause soil salinization, which will then progress to land degradation and, ultimately, possibly to desertification? And if that's not enough to consider, what will happen under conditions of changing climate when water resources may well diminish, especially in northern Tanzania after the glaciers melt on Mount Kilimanjaro?
6. Jatropha is a tree, and it wants to grow as a tree (to about 8 meters). There are dwarf varieties that have now been developed so as to allow mechanical harvesting, as is common now in India. But then this is the fundamental issue - if mechanized, then where's the need for labor? So the companies will thrive, and indeed foreign exchange earnings will be bolstered through substitution of petroleum products, but there doesn't seem to be much promise for rural development in such schemes.
7. The way that these points stack up negatively induced BioKing, a Dutch biodiesel equipment supplier, to offload its 3,000 hectare Jatropha plantation in Senegal. This is indicative of how seriously these issues should be considered. Jatropha is as yet unproven outside India.

Castor Oil:

1. We have heard that this is the newest concept being strongly promoted in some parts of the world, including Africa. Castor is another plant that grows in dry conditions, and is therefore being touted as a biofuel solution. But as with *Jatropha*, things are not quite so simple. Castor grows best where temperatures are rather high throughout the season, but seed may fail to set if it is above 38°C for an extended period. As with *Jatropha*, sufficient water is necessary: in the United States, 1,500 to 2,000 m³ of water per hectare is applied during the growing season. In Brazil 2,400 m³/ha of water is applied during the 3 months between flowering and harvest alone. High humidity contributes to the development of diseases. Because castor does best on fertile, well-drained soils which are neither alkaline nor saline; sandy and clayey loam being best, it may well conflict with food uses of arable lands.
2. Potential oil yields are from 200-2,750 kg/ha -- more than a tenfold difference, depending on soil conditions, irrigation, and the varietal planted!
3. There are 93 fungi known to attack Castor, including one responsible for root rot, as well as 6 bacteria and 23 nematode species, and *Striga lutea* parasitizes the plants (as it does to maize). Several insects are pests. Damage by capsid and myrid bugs are a limiting factor causing immature fruit to drop. Green stinkbugs, leaf-hoppers, leaf-miners and grasshoppers are pests that feed on the leaves. Most insects may be controlled by insecticides. And because some of the varieties are quite tall, wind storms are a potential hazard to a crop.
4. Castor exhausts the soil quickly. In the United States 45-135 kg/ha of nitrogen is used, and leaves, stalks and seed hulls are disked into the field following harvest. In India 89 kg/ha of nitrogen gives the highest yields. An application of 40-50 kg/ha of P₂O₅ is recommended. In Australia 200 kg/ha of superphosphate is applied.
5. Castor seeds produce one of the most toxic substances known, ricin, 3-20 seeds killing an adult human, 4 rabbits, 5 sheep, 6 cattle and horses, 7 pigs. There is a danger that widespread planting may result in inadvertent human fatalities or loss of livestock.
6. For us, the big puzzle is how castor oil can be used as a biodiesel feedstock. Castor oil is the most viscous vegetable oil. The transesterification process that produces biodiesel from vegetable oil reduces viscosity to about 1/8 that of the original oil, which is exactly why it's done - in general, vegetable oils are too viscous to use in car engines. When biodiesel is made from castor oil, the viscosity of the biodiesel is in the region of the viscosity of vegetable oils from other sources. Thus, if used in a petrodiesel-biodiesel mix, it must be in a fairly small proportion. If used to power electrical generators, then castor biodiesel likely is suitable.

Palm Oil:

1. A major push by Malaysian and Indonesian companies is in persuading buyers that palm oil is an environmentally friendly fuel. This is very deceptive. Attending the World Biofuels Market conference in Brussels at the beginning of March, we heard the arguments from the head of Malaysia's palm oil council, which we'll list and then refute.
2. He claimed that 63% of Malaysia remains forested. I'm not sure what the Malaysian's definition of "forested" entails, but clearly they're hoping that their listeners will automatically assume that this means intact forests.

3. He claimed that land covered by oil palm plantations absorbs as much carbon as does tropical rain forest. Well, yes and no. If you cut tropical rain forest, there will be a significant release of carbon dioxide to the atmosphere, which will then be taken up in the biomass of a growing oil palm plantation. But in reality, both mature oil palm plantations and tropical rainforests are carbon neutral - that is, there's neither net loss nor net gain.
4. Only 3% of palm oil imported to the EU is used as fuel currently. Because, he claimed, palm oil is so environmentally friendly, much more should be imported for fuel. Were this to happen, it would be the death-knell for the remaining rainforests on Borneo, which are already under attack through illegal timber harvests and illegal burning for the expansion of existing palm oil plantations. And the salient point is this: while the carbon balance may be equivalent between rainforest and oil palm plantations, the biodiversity certainly is not. Tropical rainforests - especially lowland rainforests, which are the ones most under threat - are the most biodiverse regions in the world. And oil palm plantations are virtual monocultures (virtual because the oil palm is colonized by various ferns and orchids).
5. The EU is engaged in finding a way to label sources of palm oil as "green" before it will be accepted as a feedstock for fuel, but even this is not really the answer. Some oil palm plantations may indeed be "green," but most are not - and shifting across markets of "green" versus "brown" palm oil will assuredly occur.
6. The correct approach to this issue is to recognize that vast areas in Borneo (some 4 million hectares) have already been cleared for oil palm plantations but have never been planted - this was merely a pretense for companies to acquire the timber. If these now-degraded lands are planted with oil palm, then further rainforest clearing need not take place.
7. Certain African locales outside of West Africa, the endemic home of the oil palm, are suitable for oil palm production. One project currently on-going is taking place on one of Uganda's Ssesse Islands in Lake Victoria. Relatively environmentally benign, this project has had to raze secondary growth forest in order to plant oil palms. On the other hand, areas around Lake Tanganyika in Tanzania are being proposed for oil palm plantations, which would have severe consequences on remaining habitat critical for chimpanzees.

Croton megalocarpus:

1. This tree is indigenous to East Africa, and has been widely grown in its mountainous regions as an ornamental for generations. We believe the center of its endemism is the Aberdare Mountains of Kenya. It is therefore almost inconceivable that an ecological catastrophe could be triggered.
2. The Croton nut is inedible, and therefore cannot directly affect edible oil prices.
3. When mature, the tree has relatively open-architecture, that is, a significant amount of sunlight penetrates the canopy to reach the ground. Other crops can in principal be grown under the trees in a two-tiered agro forestry system. Indeed, we have seen maize, a crop with a requirement for relatively high solar intensities, growing beneath *Croton megalocarpus*. Thus there is no reason to posit competition with food crops.
4. The tree grows and produces well at rainfall accumulations of 800 mm/year without need for irrigation. Because it has deep tap roots, it can access sufficient soil nutrients so that fertilization is not required. Indeed, we believe that the trees will augment the soil, in that root exudates will enrich the soil with minerals and leaf litter with organic carbon.



5. At the end of the trees' productive life, approximately 50 years from planting, they will be felled; the timber is usable for furniture production, and thus continue to temporarily store carbon.
6. One project we encountered in the Eastern Usambura mountains in Tanzania raises butterflies for export, where the caterpillars are fed on *Croton megalocarpus* leaves. We have never seen the tree infested with caterpillars to the point of causing us any concern, but it's interesting to speculate that large-scale planting of the tree may well enhance, rather than detract from, biodiversity. Too, the Company proposes to position the core plantation area immediately adjacent to part of the Biharamulo Forest Reserve, in the hope that we may become an economic buffer against continuing encroachment into this protected area.
7. Unlike the other feedstocks discussed above, *Croton megalocarpus* simply drops its seedpods when they become ripe, over the course of just a few weeks. These can be caught in inverted "umbrellas," or more simply raked together and picked up.

DUTCH CONSIDER TOUGH BIOFUELS CRITERIA

By ARTHUR MAX,  Associated Press Writer Thu Apr 26, 4:09 AM ET

AMSTERDAM, Netherlands - It's the new climate change dilemma: finding alternatives for oil and gas without doing more harm than good.

In the rush to develop biofuels, forests are burned in Asia to clear land for palm oil, and swaths of the Amazon are stripped of diverse vegetation for soya and sugar plantations for ethanol.

On Friday, a Dutch committee will unveil stringent criteria for growing biofuels in ways that don't damage the environment or release more greenhouse gases than they save.

Other European countries are working along similar lines and closely watching the Dutch initiative — the first to reach the level of government consideration.

More than a year in the making, the report reflects a heightened awareness of the risks and complexity in efforts to reduce emissions of the gases blamed for global warming.

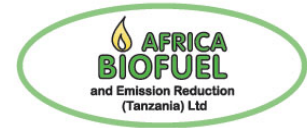
Among the criteria in a draft obtained by The Associated Press: Production of biomass cannot contribute to deforestation, deplete reservoirs of carbon captured in the earth, compete with food crops, degrade soil or water supplies, upset biodiversity, or displace local populations,

The report is by the Cramer Commission, named for its former chairwoman, Jacqueline Cramer, who in February became environment minister.

Without going into specifics, it suggests developing a track-and-trace system to follow a product from plantation to power plant, like an express delivery package.

"It should be implemented on a European scale because it will be difficult for Holland to do it on its own," said Kees Koede, of the Dutch branch of Friends of the Earth, an environmental group.

"Everyone is aware that it's crazy to pour money into a system that is not sustainable," he said.



But the European Commission, executive arm of the 27-nation European Union, is only beginning to look at the problem.

"We are working on a system of green certificates to make sure no unsustainable biofuel makes its way into the European market. But this is very embryonic at the moment," said Ferran Tarradellas Espuny, an EU energy official.

An organization of palm oil planters, processors, financiers and environmentalists in Malaysia and Indonesia has been working for more than two years to devise criteria and verification schemes.

The campaign is driven by evidence that developers in the two Asian countries have burned vast tracks of rain forest to grow palm oil. The fires unleash millions of tons of carbon dioxide and smoke that shroud entire areas of Southeast Asia in eye-watering smog for weeks at a time.

The Netherlands is Europe's biggest importer of palm oil, used in a wide range of supermarket products as well as a fuel oil supplement. One Dutch company has plans to build three 50 megawatt power stations exclusively running on palm oil.

The Cramer Commission envisions imported biomass from sustainable sources by 2020, but calls for a transition period.

"Sustainability in the long term can only be achieved if a start is made with it now," the draft says.

It calls for greenhouse gas emissions to be cut by 70 percent for generating electricity, and 30 percent for transportation fuels.

The draft criteria say new plantations must not be built in protected areas, plantations should leave 10 percent of their area in "its original state" to preserve diversity, and soil and water quality of the soil and water should be improved.

The Europeans have set high targets for cutting carbon emissions. In February, EU leaders approved a plan to trim them by at least 20 percent from 1990 levels by 2020. At least 10 percent of transport fuels will come from biomass, they decided.

With that goal in mind, a huge emphasis will shift toward biofuel production, risking even greater environmental damage.

"You need to be very quick with implementing criteria," said Sander van Bennekom of the Oxfam charity, one of the report's 14 contributors, in an interview. "Maybe we are already too late."