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Production of Renewables in the Tropics and Subtropics, the Example of Two Neglected Plants

In the future energy production from renewable fuels will gain in importance in the tropics and the subtropics too. Therefore, two tropical plants were compared for their possible use in biodiesel production. Both plants are currently being utilized, but are not domesticated. Therefore they offer considerable optimizing potential, in breeding, cultivation and in technological aspects.

Fig. 1: Vigouros Acrocomia-plant with high yield

For different reasons, like growing population and urbanisation, there is a growing demand for energy also in the Tropics and the Subtropics. But particularly in this region we have a diversity of plants that could be used for energy-production. The possibilities range from biomass production to biodiesel production. The production of oil from plants is of great interest, because it delivers an alternative fuel that can be distributed within the existing infrastructure. The energy density is comparable to that of mineral oil.

For this reason two plants, *Acrocomia totai Mart.* and *Jatropha curcas L.* as two tropical oil plants are compared in this article.

Acrocomia totai Mart. (*Fig. 1*) is a plant of the Tropics and Subtropics. It is spread from Florida to the Caribean and Amazonia to the Brasilian Cerrado-Region as well as to Paraguay and the North of Argentina. Unlike *Jatropha* it tolerates little frost and the fruits aren´t toxical. *Acrocomia* is an undomesticated plant. It grows spontaniously where native forests were being stubbed. It could hardly be found in dense woods. It is an indicator for nutrient rich, well-drained sandy soils.

Jatropha curcas L. (*Fig. 2*) is a low-growing tree native to South America but today widely spread to all regions of the humid, semi-humid and semi-arid Tropics. The plant is really pest- and drought resistant. The fruits of most varieties are toxic for animals and humans. Usually it is planted as a hedge, protecting cropland from freely ranging cattle, sheep and goats. The plant can be grown on barren and eroded land. Therefore it doesn´t compete with agricultural area for food production.

Agronomical aspects and harvesting

For example in Paraguay *Acrocomia* is grown on small-scale farms. Traditionally the plants are used for providing shade. There is no harvest technology available. The fruits are picked from the ground after having fallen down and then are delivered to the plant in cajones (dimension of 116.5 l). The plant is not yet grown in plantations, therefore we have no reliable agronomic parameters, but it is supposed to react on minimal input [5]. The rainfall from August to Novembre should not be less than 600 mm.

An analogical situation we have on *Jatropha*. Though the plant is grown for reforestation in some regions, there are also no reliable agronomic parameters available yet. It is also grown on small-scale farms and could be grown in intercropping with shade-loving plants, which can serve for an additional income. The fruits are harvested manually. It has no high requirements needs on soil and it even grows on eroded land under harsh climatic conditions [4].

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Keywords

Renewable energy, tropics/subtropics, biodiesel, wild plants

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Yields

The data for the possible yields range widely for *Acrocomia* as well as for *Jatropha*. For *Acrocomia* they vary from 15-20 kg per plant [5] to 50 kg per plant [3]. Current studies even tell about plants with up to 100 kg yield [2]. But it is not sure if the differences refer to genetical or environmental effects. The fruits contain between 4 and 26% oil, the oil yield is about 10 % of the fruit weight.

For *Jatropha* the seed yield reported varies from 0.5 to 12 t/year/ha, depending on soil, nutrient and and rainfall conditions. On good soils with rainfall from 900 to1200 mm average yields from 5 t/ha can be expected. The seed contains 30 % oil that can be converted to biodiesel by a process called "transesterfication" [4]. The yield of biodiesel after transesterification is about 92 % of the initial weight of the Jatropha oil.

By-products

Both fruits deliver a nutrient rich seed cake. The seed cake from *Acrocomia* delivers a very good animal feed. The shells deliver a high energy combustible which can be used to produce the process energy for example. Although the seed cake of some *Jatropha* varieties can be eaten, the presence of some toxins in the raw seedcake of other varieties render it unsuitable for human consumption or animal feed. But anyway it can be used as a organic manure or a pesticide and also the leftover shell delivers with 19 MJ/kg a high energy raw material [4].

Table 1: Exemplary cost-benefit analysis for a Jatropha plantation in India and a small-scale Acrocomia plantation (2 ha) in Paraguay (utilization time for a tree 30 years[1]).

	Jatropha	***Acrocomia***[2]
Plant density	1200 Pl./ha	400 Pl./ha
Yield/year/plant	1.5 kg	35 kg
Yield/year/ha	1800 kg	14 t
Price for fruits	0.11 US$/kg	30 US$/t
Price/ha	198 US$/Jahr	420 US$/Jahr
Total proceeds	307 US$ [3]	420 US$
Costs		
Establishment	435 US$	626 US$
Allocated on 30 years [4]	34 US$/ha	66 US$/ha
Maintenance	109 US$/ha	52 US$/ha
Total costs/ harvested year	143 US$	118 US$
Total benefit	**164 US$**	**302 US$**

[1]. data base Jatropha [4], Acrocomia [7]
[2] assuming family farm without costs for collecting
[3] total annual yield from year 5 on with additional income from vegetable intercropping 109 USD/a
[4] addition of accrued interest 10%

Fig. 2: Jatropha curcas plantation

Quelle/Source: http://www.euphorbia.de/fiends_rh-htm, von Reinhard Henniges

Future requirements and potentials

For *Jatropha* as well as for *Acrocomia* optimal cropping systems concerning plant density, fertilisation and in some cases irrigation and plant protection need to be developed. There is also a need for selective breeding of adapted genotypes to improve the yields in fruits and oil. In both cases we have enough genetic diversity. If we have adapted and promising genotypes are identified they need to be propagated. Jatropha can be propagated with seedlings, Acrocomia can actually only be propageted via seeds. Particularly the harvest and post-harvest technology have to be improved, because on large-scale plantations harvest costs are an important expense factor.

Conclusions

Both plants, *Jatropha* and *Acrocomia*, have a great potential to provide biodiesel and vegetable oil in the Subtropics. *Acrocomia totai* is well-known in South-America and can therefore play a decisive role there. Especially in areas where some frost can be expected it has a great potential.

Jatropha curcas has got a great potential on eroded land with poor soils. These areas can be afforested and meanwhile income for local communities can be generated. Also the particular by-products can be marketed effectively. All these requirements need the acceptance of local farming communities which can also provide the needed traditional know-how for handling the plants.

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