Jatropha facts

Are jatropha and other biofuels profitable in Africa?

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Policy message

- The profitability of biofuels must be considered relative to the prices of other fuels. Biofuels produced from feedstock only become commercially viable when oil is at least USD 60-70/barrel.
- Productivity is a key factor for determining jatropha's profitability. Reliable data on jatropha productivity, however, is still missing.
- The profitability of jatropha depends on the system of production. Compared with other fuels, jatropha is barely profitable in terms of gross margins and returns to labour. However, biofuel production does become competitive when by-products and externalities are taken into consideration.

Figure 1: A Malian farmer from Koulikoro Region is being interviewed about jatropha profitability. Low price and reduced seed productions are their mayor concerns. (©Soto)

Current fuel prices suggest that jatropha biofuel production is not profitable in most areas, and some farmers are even abandoning jatropha cultivation. The valorisation of jatropha by-products might fundamentally increase jatropha profitability, but even so, jatropha production can create an alternative source of energy in remote areas highly dependent on energy imports. Live-fence hedges seem to be the most profitable option for cultivating jatropha in Africa. Research is still needed on ways to increase crop productivity, reduce labour costs and increase the value of by-products.

High variance in returns on biofuel feedstock crops

There is vast potential for producing biofuels in developing countries, especially in those with a tropical climate. The process could enhance rural development, generate new industries and jobs and reduce dependency on imported energy. Assuming oil prices of USD 90 per barrel or more, economic returns can be high for some potential biofuel feedstock. As Figure 1 shows, the annual return for sugar cane could be more than USD 2,000 per hectare, sweet sorghum could be more than USD 800 per hectare, and cassava more than USD 200 per hectare (Wiggins et al., 2011). These returns are many times higher than those obtained by growing maize and beans, the main food crops.

Returns to labour for biofuels could be similarly high: well over USD 10 a day for sugar cane and sweet sorghum (Wiggins et al., 2011). Cassava and sugar cane are already widely cultivated across the Eastern Africa Region, while sweet sorghum is particularly attractive for its ability to grow in semi-arid areas. Although returns on sugar cane as feedstock are high, they may be even higher for sugar itself. This qualification does not apply, however, to cassava and sweet sorghum, and there seems to be some potential for developing ethanol plants using these feedstocks. The resulting biofuel could then be blended into transport fuels, and replace some of the kerosene currently consumed for cooking and for electricity generation in rural areas.

Returns for biodiesel oil crops would be much less. Oil from Croton megalocarpus, a tree, appears to be the only crop with an annual return topping USD 150 per hectare, while jatropha barely breaks even (Wiggins et al., 2011).

Jatropha Production Costs and Systems

Analysis of the jatropha's economic profitability highlights concerns about the cultivation stage, during which a considerable amount of the total costs are incurred. As Figure 2 shows, a substantial cost reduction can be achieved by optimizing the use of fertilizer and irrigation, and limiting transportation and fossil fuel use during jatropha's cultivation. On large-scale jatropha plantations, considerable care should be taken in choosing optimal levels of agricultural inputs. Improvements are also needed during the processing and use phases, in terms of demand for fossil fuels, chemicals and transportation (Feto et al., 2011).

The Net Present Value (NPV) of jatropha cultivation is at the breakeven point when the price of seed is USD 210 per ton. However, jatropha production is not profitable

Featured case studies

Feedstock availability: The bottleneck in producing biodiesel. A case study in Mali has shown that the harvesting period for jatropha and cereals overlap, which prevents farmers from collecting jatropha seeds (Soto et al., 2013) due to labour costs. Low seed prices were also a major concern among Malian farmers, and caused farmers not to collect seeds or even to abandon jatropha cultivation (Soto et al., 2013). This makes it difficult to estimate the real productivity of jatropha trees and might draw the profitability of the actual production system into question.

Production cost of jatropha biodiesel vis-à-vis fossil diesel. A financial and economic assessment conducted in Ethiopia on the cultivation stage of jatropha showed that optimal use of agricultural inputs, improved yield productivity, and use of fence hedges as a cultivation system helped jatropha biodiesel become competitive with other biofuels and fossil diesel (Feto et al., 2011).

Figure 2: Soap production in a biodiesel factory in Mali. The profitability of jatropha system can be improved by using the by-products. (©Soto)

considering the resources used (at the market prevailing price USD 137-161 per ton). The sensitivity analysis also showed that feasibility results deviate widely from the base case. Since the by-products of jatropha play an important role in the economic feasibility of the biofuel value chains (Figures 2 and 4), their uses should be further diversified and supported with new technologies and research (Feto et al., 2011).

A study of Ethiopian sites showed that of all jatropha production systems, cultivation in live-fence hedges is the most feasible from an economic point of view (Figure 5). Jatropha plantations should be developed on marginal lands and natural vegetation should not be replaced for large-scale plantations. In Ethiopia, the substitution of natural vegetation with large-scale jatropha plantations is the primary cause of higher economic costs (Feto et al., 2011).

Relying on domestic energy production and use versus international markets

The value of biofuels will be higher if they are used locally, either directly as vegetable oil to generate electricity or in a processed form as biodiesel to power engines and motors. Locally, jatropha may be viable in areas with low wages and land costs, and high fuel prices. In landlocked countries and remote areas where imported fuels are particularly expensive, small-scale biofuel production may be very commercially attractive. This is the case in Mali, where the oil bill in 2005 was CFA franc 242 billion which constitutes a substantial portion of the national export earnings that maintain the structural deficit of the trade balance. Local biofuel production and use might reduce the trade balance deficit.

Which type of farmers get involved with jatropha cultivation?

Wealthier farmers with more natural, financial, human and social capital and less dependence on agricultural activities tend to cultivate jatropha, while farmers dealing with labour shortages, poor biophysical conditions, and small land areas tend not to become involved in jatropha cultivation (Soto, PhD ongoing). Farmers who are able to develop better risk avoidance strategies are also more likely to grow jatropha.

Some farmers have abandoned jatropha cultivation. The main reasons they cite for this decision are that the lengthy harvesting period partly coincides with the harvest of the main staple food and cash crops, and that the price of jatropha seeds was very low (Soto et al., 2013). This might indicate that jatropha cultivation is currently not profitable enough and some farmers

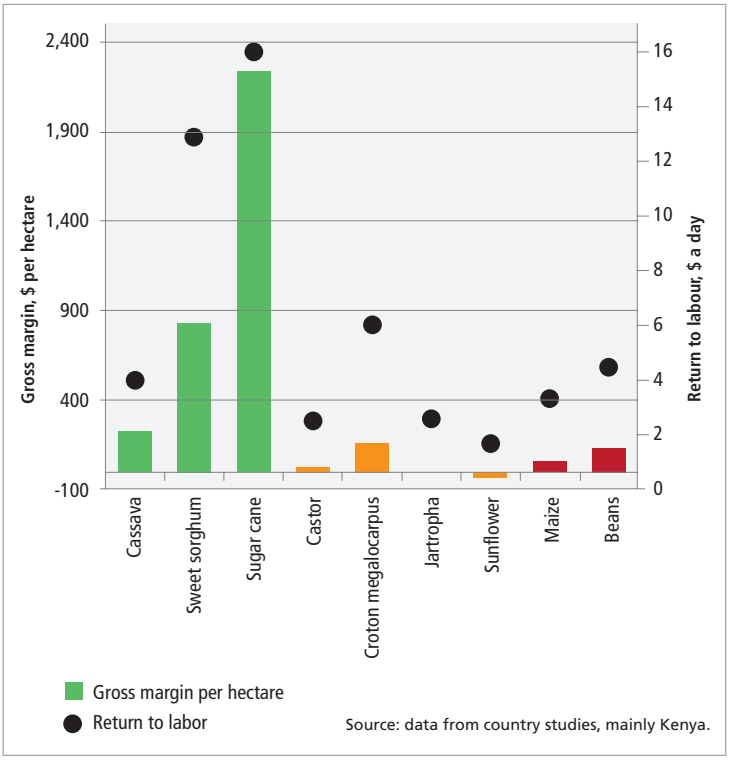

Figure 3: Returns on growing biofuel feedstock in Eastern Africa. Source: Data from country studies, mainly Kenya; reported in Wiggins et al. (2011).

Figure 4: Jatropha press-cake can be used as fertiliser or as fuel in special cooking stoves. The use of by-products is crucial in achieving economic feasibility of jatropha cultivation. (©Soto)

have decided to go back to their traditional crops.

Further research needed

Although there is much public debate about biofuels and despite the hype over jatropha, many uncertainties remain about a variety of issues that are essential to properly determining the profitability of biofuel production. Topics that require additional attention:

- **Agronomic research:** The agronomy of promising biofuel feedstock needs testing, adaptation and dissemination. Although the economics of jatropha look unpromising, work still needs to be done regarding the crop's yield and agronomic potential. Accurate yield estimates together with accurate productivity assessments under different agronomic conditions and research on genetic improvements to increase productivity are essential to build the body of knowledge on jatropha's profitability and may change the plant's economic feasibility.

- **Seed harvesting:** Jatropha seed ripening is an uneven process that can take as long as 4-5 months. This characteristic of the seeds means that harvesting must be done mainly by hand. It is a very labour-intensive process (Figure 6) that has a high impact on the production costs of jatropha oil. There have been many attempts to improve this process by mechanisation, but thus far these have only been applied in pilot projects.

- **Economic assessments:** Economic and market analysis provides a broad understanding of the profitability of biofuels, but more precise and specific information, spanning different locations and situations, is needed. More accurate and compatible profitability assessment tools (i.e. standardized model for comparing different biofuels value chains) could help to increase the understanding of the economics of biofuels.

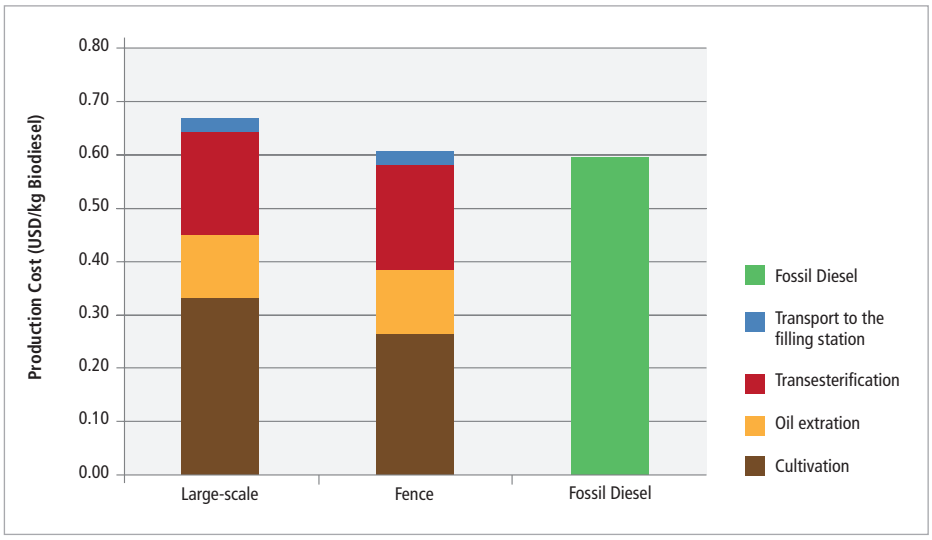

Figure 5: The cost of jatropha biodiesel production on large-scale plantations (USD 0.67/kg) is not economically competitive with fossil diesel (USD 0.61/kg), but production costs for fence plantations make it nearly competitive (cases study from Ethiopia in Feto, et al., 2011).

Definitions

Croton megalocarpus: An oil-bearing fruit tree native to Central Africa. In recent years, the oil has been extracted to produce biofuels.

Externalities: A cost or benefit that can not be valued by using the price as an indicator, and which is incurred by a party that was not involved as a buyer or seller of the goods or services causing the cost or benefit.

Gross margin: The earnings, after taking the respective production costs into consideration. It is a good and basic indication of a product's profitability.

Jatropha value chain: The jatropha value chain consists of various activities starting from raising the plants in a nursery to the distribution of biodiesel to end-users. Broadly speaking, the activities can be classified into four categories: farm production of seeds, seed marketing, biodiesel production, and biodiesel distribution.

Returns to labour: Wages are the return to labour – the return to an individual's involvement (mental or physical) in the creation or realization of goods or services.

Sensitivity Analysis: Assesses risk by identifying the variables that most influence a project's net benefits and quantifying the extent of their influence on the project's BCR (Benefit Cost Ratio), IRR (Internal Rate of Return) and NPV (Net Present Value).

Figure 6: Farmers in Mali manually harvest jatropha seeds. The activity is very time consuming and coincident with the harvesting period of important staple crops.This implies that many farmers only harvest jatropha for a short period of time. (©Soto)

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Jatropha Facts *Jatropha Facts* is a series of five policy briefs providing research insights on important issues of jatropha and bioenergy. Each policy brief addresses a specific, policy-relevant aspect: (1) jatropha growth and oilseed production in Africa; (2) the potential of jatropha for climate change mitigation; (3) the potential of jatropha for rural energy supply in Africa; (4) the economic feasibility of biofuels in Africa; and (5) the food security implications of jatropha and other biofuels.

Policy implications

When do biofuels become profitable?

It has been projected that when oil prices rise above a threshold of around USD 60-70 a barrel, biofuels made from most feedstock become commercially attractive. However, no sustainable projects relying solely on jatropha are known. Low returns have led to the abandonment of most commercial large-scale plantations in East Africa and they also explain the poor harvesting performance of small-scale jatropha farmers on the African continent (Bart et al. 2012)

Gap of knowledge regarding jatropha productivity

Jatropha profitability is very closely linked to seed production. There is still limited understanding of the factors determining yield production, and reliable data on jatropha productivity does not exist yet. Trabuco et al. (2010) estimated global productivity, but there is a need to generate local and consistent yield estimations.

What can be done to make jatropha profitable?

Costs can be substantially reduced by optimizing the application of agricultural inputs at the cultivation stage (Feto et al., 2011). Under current market conditions, jatropha production is not profitable considering the resources used. Therefore, more research is needed on the yield productivity and management of jatropha. Since the by-products of jatropha are important for the economic feasibility of most biofuel developments, their uses should be further diversified and supported with new technologies (Feto et al., 2011). It is still not clear how profitable jatropha is when compared with other renewable energy sources.

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ERA-ARD
Jatropha Facts is a joint output of three research projects implemented in the first phase of the ERA-ARD funding scheme (www.era-ard.org). The projects are: (1) Prospects for sustainable biofuel production in developing countries: a case study of Kenya, East Africa (PROBIOFUEL), *http://www.nas.boku.ac.at/14650.html*; (2) Impacts of tropical land use conversion to Jatropha on rural livelihoods and ecosystem services in India, Mexico, Mali and Burkina Faso (JATROPHABILITY), *http://www.era-ard.org/funded-projects/jatrophability/*; and (3) Bioenergy in Africa and Central America: opportunities and risks of Jatropha and related Crops (BIA), *www.bioenergyinafrica.net*.

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This issue
Editor: Robert Blasiak
Series editor: Albrecht Ehrensperger
Design: Simone Kummer
Printed by: Varicolor AG, Bern

Citation
Soto I., Feto A. and Keane J. (2013): Are jatropha and other biofuels profitable in Africa? Jatropha Facts Series, Issue 4, ERA-ARD.