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Impact of Sustainability Standards on Jatropha Cultivation in Tanzania. An Economic Land Evaluation Approach.

A. Segerstedt[a], J. Bobert[b], A. Faße[a], U. Grote[b], H. Hoffmann[b], H. Kabir[c], S. Sieber[b], G. Uckert[b]

[a] Leibniz Universität Hannover, Germany

[b] Leibniz Centre for Agricultural Research, Germany

[c] Sumagro Ltd, Kilosa, Tanzania

Introduction

The importance of sustainability standards in the biofuels sector has been recognized by the private sector and the public sector alike. For example, the European Union (EU) has introduced environmental criteria tied to its obligatory blending targets. Further certification initiatives include for instance the more far-reaching *International Sustainability and Carbon Certification* (ISCC), which is already operational. For many developing countries like Tanzania, such certification could be a possibility to further encourage the conservation of the local environment. On the other hand, both meeting the criteria and paying the direct certification fees are related to higher costs.

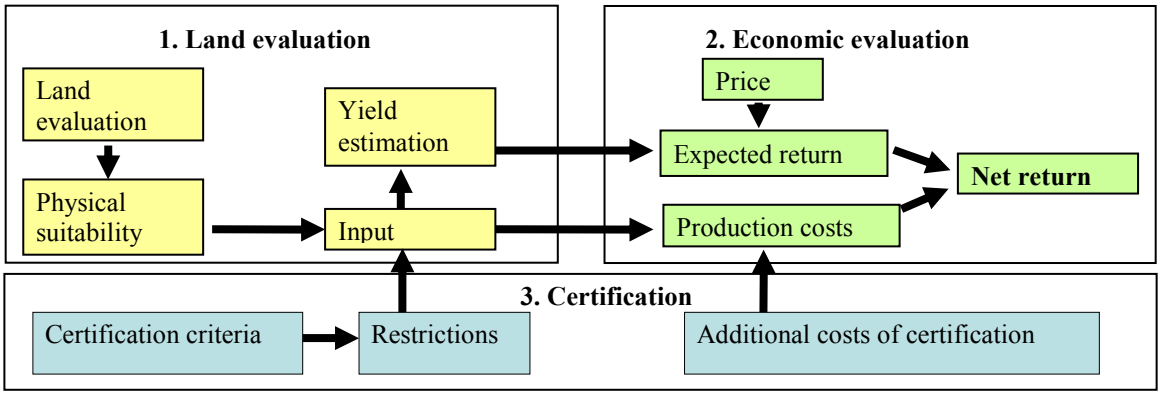
This paper aims at assessing the potential and impact of Tanzanian energy crop production, first with regard to national consumption and second considering exports on the basis of the ISCC standard. We choose to concentrate our research on oil from the perennial shrub *Jatropha curcas L* (in the following "Jatropha"), as it represents the most common feedstock among investors. Especially in the beginning it was promoted as a non-edible feedstock with a relatively low negative impact on the environment. Following this line of argument, the adaptation to comply with sustainability criteria should be relatively straightforward.

2. Method and Data

We conduct our analysis in three steps. First, we estimate the physical suitability of the study site by means of a land evaluation approach. On the basis of this, we derive the necessary inputs to

obtain certain levels of yields. Second, we look at the optimal input-output level with regard to economic costs and benefits. Finally, we introduce certification criteria to see where input restrictions may appear (see Figure 1). In terms of costs and benefits of certification, we therefore have to include both compliance costs related to changes in the production system and direct certification costs. In total, three scenarios are considered; (1) Jatropha oil production for own consumption as complement to other farming activities; (2) Jatropha oil for export to countries without mandatory certification; and (3), Jatropha oil for export to the EU when taking the criteria of the ISCC into account[1]. Data for the farming system were collected from secondary literature and from one plantation in Kilosa, a district in the Morogoro region in the South-East of Tanzania, which took up jatropha production in 2007.

Figure 1 Methodology



3. Results

3.1 Land Suitability and yields

Based on the FAO Framework for Land Evaluation[2] and the Booker Tropical Soil Manual[3], we find that the present luvisols and fluvisols show an overall good potential for the production of Jatropha. As can be seen in Table 1, all indicators range between highly Suitable (S1) and moderately suitable (S2). Looking at the water balance, the efficient rainfall is sufficient to cover the evapotranspiration except for Mid-June to Mid-October, where irrigation is applied once a week using buckets.

Table 1 Land suitability classification for a luvisol at the study site following the FAO framework with S1=highly suitable, S2=moderately suitable, S3=marginally suitable, N1=currently not suitable, and N2=permanently not suitable.

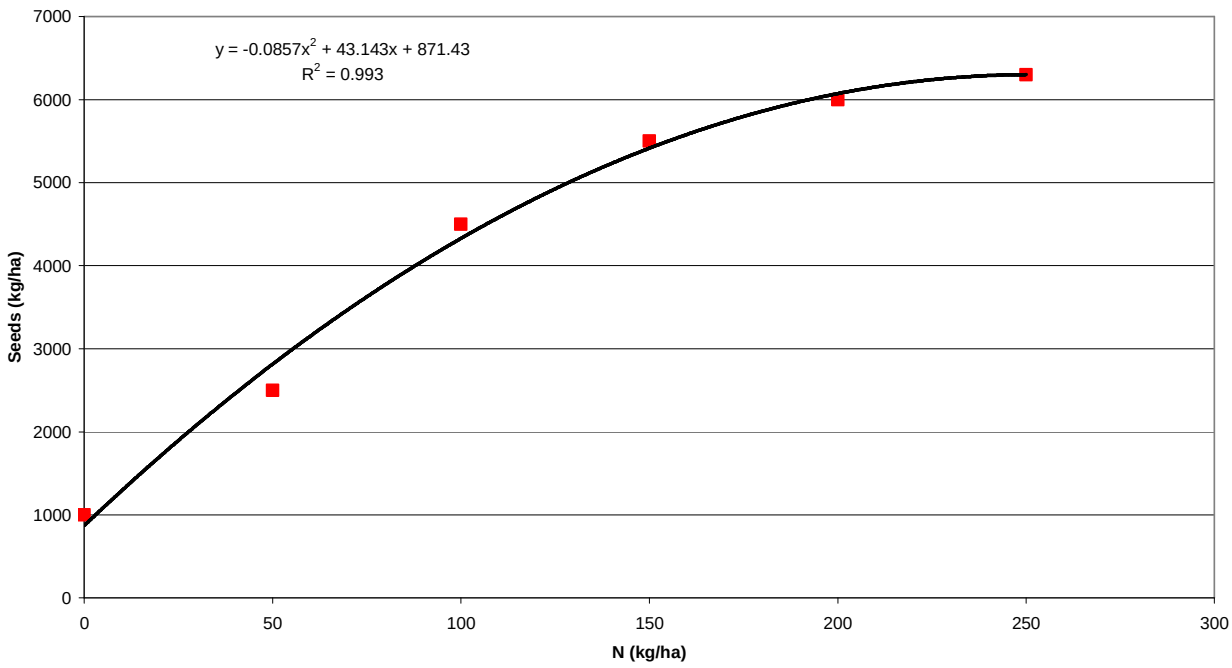
	Land suitability
Soil texture	S2
pH	S1
Soil organic matter	S1
Available soil phosphate	S2

[1] For more information on the ISCC sustainability criteria, see http://www.iscc-system.org/index_eng.html.
[2] FAO. 1976. S*oil resources development and conservation service land and water development division.* Rome.
[3] Landon, J.R., 1991. *Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics*, Harlow, Essex, England et al.: Longman Scientific & Technical.

Cation exchange capacity	S1
Base saturation	S1
Slope	S1
Temperature	S1
Rain	S2
Length of growth period	S2
Overall rating	**S1/S2**

Future yields are estimated based on the performance in the first three years and the expected impact of macro nutrients. As there is only very limited data available on African cultivation, the response function depicted in Figure 2 is based on studies carried out in India[4]. Even so, compared with observations from other parts of the world 6,300 kg seeds per hectare (2.52 kg per plant) seem to be a realistic approximation of the yield potential. At current fertilizer applications (ca 95 kg N/ha), yields of approximately 4,050 kg per hectare or 1.62 kg per plant are possible.

Figure 2 Deduced N response function of Jatropha.



3.2 Costs and Benefits

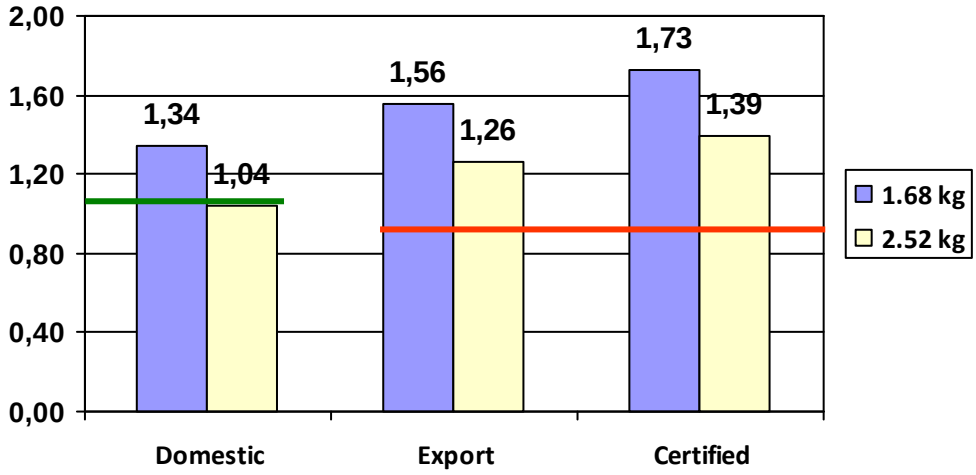
Considering the net present values, Jatropha oil for local consumption would be viable from approximately 140 hectares and upwards in the high-yield scenario (2.52 kg seeds per plant). For lower yields, the cultivated area has to be substantially larger (200 hectares for 2 kg and up to 1000 hectares for 1.62 kg seeds/plant). Oil production with trees yielding only 1 kg seeds or lower

[4] Compare Wani, S., Sreedevi, T., S Marimuthu, Rao, A. K., & Vineela, C. (2009). Harnessing the Potential of Jatropha and Pongamia Plantations for Improving Livelihoods and Rehabilitating Degraded Lands. En Conference Proceedings. Presented at the 6th International Biofuels Conference, New Delhi, India; Ghosh, A., J. S. Patolia, D. R. Chaudhary, Jitendra Chikara, S. N. Rao, Dheerendra Kumar, Boricha, G. N., et al. (2007). Response of Jatropha curcas under different spacing to Jatropha de-oiled cake. FACT Foundation; Kalannavar, V. N., Angadi, S., Patil, V., Angadi, S., & Byadagi, A. (2009, Diciembre). Effect of major nutrients on yield and quality of Jatropha curcas. *International Journal of Agricultural Sciences*, *5*(2), 390-393.

never become feasible. Wages and the manager salary represent the largest cost factors (39 and 23% respectively). However, also fertilizers have a large share in total costs (ca 22%), even when incorporating the seedcake as fertilizer. Clearly, even though stated a low-input crop, the yields required to make large-scale Jatropha cultivation feasible depend to a large extent on the price and availability of agro-chemicals.

Looking at export and certification, the export costs (including taxes and transport to the harbor in Dar es Salaam) would add up to $0.16 per liter (11-16% of total costs). Among the certification criteria, the adaptation to social criteria would implicate the highest cost increase of 5.33% of total costs. Included are e.g. wage increases to meet the official minimum wage, health insurance packages for the workers with families and first aid kits. Other criteria refer to the pesticide and fertilizer management (2.68 and 0.60% respectively). Given the high potential of the soil, there is little need to change the input quantities as long as the detracted nutrients are replenished and the organic matter content is maintained. Direct costs of certification would raise costs by 1.04%. In total, certifying the Jatropha oil would involve life-time costs in the range of $1,832 per hectare or a 10.33% cost increase considering 2.52 kg seeds per plant. As can be seen in Figure 3, except for the high-yield alternative for domestic consumption, the production costs of Jatropha oil per liter are well above the national and international break-even prices[5]. Consequently, it is hard to see that Tanzanian large-scale production of Jatropha oil could become competitive with other vegetable oils on the global market, at least when considering the current big importers. Hence, although certification costs per se may not be excessive, Jatropha oil for other causes than own consumption will probably not become an interesting option in the short-term.

Figure 3 Net present costs of Jatropha oil (per liter) for domestic consumption, export and certification on 150 hectares. The green and red lines represent the break-even prices for the domestic and foreign market respectively.



[5] The domestic break-even price is reflected in the diesel price of Tsh 1616 or US$ 1.06 at the site. For export, the break-even price is based on the average rapeseed oil price, which corresponded to USD 0.9 per liter in the Tanzanian harbor.