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Review

Jatropha bio-diesel production and use

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ABSTRACT

The interest in using *Jatropha curcas* L. (JCL) as a feedstock for the production of bio-diesel is rapidly growing. The properties of the crop and its oil have persuaded investors, policy makers and clean development mechanism (CDM) project developers to consider JCL as a substitute for fossil fuels to reduce greenhouse gas emissions. However, JCL is still a wild plant of which basic agronomic properties are not thoroughly understood and the environmental effects have not been investigated yet. Gray literature reports are very optimistic on simultaneous wasteland reclamation capability and oil yields, further fueling the *Jatropha* bio-diesel hype. In this paper, we give an overview of the currently available information on the different process steps of the production process of bio-diesel from JCL, being cultivation and production of seeds, extraction of the oil, conversion to and the use of the bio-diesel and the by-products. Based on this collection of data and information the best available practice, the shortcomings and the potential environmental risks and benefits are discussed for each production step. The review concludes with a call for general precaution and for science to be applied.

Contents

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1. Introduction

In a context of growing interest for renewable energy sources, liquid bioenergy production from vegetable oils is proposed as one of the possible options to reduce greenhouse gas (GHG) emissions. Against this background bio-diesel production from *Jatropha curcas* L. (JCL) has become a booming business. The oil produced by this crop can be easily converted to liquid bio-fuel, which meets the American and European standards [1,2]. Additionally, the press cake can be used as a fertilizer and the organic waste products can be digested to produce biogas (CH_4) [3–7]. The plant itself is believed to prevent and control soil erosion or can be used as a living fence or to reclaim wasteland [8–12]. JCL is still a wild plant, which can grow without irrigation in a broad spectrum of rainfall regimes, from 250 up to 3000 mm per annum [13]. Furthermore, JCL is reported to have few pests and diseases [5,10], but this may change when it is grown in commercial plantations with regular irrigation and fertilization [14]. Based on these interesting properties, potentials and hyped claims, a lot of investors, policy makers and clean development mechanism project developers are interested in JCL to tackle the challenges of energy supply and GHG emission reduction [12,15].

The essential minimum requirements for bio-fuels to be a more sustainable alternative for fossil fuels is that they should be produced from renewable raw material and that their use has a lower negative environmental impact [16]. Closer investigation is needed in order to conclude if both minimum requirements are fulfilled. Different sustainability evaluation tools and environmental impact assessment tools are available to investigate if an agricultural production process meets these requirements [17]. Life-cycle assessment (LCA) is such an instrument and has already shown its utility to evaluate the environmental balance of bio-fuel from other vegetable oils [18–21]. Using LCA or any other sustainability evaluation tool will need input data as a start to perform the evaluation or the assessment.

In this paper, we present a state-of-the-art literature review of the whole JCL bio-diesel production process and use. For each production step the available published information on inputs and outputs is compiled. This collection of data and information enables us to discuss (i) the actual best practice(s) for production of JCL bio-diesel, (ii) the most persistent shortcomings, and hints of remedies and (iii) the most prominent potential environmental issues, using a limited LCA approach (energy balance, GHG balance, land use impact). Information was compiled not only from peer-reviewed literature but also from reports and conference proceedings. Doing so we could cover a wider range of information, which allowed us to obtain quantitative data presented as ranges, averages and standard deviations.

2. Botanical description of *Jatropha curcas* L.

JCL or physic nut is a small tree or large shrub, up to 5–7 m tall, belonging to the Euphorbiaceae family, with a soft wood and a life expectancy of up to 50 years. The plant has its native distributional range in Mexico, Central America, Brazil, Bolivia, Peru, Argentina and Paraguay [22], although nowadays it has a pantropical distribution [12] with distinct JCL