Study of the Eco-efficiency of Biodiesel Production from the Fruit of the Jatropha Curcas Plant

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In the present study, the Life Cycle Analysis methodology is applied to the production of Biodiesel from Jatropha Curcas, with the objective to identify the stages of the life cycle that affect to a larger extent the environment. This was done by defining the function of the system, the limits of the system, the allocation procedure, the method of environmental impact assessment with its respective categories of impact, and finally, the data quality requirements. During the elaboration of the inventory, each of the basic activities for the Jatropha Curcas cultivation was taken into account. From the conditioning of the ground, followed by the pre-nursery-nursery, field management, and transportation of agricultural inputs. Also, the stages of harvest from the fruit of Jatropha Curcas were included for obtaining the oil and its subsequent transesterification. All this information was acquired in the field, in technical reports, articles and elaboration of simulation for the industrial stages. For the environmental impact assessment of the life cycle, the EPD (Environmental Product Declaration) methodology was used. This methodology is commonly used for the creation of the environmental product declarations. In the economic evaluation of the process, the classic project evaluation methodology was used. This starts with the calculation of fixed capital and working capital investment, salvage values, costs and revenue and after-tax gain. The cash flow net diagram is then constructed with which the decision-making indicators are obtained: NPV (net present value, typically in the year of production start-up), IRR (internal return rate), PT (payback time), and different sensitivity indexes or equilibrium values. With regard to investments and salvage value, it is about values at a certain point in time. Finally, the eco-efficiency of Jatropha Curcas biodiesel was evaluated by relating environmental performance and process profitability. It was found that the production of biodiesel from Jatropha Curcas is not a process with high potential environmental impacts, compared to other commodities. From the economic point of view, it is not viable given the high cost of the seed and the market price of oil.

1. Introduction

The progress of human society has been based on natural systems, which have been a source of resources and waste sinks, but as people were growing and industrializing, the exploitation of ecosystems became intensive, generating important environmental problems. These problems have been reflected in the decrease of the ozone layer, species extinction, the decrease in water sources and the Earth’s temperature rise. The highest percentages of participation in this problem, correspond to the use of fossil fuels in industrial activities and transportation (PNUMA, 2012). The general concern about the non-renewable nature of fossil fuels and the air pollution that their use entails has become the force that is driving so that the world to research in alternative sources of fuel, especially of agricultural origin. In Colombia, the consumption of the petroleum-derived fuels is the most used energy source, distributed its use in the transportation sector (90.8%), residential use (8.7%) and industrial use (0.5%). According to this information, it can be thought that the immediate need in terms of renewable energy production should be directed to mobile sources, which are the most polluting in relation to the production of greenhouse gases such as CO2 (Amaya & Becerra, 2009). Obtaining biofuels has been linked to the search for raw materials that optimize the energy efficiency of production processes. In the world, the biodiesel production experienced a growth of 525% between 2000 and