Greenhouse Gas Emissions and Energy Balances of Jatropha Biodiesel as an Alternative Fuel in Tanzania

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Abstract

This paper evaluates GHG emissions and energy balances (i.e. net energy value (NEV), net renewable energy value (NREV) and net energy ratio (NER)) of jatropha biodiesel as an alternative fuel in Tanzania by using life cycle assessment (LCA) approach. The functional unit (FU) was defined as 1 tonne (t) of combusted jatropha biodiesel. The findings of the study prove wrong the notion that biofuels are carbon neutral, thus can mitigate climate change. A net GHG equivalent emission of about 848 kg t^{-1} was observed. The processes which account significantly to GHG emissions are the end use of biodiesel (about 82%) followed by farming of jatropha for about 13%. Sensitivity analysis indicates that replacing diesel with biodiesel in irrigation of jatropha farms decreases the net GHG emissions by 7.7% while avoiding irrigation may reduce net GHG emissions by 12%. About 22.0 GJ of energy is consumed to produce 1 t of biodiesel. Biodiesel conversion found to be a major energy consuming process (about 64.7%) followed by jatropha farming for about 30.4% of total energy. The NEV is 19.2 GJ t^{-1}, indicating significant energy gain of jatropha biodiesel. The NREV is 23.1 GJ t^{-1} while NER is 2.3; the two values indicate that large amount of fossil energy is used to produce biodiesel. The results of the study are meant to inform stakeholders and policy makers in the bioenergy sector.

Keywords

Jatropha biodiesel;
Greenhouse gas emissions;
Energy balances;
Life cycle assessment;
Tanzania