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Modeling and Analysis

Economic, environmental, and social impacts of different sugarcane production systems

Terezinha F. Cardoso, Marcos D.B. Watanabe, Alexandre Souza, Mateus F. Chagas, Otávio Cavalett, Edvaldo R. Morais, Luiz A.H. Nogueira, M. Regis L.V. Leal, Oscar A. Braunbeck, Luis A.B. Cortez, Antonio Bonomi

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Abstract

Mechanization in the sugarcane agriculture has increased over the last few years, especially in harvesting and planting operations, in the Brazilian Center-South region. The consequences of such a technological shift, however, are not fully comprehended when multiple perspectives are considered such as economic aspects, environmental regulations, and social context. The main goal of this study is to generate comprehensive information to subsidize decision-making processes not only in Brazil but also in other countries where sugarcane production is still under development. Manual and mechanical technologies for planting and harvesting were evaluated (with and without pre-harvest burning), as well as straw recovery, seeking to identify their advantages and disadvantages, considering economic, environmental, and social aspects. Considering vertically integrated production systems (agricultural and industrial phases), sugarcane production scenarios were compared under the metrics from engineering economics, life cycle assessment (LCA), and social LCA. Manual technologies were related to the highest job creation levels; however, lower internal rates of return and higher ethanol production costs were also observed. In general, mechanized scenarios were associated with lower ethanol production costs and higher internal rates of return due to lower biomass production cost, higher ethanol yield, and higher electricity surplus. Considering the restrictions for sugarcane burning and practical difficulties of manual harvesting of green cane, environmental analysis showed that mechanical harvesting of green cane with straw recovery presents, in general, the best

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