ENVIRONMENTAL EFFECTS AND ENERGY BALANCE OF SHORT ROTATION CROPS FOR BIO-ENERGY PRODUCTION: A REVIEW

Ouafik El Kasmioui, Sylvestre Njakou Djomo and Reinhart Ceulemans

University of Antwerp, Department of Biology, Research Group of Plant and Vegetation Ecology, Universiteitsplein 1, B-2610 Wilrijk, Belgium

Abstract

Short rotation woody crops (SRWCs) are a potential future source of renewable energy. They can be converted into electricity and/or heat using conventional or modern biomass technologies. In recent years many studies have examined the energy balance and environmental impacts of short rotation bio-energy production systems using various approaches. The outcomes of these studies have, however, generated controversy among scientists, policy makers, and the society. This paper reviews 26 studies on the environmental effects and energy balance of poplar and willow SRWC for bio-energy production published between 1990 and 2009. The data published in the reviewed literature gave energy ratios (ER) between 13 and 55 for the cradle-to-farm gate and between 3 and 11 for cradle-to-plant assessments, while the intensity of greenhouse gas (GHG) emissions ranged from 0.55 to 10.6 g CO_{2eq} MJ^{-1} and 39 to 132 g CO_{2eq} kWh^{-1}. These values vary substantially among the reviewed studies depending on the system boundaries and the methodological assumptions. Among the reasons for the conflicting numerical results in the literature are different system boundaries and lack of transparency, which hampers meaningful comparisons among studies. Although specific numerical results differ, our review revealed a general consensus on two points: the ER is greater than unity and GHG emissions are lower than those of fossil fuels. These conclusions were independent of biomass yield, or the definition of the system boundaries. ER and GHG emissions are the most studied impacts, while acidification and eutrophication impacts are common to only seven of the reviewed studies. Land and water use, biodiversity, and human and eco-toxicity are seldom included. The review suggests the need for a unified and rigorous system boundary, the adoption of particular assumptions that are more representative for bio-energy systems and for the development of a widely accepted framework toward a reliable analysis of energy in bio-energy production systems.

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