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Environmental and Economic Assessment of Bioethanol Production from *Musa* spp. Waste

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Abstract

Waste generated within the production cycles of starch and sugar crops has a promising potential to be processed into bioethanol by means of enzymatic fermentation. This is especially due for *Musa* spp. production systems, in which large amounts of fruits with no sufficient quality for the market accumulate. The present study aims to conduct an environmental and economic assessment of the potential to process *Musa* spp. waste into bioethanol within the region of a coffee cooperative in the province of San José, Costa Rica. The study area comprises 1500 ha small-scale coffee plantations at altitudes between 1500 - 1900 m asl providing livelihood to ca. 780 families. Within the coffee fields *Musa* spp. are grown mainly to provide shade to coffee trees, and therefore are not harvested for either human or animal consumption. Due to the stringent seasonal production cycle of coffee, alternatives for income generation during the off-season are urgently needed and demanded by the community, and bioethanol production has been identified as a suitable alternative. The cooperative already operates a pilot bioethanol processing plant for coffee pulp, which accumulates at a rate of 3 Mio. t year⁻¹ and needs to be disposed properly. Although coffee pulp provides an excellent biomass source, it is also highly seasonal, and biomass from *Musa* spp. fruits could become an important source of biomass to sustain bioethanol production all year around. It is intended that the obtained biofuel will be distributed to the cooperative members for use in their vehicles.

By means of farmer interviews data is being collected on management practices, the availability of *Musa* biomass, and fuel demands of the farm households. Experiments with the processing plant are conducted in order to calculate its processing capacity. With this data we want to (1) estimate social as well as economic costs and benefits for the farmers, (2) evaluate the banana-coffee production system, and (3) calculate the ecological footprint of the entire bioethanol production chain.

Keywords: Bioethanol, Costa Rica, ecological footprint, life cycle analysis, *Musa* spp.