Life Cycle Assessment on Climate Change Impacts from Sugarcane Cultivation in Sri Lanka and their Mitigation Potentials through Effective Utilization of Crop Residues

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Abstract

Sugarcane is the feedstock for raw sugar manufacturing in Sri Lanka where the existing cultivation occupies 30,000 hectares that is around 35% of the arable land area for sugarcane. Future improvements in the local cane sugar industry require expansion of cultivation in the full capacity. The conventional rain-fed sugarcane cultivation method in Sri Lanka utilizes diesel-operated tractors/equipment and manual agricultural operations in land preparation, crop establishment, crop maintenance and harvesting activities with open burning of crop residues. Since these agricultural operations contribute many airborne emissions (CO_2, SO_2, NO_x, CH_4, NH_3, N_2O, particulates, etc.), a quantitative assessment of life cycle climate change impacts is required for future policy decision making towards sustainable expansion of sugarcane cultivation. A published life cycle impact assessment on cradle-to-gate life cycle of sugarcane cultivation in Sri Lanka has not been reported. Hence, the novelty of this study is the evaluation of four major climate change impacts (global warming potential, terrestrial acidification, photochemical oxidant formation, and particulate matter formation) and associated airborne emissions. Inventory data on materials/resources utilization and energy consumption are collected from a data survey through interviewing sugarcane farmers and industry statistics, which are applied to estimate emissions from individual operations: agrochemical manufacturing/transportation/application, agricultural machinery operations, seed cane transportation, crop residues burning, etc. The corresponding climate change impacts were quantified using the ReCiPe midpoint (H) V1.12 impact assessment method in SimaPro Life Cycle Assessment (LCA) software. The results indicate the contributions from agricultural operations in the conventional cultivation practice for all climate change impacts. Global warming potential impact result is 3,120 CO_2 eq where the major contributors are chemical fertilizers application (45%) and open burning of crop residues (40%). More than 50% of terrestrial acidification and particulate matter formation impact results are also represented by chemical fertilizers application while open burning of crop residues is responsible for almost 95% of the photochemical oxidant formation impact result. Therefore, the study compares impact results with a scenario for effective crop residues utilization (zero crop residues burning with 50% utilized as organic manure in the same cultivation field) and the respective climate change impact mitigation potentials are quantified.

Keywords: Airborne emissions, Climate change impacts, Crop residues burning, Sugarcane cultivation

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