

Study on environmental impacts of production and application of organic fertilizers for the Vietnam Mekong Delta agriculture

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(ベトナムのメコンデルタ地域の農業における有機肥料生産および施肥がおよぼす環境影響に関する研究)

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Thesis Summary

The Sustainable Development Goals (SDGs) define a universal, holistic set of objectives to help countries move towards the three dimensions of economic, social, and environmental sustainability. Climate change is related to SDG13 (Climate action) deals with climate changes, including global warming resulting from greenhouse gas (GHG) emissions. Agriculture is vulnerable to climate change, and a significant source of GHG driving those changes is considered to contribute to 30-40% of anthropogenic GHG emissions and continue to contribute significant amounts of emissions in the next ten years. On the other hand, agriculture plays a vital role in CO₂ sequestration by vegetation and the soil environment. In this study, the LCA method, a tool for an environmental impact assessment that helps improve one current phase to better another, was applied for estimating the GHG emissions and energy requirements from Vietnam Mekong Delta agriculture with several different practices and many crop types. Besides that, the LCA methodology was also applied to qualify the GHG emissions and energy requirements from cow manure and rice production residues mixture composting. Generally, this study can be presented in detail as follows:

The literature review in Chapter I showed the two side effects of agriculture to mitigate and harm climate change by GHG emissions and carbon sequestration. The improved practices in irrigation, nitrification inhibitors, and biochar could reduce the specific CO₂, CH₄, or N₂O emissions. The LCA methodology was applied to compare the GHG emissions from conventional and organic cultivation showing the potential to mitigate the total GHG emission.

Chapter II focused on evaluating GHG emissions from seedless lime cultivation using the LCA methodology with the emission factors collected from MiLCA software, the IPCC guidelines, and previous studies. The results showed that in the long term, organic fertilizers could reduce GHG emissions from SL cultivation by replacing 25% and 50% of N-CF. These replacements mitigated 11.7–22.5% GHG emissions per hectare of growing area and 12.2–25.6% per tonnage of commercial fruit.

Chapter III was conducted to calculate the energy and carbon balance and environmental pay to gain the benefits from conventional and organic coconut cultivation. Organic coconut cultivation required less carbon and energy than conventional cultivation; however, organic practice produced higher net energy and carbon. Getting nutrients from organic coconut cultivation had to pay much

more environmental impact ($17.8\text{--}7.8 \times 10^3 \text{ kcal MJ}^{-1}$ and $1.37\text{--}1.29 \times 10^3 \text{ kcal kg-CO}_2^{-1}$). However, the calculation of protein-based organic cultivation benefits more than conventional ($0.10\text{--}0.23 \text{ kg-protein MJ}^{-1}$ and $99.7\text{--}105.7 \text{ kg-protein kg-CO}_2^{-1}$).

In Chapter IV, the GHG emissions and energy provided for composting agricultural residues to produce organic fertilizer and its application for morning glory were conducted. One tonnage of composted organic fertilizer production needed $23.2\text{--}72.8 \text{ MJ}$ from fossil fuel and emitted $24.7\text{--}58.5 \text{ kg-CO}_2\text{e}$. Org-MG cultivation and commercial product achieved all better values than conventional in the comparisons in energy analysis such as energy productivity, specific energy, net energy, and energy use efficiency. GHG emission from organic morning glory cultivation was lower than conventional ones (135.59 and $142.61 \text{ g-CO}_2\text{e m}^{-2}$); however, in calculation of commercial product weight, specific emission of Org-MG was higher than conventional morning glory (109.35 and $101.86 \text{ g-CO}_2\text{e kg-edible}^{-1}$).

In Chapter V, this study confirmed that applying the LCA methodology for agricultural cultivation is excellent potential for Vietnam and other countries to identify the role of nation agriculture cultivation, contributing to mitigating or causing climate change more seriously. Based on the current results, it would be improved by evaluating carbon trap from agroecosystem through soil organic carbon alongside carbon biomass that will general a more straightforward explanation of carbon balance and specific carbon emissions.