

Estimation of greenhouse gases emission from a rice field of Kelantan, Malaysia by using DNDC model

ABSTRACT

Global warming is the main cause of greenhouse gases (GHG) including carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). The Denitrification and Decomposition (DNDC) model is considered a good tool to validate and estimate these gases from various agricultural practices. The farmers of Kota Bharu, Kelantan, Peninsular Malaysia grow rice in soils which has clay loam soil texture with 5.59 soil pH and 0.0193 kg ha⁻¹ initial soil organic carbon. The farmers grow two rice crops by applying 248 kg N ha⁻¹ year⁻¹. The model validation was found satisfactory and gave correct simulations while comparing with other international modeled studies. The yearly DNDC simulation for CO₂ flux rate was 4392 kg C ha⁻¹, 33.7 N₂O kg ha⁻¹ year⁻¹ with -2 CH₄ flux. The Global Warming Potential (GWP) for CO₂ flux was 16105 kg CO₂-eq ha⁻¹ and N₂O of 16403 kg CO₂-eq ha⁻¹; however, CH₄ was found as sink (-66 kg CO₂-eq ha⁻¹). Bulk of all these gases had 32442 kg CO₂-eq ha⁻¹ net GWP. The DNDC simulations of field uncertainties by N rates (20% less than recommended, recommended and 20, 40 and 60% more than recommended) and SOC rates at 0.04, 0.03, 0.02 and 0.0193 kg C kg⁻¹) were run through linear correlation. The unit increase in N as well as SOC rates correspondingly increased NH₃ volatilization by 4.09, 3.76, 2.31 and 1.28 kg N ha⁻¹ year⁻¹, respectively, N₂O flux by 10.06, 6.80, 6.51 and 1.16 kg N ha⁻¹, respectively, NO flux by 0.76, 3.25, 3.14 and 2.03 kg N ha⁻¹ year⁻¹ and N₂ flux by 17.87, 18.21, 21.75 and 25.22 kg ha⁻¹ year⁻¹, respectively. In conclusion, the validation of agricultural data through DNDC model was perfect. The ongoing agricultural practices in the area have been found contributing small quantities of CO₂ and N₂O except CH₄ which is serving as sink. In future, the increase in soil organic carbon as well as nitrogen rates probably may involve this area towards more GHG (CO₂, N₂O, CH₄) emissions.

Keyword: CH₄; Climate change; CO₂; GHG; N₂O; Rice