Performance of the DNDC in Estimating CO_2 and N_2O emissions of Integrated Crop-Livestock Systems

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Integrated crop-livestock (ICL) systems can have a complex of effects on soil properties that can influence greenhouse gas emissions (GHG). The ICL aim to capture atmospheric CO_2 and sequester it in the soil, holding promise for reducing GHG emission intensity from livestock products. Moreover, modeling N_2O emissions can help assess the potential impact of N management on the ICL system to optimize the sustainability of agriculture production. Field data were obtained from an ICL experiment of EMBRAPA-Rice and Beans, located on Capivara farm, Santo Antônio de Goiás/GO, Brazil (16°28´S; 49°17´W; 823 m alt.). The ICL experiment was evaluated for four years (2013-2016) with the following crop rotation sequence: pasture-fallow-maize, fallow-soybean, maize-fallow-maize, and beans-fallow. The N_2O data was obtained from the 2013-14 season, which was measured in a static chamber during maize cultivation. The experiment consisted of 9 treatments (N sources and rates) with 5 replicates. The N_2O was measured in 30 sampling events over almost 100 days. The daily N_2O fluxes from the treatments control (No N), urea (UR), calcium ammonium nitrate (CAN), and ammonium sulfate (AS) at an N rate of 150 kg/ha were used to parametrize the DNDC. Model crop and soil parameters were adjusted to better simulate maize production and N_2O emission according to observed data. DNDC simulated CO_2 emissions, quantified as Net Ecosystem Exchange (NEE), were validated against CO_2 emissions derived from eddy-covariance data, using statistical parameters such as R^2, RMSE, MAE, and Bias. While data refinement is ongoing, preliminary findings indicate that DNDC shows promise for estimating CO_2 emissions IPS under tropical conditions The DNDC had a satisfactory performance in predicting N_2O emission in the ICL system, resulting in a significant correlation with the observed data ($r = 0.63$, $p < 0.001$), MAE of 0.024, and RMSE of 0.036. The average daily N_2O-N emission observed was 0.026 kg ha^{-1} day^{-1} and simulated was 0.025 kg ha^{-1} day^{-1}. The UR, CAN and AS applications showed a peak of N_2O emission on 31th day after sowing (2 days after fertilization) corresponding to 0.175, 0.217, and 0.163 kg ha^{-1} day^{-1}, respectively, where the model simulated N_2O peaks of 0.151, 0.123, and 0.173 kg ha^{-1} day^{-1}. The accumulated N_2O emissions were 0.513, 1.148 1.738, and 0.890 kg ha^{-1} for control, UR, CAN, and AS respectively, in which the simulated by DNDC were 0. 778, 1.612, 1.391, and 1.755 kg ha^{-1}. In general, the model had a good fit with daily N_2O emissions, but it tended to overestimate the N_2O emission

from UR and AS, and underestimate from CAN. Further model parametrization and calibration may be necessary to better predict N_2O and CO_2 emissions. The DNDC satisfactory simulated the N_2O emissions from different N sources applied to ICL system, which can be used to evaluate the potential emissions and mitigation according to N management in ICL.