

水田における窒素収支評価を目的とした DNDC-Rice モデルの改良 Modification of the DNDC-Rice model to evaluate the nitrogen balance at a paddy field

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The DNDC (DeNitrification-DeComposition)-Rice model simulates the processes of carbon and nitrogen turnover in ecosystems for estimating greenhouse gas emissions from paddy fields, and can be used to simulate the N balance of a paddy field. In this study, we validated DNDC-Rice using field observation data, including N balance data, to reveal problems when using the model to evaluate a paddy field's N balance. To validate the N balance components of DNDC-Rice, we used data collected at the Mase paddy flux site (36.03N, 140.01E), in the middle of the Kanto Plain of Japan's Ibaraki Prefecture, in 2009. Before the validation, a process for adsorption of ammonium (NH_4^+) ions by clay was modified based on the results reported by Katayanagi et al. (2012) Soil Sci. Plant Nutr. 58:360-372. The modified DNDC-Rice simulated the dry weight of roots, stems, and grains well, but overestimated leaf dry weight. The normalized root-mean-square errors (nRMSEs) for the root, stem, grain, and leaf dry weights were 13, 16, 7, and 60%, respectively. DNDC-Rice also overestimated the leaf area index (LAI) and leaf N content, with nRMSEs of 125 and 37%, respectively. The overestimation of leaf dry weight and LAI resulted from overestimation of N uptake by rice and of N allocation to leaves. The high N uptake could be due to either a high available soil N content, crop N recovery from the soil or both. At harvesting, the simulated N balance (= N input - N output) was -38.8 kg ha^{-1} , which was much lower than the N balance determined by observations and from relevant literature (12.8 kg ha^{-1}). The underestimation of the N balance resulted mostly from the model's inability to calculate dry N deposition and N fixation as inputs and from overestimation of grain N uptake and underestimation of N_2 emissions through denitrification as outputs. Based on the result, the model has been being modified using the data collected at Tsukuba FACE (Free-Air CO_2 Enrichment) experimental site. Tsukuba FACE (35.97N, 140.00E) was established in farmers' rice fields in Tsukubamirai City located near the Mase site. The elevated $[\text{CO}_2]$ treatments were imposed on experimental plots in Tsukuba FACE to evaluate responses of rice and carbon and nitrogen cycles to high CO_2 and soil temperature. The modification based on the data collected at Tsukuba FACE will make it possible to predict future carbon and nitrogen dynamics at paddy fields more accurately.

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