

# Understanding soil processes in oil palm plantations using an agricultural systems model

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## *Abstract*

Many soil processes are related to cycles of water, carbon and nitrogen. Agricultural systems models are regularly employed to study such processes because of their ability to integrate and explore a range of environmental and crop management factors. However, no such model is currently available for oil palm production systems. We developed one within the Agricultural Production Systems Simulator (APSIM) framework and tested it using data from nitrogen (N) fertiliser trials across a range of environments within Papua New Guinea. The model captured key trends in canopy development, biomass production and yield of fresh fruit bunches due to plantation age, climate and N management. The model was used to estimate the effects of plantation age and N-fertiliser management on soil carbon and N-cycling processes at one site. Soil carbon increased during the immature phase and then remained constant (with high fertiliser rate) or declined (zero fertiliser) during the mature phase. During the immature phase, there were substantial leaching losses of nitrate, and gaseous emissions of nitrous oxide and N<sub>2</sub> from the soil, driven by the inputs of N from the previous oil palm crop residues and from N fixation by the leguminous cover crop. During the mature phase, N losses increased with increasing N-fertiliser rate. The model was shown to be a useful tool for exploring possible effects of environmental and management factors on soil processes. Simulations suggested that the immature phase is an important and understudied period for N losses and soil organic matter accumulation.

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