IN-Palm: an agri-environmental indicator to assess potential nitrogen losses in oil palm plantations

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Oil palm is currently cultivated on about 19 M ha (FAOSTAT, 2014) and palm oil represents more than one third of the global vegetable oil market (Rival and Levang, 2014). Addition of nitrogen (N) via legume cover and fertilisers is a common practice in industrial oil palm plantations. A part of this N is prone to be transferred to the environment, which can lead to negative environmental impacts (Schmidt, 2010, Choo et al., 2011, Pardon et al., 2016a). In order to improve the sustainability of palm oil production, it is crucial to revisit the management practices in order to minimise N losses. Continuous field measurements would be prohibitively costly as a monitoring tool, and in the case of oil palm, available models do not account for all the potential N inputs and losses or management practices (Pardon et al., 2016b).

In this context, we decided to develop IN-Palm, a model to help managers and scientists to estimate N losses to the environment and identify best management practices. The main challenge was to build such a model in a context of knowledge scarcity. Given these objectives and constraints, we reviewed in the literature the measurements and modelling of N fluxes and losses in oil palm, and we developed an agri-environmental indicator using the INDIGO® method (Bockstaller et al., 1997; Bockstaller and Girardin, 2008). We used a decision tree modeling approach (Breiman, 1984) to design most of the indicator modules, combined with fuzzy logic (Zadeh, 2008). We performed a validation of the N leaching module of IN-Palm against field data from Sumatra, Indonesia. We also used IN-Palm to test theoretical management changes in residue and fertiliser management.

IN-Palm is implemented in an Excel file and uses 21 readily available input variables in most of oil palm companies, to compute 17 modules. It estimates annual emissions and scores for each N loss pathway and provides recommendations to reduce N losses. IN-Palm predictions of N leaching against measured data in Sumatra, Indonesia, were acceptable according to several statistics calculated, with a tendency to underestimate N leaching. We showed that IN-palm provided an efficient means of testing management scenarios in a given context, and identifying practices likely to reduce N losses. Therefore, our indicator constitutes a useful tool for managers and scientists to identify and study local management options to address global change.

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