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Prototyping sustainable banana based cropping systems with the SIMBA model

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Monospecific banana (*Musa* spp., AAA group, cv. Cavendish Grande Naine) based cropping systems may present important threats for the environment. The pesticides, used to control plant-parasitic nematodes, fungi (*Mycosphaerella fijiensis* and *M. musicola*) and insects (*Cosmopolites sordicus*), endanger water resource, biodiversity and human health. These risks are magnified in fragile tropical insular conditions of French West Indies (F.W.I.) where inhabited areas, coral reefs and rainforests are interconnected with agrosystems. A model called SIMBA was built to help designing more sustainable cropping systems. SIMBA simulates the major ecological processes of the soil-bananas-nematodes system. This model runs at the field scale with a weekly time-step and simulates over many cropping cycles the heterogeneity of stages of the banana plant population, banana growth and yield, plant-parasitic nematodes population dynamics, water balance, soil structure, and gross margin. Inputs include climatic data and farmers practices via decision-rule processes. A set of agri-environmental indicators linked to the model were developed to assess the potential risks of erosion and pollution of ground and surface water. SIMBA was calibrated and validated with data from Guadeloupe and Martinique (F.W.I.) and hence allows the evaluation of existing or virtual cropping systems on a multicriteria basis (performances and impacts). Selection of cropping systems is realized by weighting the model's outputs (economical margin and environmental risks) according to a point of view (minimizing environmental risks or maximizing the economic margin with minimum environmental risk). It is used for strategic thinking with farmers and advisers as it provides ex ante assessment of the impact of technological or management innovation in existing bananas cropping systems. It is also a research tool to prototype new cropping systems by testing pre-defined scenarios or by exploring complex sets of decision-rules, before on farm testing. A broad exploration of decision rule sets showed that "rotations with 2 banana crop cycles and fallow" have the best economic/environmental trade-off evaluation.

Key words: banana cropping systems, simulation model, prototyping

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