SIMBA: a comprehensive model for agro-ecological assessment and prototyping of banana-based cropping systems. An application in the French West Indies.

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Monospecific banana (Musa spp., AAA group, cv. Cavendish Grande Naine) based cropping systems may present important threats for the environment. In these agrosystems, pesticides cause significant risks of pollution for surface and ground water, especially in the tropical insular conditions of French West Indies. In order to asses these risks and to help design more sustainable cropping systems a specific model called SIMBA was built. SIMBA simulates banana cropping systems through several cropping cycles. It includes sub-models that simulate soil structure, water balance, root nematode populations, yield, economic outputs. Agri-environmental indicators linked to the model allow assessment of potential environmental impacts. The model has been implemented in Guadeloupe (F.W.I. , 16°15'N, 61°32'W) and allow practical recommendations to farmers, virtual test of agro-technological innovations or management strategies at field level.

The challenge of banana based cropping systems in F.W.I.

Environmental: pollution of water by pesticides, erosion
Agronomical: sustainability due to loses of fertility, development of nematodes
Economical: fluctuation of market price,
→There is a need for new innovative banana based cropping systems, we propose a complete tool to assess and generate such systems

Requirements for the model

- Simulate crop rotations and nematodes dynamics
- Take into account the specificity of the banana crop (evolution of the plant population structure)
- Calculate agronomic, environmental and economic outputs
- Biophysical model driven by decision rules

Structure of SIMBA

- **Biophysical sub-models** that simulate plant growth, plant population structure (cohort population concept, Tixier et al. 2004), physical soil properties, water balance, dynamic of multi species nematode population.

- **Qualitative models of environmental impacts** (based on expert system and fuzzy logic, Girardin et al. 1999) that lead to **indicators** notes.

- **Inputs**: climate, soil properties and farmers' practices via decision-rule processes (managed through a decision rules generator).

- **Outputs**: agronomic performance (yield, pest), economic results (profit margin) and environmental assessment (indicators of exposure of water to pesticides, erosion and soil quality)

- **Weekly step** simulations at the **field scale** on the **long term**. Developed on STELLA® software environment (HPS®)

- **Calibration** and **validation** of most module with data from Guadeloupe

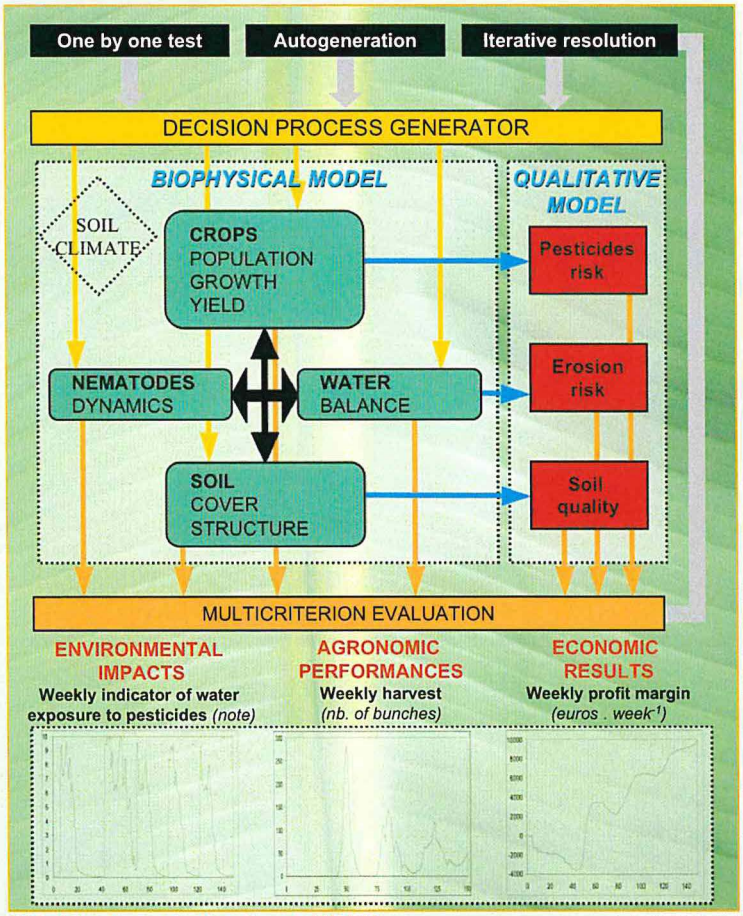
Uses of SIMBA

Multicriterion assessment

- **Detect** periods of risk of water pollution and erosion
- **Compare** cropping systems (rotation and crop management)

Cropping system prototyping

- **Test** of tactical or strategical decision rules sets (**one by one test)**
- **Sort and select** the best sets of decision rules that fit to objectives (minimizing environmental impacts, maximizing economic margin or a trade off between these two objectives) by an **autogeneration** of a large number of sets of decision rules or an **iterative resolution**.



Global structure, outputs and uses of SIMBA.

Conclusion

SIMBA is a powerful tool to aid to prototype new cropping systems, it allows a multicriterion assessment of different crop management strategies in order to come up with practical recommendations to assist farmers, regarding the efficiency of new agro-technological innovations and field management strategies. **The global and long term approach allows realistic solutions to agronomic or environmental problems that are not possible with existing crop models.**

References

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