Reintroducing agrobiodiversity to design more sustainable banana cropping systems in the French West Indies

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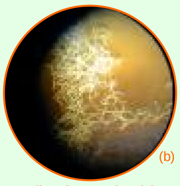
In most banana producing countries, banana production for export is based on intensive monocropped, monospecific and monocultivar systems that require high chemical inputs and frequent plantings to obtain a steady production. In the French West Indies Guadeloupe or Martinique (16°15'N, 61°32'W), the monoculture of banana (Musa spp., AAA group, cv. Cavendish Grande Naine) requires several applications of fongicides, nematocides, insecticides and herbicides per year, frequent plantings (pests reduce yields and increase plant falls due to poor root system). These practices can thus lead to serious threats to air, soil and water quality, with major detrimental impacts. These risks are magnified in fragile ecosystems such as tropical islands where inhabited areas, coral reefs and rainforests are located close to agrosystems. Designing more sustainable agricultural systems appears hence as a key ecological and social challenge. In this context, reintroducing agrobiodiversity at different scales (plot, farm, region) could provide a solid foundation for designing more sustainable alternative systems.

The impacts of intensive monoculture

Agronomical sustainability

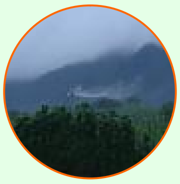
Long-term monoculture leads to the high parasite pressure wich is responsible for high pesticides use and hence pollution.

- **Fongi** (*Mycosphaerella musicola responsible of* Sigatoka disease)
- **Nematodes** (*Radophollus similis, others phytoparasitic nematodes and fungi responsible for roots lesions*)
- **Insects** (*Cosmopolites sordidus that affects bulbs*)



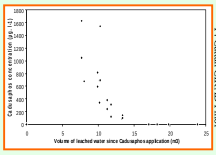
Pathogens and diseases (leaf attacked by sigatoka[(a)], nematodes *Radopholus similis*[(b)] and bulb invaded with *Cosmopolitus sordidus* [(c)])

Threats for environment



Air fungicide application to control sigatoka

High erosion risks on plowed and uncovered soil



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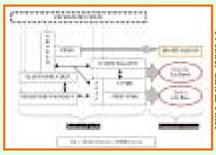
Water

Pesticide in leaching water constitute a serious threat for ground and surface waters

Tools to assess and design cropping systems

- **Models and indicators are built** to assess and prototype new cropping systems (Model SIMBA). These tools helps to define new sets of practices and to optimise rotations.
- Use of **remote sensing** to assess crop stages and diversity at the region scale.



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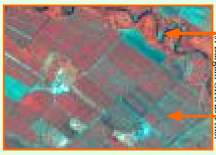
SIMBA model structure



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Satellite image

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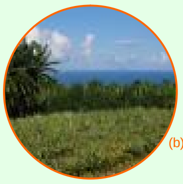
The role of agrobiodiversity to design more sustainable systems

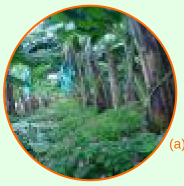
As a preliminary strategy, fallows, cover crops and rotation crops such as sugarcane, pineapple or forage have been introduced in these systems and could be an effective way to improve pest and weed control, while reducing pesticide use and erosion.

Biodiversity management over space and time.

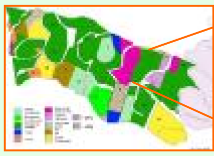
Agrobiodiversity through its complex interactions with the cultivated crop, the pathogens and the components of the environment, play an important role in the functioning and resilience of systems. Reintroducing biodiversity at different scales of time and space is a credible alternative to monoculture.



Pest control: use of non inoculated material (banana vitroplants) after fallow[(a)], rotations with sugar cane[(b)] or pineapple[(c)] allow a better control of nematodes and decrease nematocide use.



Weeds control and beneficial impacts : Covercrops such as *Impatiens. sp.*[(a)], or sugar cane residues[(b)] used as much allow a better contrôl of weeds, a decrease of herbicide use and a better contrôle of erosion and water transfert.



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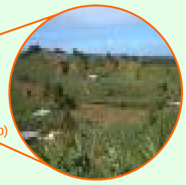

Diseases control: New hybrids resistant to Sigatoka[(a)] are under development. **Epidemiologic risks:** Spatial arrangement of species at field and farm scale[(b)] may reduce these risks.

Conclusion

The sustainability of future banana-based cropping systems will depend on our ability to combine agro-technological innovations, field management strategies and enhanced knowledge on the functional ecology of these systems. Further ecological studies are required to improve the knowledge of the ecology of these new agrosystems.

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In most banana producing countries, banana production for export is based on intensive monocropped, monospecific and monocultivar systems that require high chemical imputs and frequent planting to obtain steady production. Associated direct environmental risks include pesticide leaching into surface and ground water, soil erosion and compaction. These practices can thus lead to serious threats to air, soil and water quality, with major detrimental impacts on fragile ecosystems such as tropical islands. Designing more sustainable agricultural systems is hence a key ecological and social challenge in the European islands of Guadeloupe or Martinique (FWI).

In this context, reintroducing agrobiodiversity at different scales (plot, farm, region) could provide a solid foundation for designing more sustainable alternative systems. As a preliminary strategy, fallows, cover crops and rotation crops such as sugarcane, pineapple or forage have been introduced in these systems and could be an effective way to improve pest and weed control, while reducing pesticide use and erosion.

The sustainability of future banana-based cropping systems will depend on our ability to combine agro-technological innovations, field management strategies and enhanced knowledge on the functional ecology of these systems. This presentation explores possible solutions and analyses current research needs.

Keywords: agrobiodiversity, monoculture, banana, cropping systems