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# MATHEMATICAL MODELING AND CONTROL OF NEMATODE IMPACT ON BANANA PRODUCTION

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The production of bananas and plantains is one of the most important agricultural activities in many countries around the world. A major constraint for this production is due to the serious damage caused by a nematode called *Radopholus similis*. This nematode spends most of its life cycle in the roots of the banana plant, which makes it quite difficult to control. Our aim is to tackle this issue by a modeling approach.

In this work, a 4-compartment model describing the banana-nematode interactions is formulated. The originality of this model is that we consider both infected root and infesting nematodes which allows variable nematode densities in the roots. First, considering that root infestation is fast compared to the nematode development, we use Tikhonov's theorem on slow-fast systems theory to reduce the dimension of our system.

Then we analyse the reduced model. More precisely, we derive a threshold $\mathcal{R}$ which classically determines the stability of the disease-free equilibrium and identify backward or forward bifurcations at its threshold value 1. Hence, $\mathcal{R} < 1$ may not be sufficient to eradicate the disease, as a stable endemic equilibrium may exist.

In the third part, the reduced model is extended to include a control strategy consisting in reducing the root infestation rate. The goal of our control is to maximize the banana production while minimizing the control costs and the final infected biomass that will impact the infestation during the next growing season. The existence of an optimal control is demonstrated and necessary optimality conditions are carefully established. Finally, numerical simulations are presented, using a forward-backward sweep method to solve the optimal control problem, which show the effectiveness of the control.

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