Pineapple cropping system design with the simpiña modelling framework

E. Dorey[1] – M. Rothe[2] – S. Pissonier[3] –T. Michels[2] –P. Tixier[4]

[1] UPR GECO, CIRAD, Bassin plat, 97455 Saint Pierre cedex, La Réunion, France, elodie.dorey@cirad.fr
[2] UPR HortSyst, CIRAD, Bassin plat, 97455 Saint Pierre cedex, La Réunion, France
[3] UMR Innovation, CIRAD, 34398 Montpellier, France
[4] Departamento de Agricultura y Agroforesteria, CATIE, 7170, Cartago, Turrialba, 30501, Costa Rica
[5] UPR GECO, CIRAD, CAEC, Quartier Petit Morne, BP 214 - 97285 Lamentin Cedex 2, Martinique, France

Introduction

It is a major issue to include field and farm constraints in model-based cropping system. Pineapple ('Queen Victoria' cultivar) is the first fruit to be produced on Réunion Island under a large range of climatic conditions and cultural practices. This implied a great variability on system performances (yield, fruit quality, N leaching). We designed a comprehensive model (Simpiña) to simulate combinations of cultural practices (planting periods, planting density, weight of sucker, date of flowering induction, N fertilization and irrigation) that maximize agronomic, environmental (N leaching), fruit quality (acidity and sugar contents), and economical criteria in relation to climatic and structural constraints identified in a typology. We discussed the sensitivity of each cultural practice in the definition of sustainable systems and the gap between systems selected by the model and current systems for each type identified.

Materials and Methods

Plant growth and fruit development, affected by daily changes in soil N and soil water was determined with Simpiña model (Dorey et al., 2015). The sugar content and titratable acidity were simulated in two sub-modules linked to the plant growth module. We evaluated the grower's gain using an economic balance (Pissonnier et al., 2015). A typology of practices was performed in 39 farms representative of pineapple production on Réunion Island. SIMPIÑA was used to explore a wide range of practices combination in different locations, taking into account the constraints identified for each groups defined with the typology. Each combination of practices was evaluated for its: (i) agronomic performance (ii) fruit quality performance (iii) environmental performance, and (iv) economic performance

Results and Discussion

The typology led to three groups of farmers (A, B, and C) according to their location and the climatic conditions. We explored 8748, 34992 and 69984 systems with the Simpiña model and we selected 81, 77, and 101 systems that satisfy all criteria for the 3 types, respectively. Promising systems selected varied according to the farm-types identified (Figure 1). In farm-types A and B, systems selected showed earlier dates of flowering induction than current systems and N fertilization < 200 kg ha^{-1}. Inversely, in farm-type C, date of flowering selected was later than current systems and the level of

N fertilization is extended compared to farm-types A and B There were some similarities between the 3 farm-types, e.g. most promising systems showed high performances with lower of N application. The level of N fertilization can probably be decreased in order to decrease N leaching while maintaining high yield. For the three farm-types, planting density was generally higher in the selected systems than in current ones. High sucker's weight also seems to improve performances of promising systems. The method used for selecting promising system is interesting because it did not generate a single solution, but range of combination of practices. This variability within practices selected highlighted that farmers could identify management recommendation which match with their objectives and strategic choices (Grechi et al., 2012).

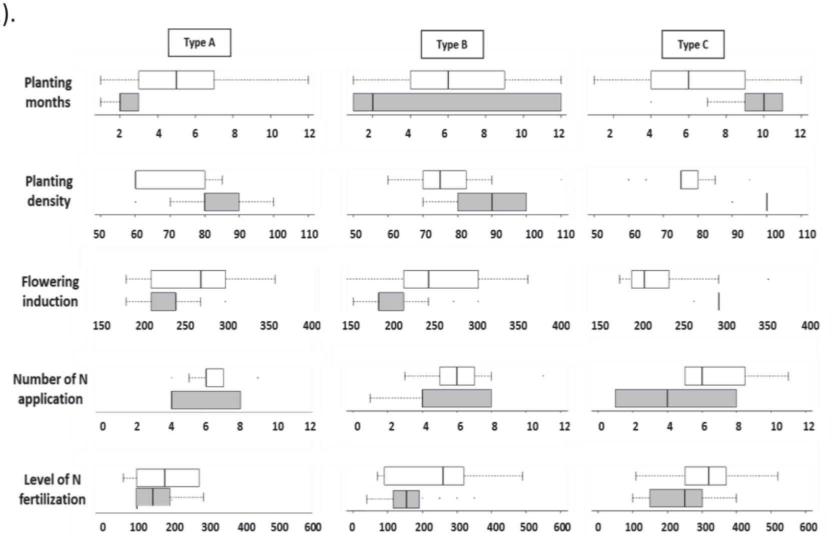

Figure 1. Representation of range of practices for actual pineapple system (white) and selected system (grey)

Conclusions

We demonstrated that a dynamic crop model that takes into account the key biophysical processes evaluated with a multi-criteria analyses associated with a typology of practices provide a useful framework for the design of innovative pineapple systems.

References

Dorey, E., P. Fournier, M. Léchaudel, and P. Tixier. (2015). Validity of the pineapple crop model SIMPIÑA accross the climatic in Réunion Island. *European Journal of Agronomy* 62:1-12.

Grechi, I., Ould-Sidi, M. M., Hilgert, N., Senoussi, R., Sauphanor, B. and Lescourret, F. (2012). Designing integrated management scenarios using simulation-based and multiobjective optimization: Application to the peach tree-Myzus persicae aphid system. *Ecological Modelling* 246: 47-59.

Pissonnier, S. (2015). Simulating impacts of marketing strategies on pineapple growers and grower organizations' profits on Reunion Island. In 'International Symposium on Innovation in Integrated and Organic Horticulture – Avignon, France 8-12 June 2015, *in press.*