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# EMERGY† EVALUATION AND ECONOMIC PERFORMANCE OF BANANA CROPPING SYSTEMS IN GUADELOUPE (FRENCH WEST INDIES)

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## INTRODUCTION

Banana is the second most important agricultural commodity in Guadeloupe (French West Indies—FWI). It represents 24% of local agricultural production, 12% of the total cultivated area, and generates about 5000 direct jobs. For several years this sector has been facing severe environmental and economic crises, mostly due to market liberalization that has prevailed during the last 15 years, causing the price of bananas to decline by an average rate of 1.4% per year, often compelling farmers to intensify their production systems in order to maintain their income. Looking for higher productivity, farmers have increased the use of technological inputs such as intensive use of machinery, fertilizers, pesticides, and irrigation, that push energy flows through the agro-ecosystem to unsustainable levels.

The intensive use of technological inputs in banana production in the FWI has been associated with severe impacts on the environment, because the systematic use of ploughing and pesticides has led to chronic contamination of soils and waters by organochlorine compounds like Chlordecone. The reported contamination problem has in turn contributed to a decrease in soil biological diversity and consequent reduction in fertility, while contaminating drinking water sources. These environmental costs or the externalities of such detrimental environmental impacts of agricultural practices are typically unmeasured and often do not influence farmers' or societal choices regarding agricultural production practices.

The goals of the present study are: (1) to compare the different banana cropping systems in Guadeloupe with regard to: resource use, productivity, environmental impact, and overall sustainability; (2) to evaluate the eMergy signature of the banana production as a whole in the region; (3) to contrast an ecocentric analysis (eMergy) with an anthropocentric analysis (economic) of the banana cropping systems and determine their respective tradeoffs; and (4) to highlight points where innovations might result in greater improvements toward overall sustainability of banana cropping systems in Guadeloupe.

## MATERIALS AND METHODS

In Guadeloupe, six different cropping system types for banana production have been identified: (1) Lowland intensive small farms; (2) Lowland intensive medium farms; (3) Lowland intensive large farms; (4) Flat uplands intensive medium farms; (5) Highlands moderately intensive small farms and (6) Highlands extensive small farms. Each type described above has been translated into a hypothetical farm that represents the average flows of resources and outputs for all farms in the type class.

After quantifying annual flows for each component and cropping system in physical units (i.e., joules, grams, US$), these values were normalized for area (1 ha) and translated into eMergy units (solar eMergy Joule - seJ) through previously calculated transformities for each item. For some components and products, different transformities had been derived in different contexts, so the transformity calculated under the most similar conditions to those observed in the studied situation has been selected. Furthermore, each component or production item was classified whether it is a renewable resource (R), a

† eMergy (spelled with a "M") is defined as the total energy of one kind (usually solar equivalent) directly and indirectly in the work of making a product or service (Odum, 1996; Odum et al., 2000).

local non-renewable source (N), a resource purchased from outside (P) or an exported product (Y). Several performance and sustainability indices have been calculated for the different cropping systems. These indices (Transformity, Mass-eMergy, Fraction renewable, Environmental loading ratio, eMergy investment ratio, eMergy yield ratio, eMergy exchange ratio and eMergy sustainability index) summarize the systems' resource use intensity, process efficiency, economic–environment interactions and quantify sustainability (Rodrigues et al., 2002). Additionally, aiming at improving managerial capacity and investment decision making, the environmental performance results obtained were contrasted with economic analysis for the six cropping systems.

## RESULTS AND DISCUSSION

As a general outcome, the analyses showed that the better the environmental performance of the cropping system, the worse its economic performance. This result was corroborated by an increased contrast among cropping systems as related to their dependence on purchased inputs, although all cropping systems followed the same intensive and arguably wasteful agricultural model. Therefore, the analyses point out that sustainable banana production in Guadeloupe depends on a shift from the high fossil input model to a natural resources intensive one.

In this sense, eMergy flow analysis showed that innovation toward environmentally sound practices that would enhance nutrient cycling; integrate weeds, pests and diseases control; and improve the banana packing process might result in most positive impacts on overall sustainability.

Economic analysis showed that the high labor and input costs, as well as post-harvest processing contribute largely to the dependency of banana production on agricultural subsidies. These issues stem from European Commission's regulations on quality standards for commercial bananas that, by imposing strict aesthetic benchmarks, have had a negative effect on the sustainability of banana production; because substantial nonrenewable and purchased eMergy inflows into banana production systems aim to impose improved aesthetic standards over sound ecological management.

Therefore we may conclude that reorienting the current European agricultural income policy to an environmental performance-based subvention might be a policy opportunity to achieve the present socio-economic goals while promoting sustainability in banana production.

## REFERENCES

Odum, H.T. Environmental Accounting: Energy and Environmental Decision Making, John Wiley and Sons Inc., New York, USA (1996).

Odum, H.T.; Brown, M.T. and Brand-Williams, S.L. Handbook of Emergy Evaluation: Folio #1: Introduction and Global Budget, Center for Environmental Policy, University of Florida, Gainesville, FL, USA (2000).

Rodrigues, G.S., Brown, M.T., Odum, H.T. SAMeFrame – Sustainability Assessment Methodology Framework. In: Ulgiati, S., Brown, M.T., Giampietro, M., Herendeen, R.A., Mayunil, K. 3rd Biennial International Workshop Advances in Energy Studies: Reconsidering the Importance of Energy. Porto Venere (Italy), September 24-28, 2002. SG Editoriali Padova (IT), p. 605-612.

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