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Harry Ozier-Lafontaine, Valérie Angeon

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Supporting small island communities

Drs Harry Ozier-Lafontaine and Valérie Angeon talk to *International Innovation* about efforts to determine current trajectories of evolution in small island territories' agroecosystems and analyse their adaptive capacity



Could you outline the main objectives of the Gaia-Trop project?

VA & HOL: Gaia-Trop aims to co-construct conditions that reinforce the viability of farming systems in small island territories alongside stakeholders from the agricultural sector.

The project is contributing to collective trial processes related to the successful development of farming systems, supply chains, agricultural practices and incentives to strengthen resilience of agrosystems while keeping the quality of soils unspoiled.

To achieve this, we are building a scientific international and national partnership focusing on agroecological innovations, similar to CARibbean netWork for Agroecological Innovation (CAWAI), initiated by the French Institute for Agricultural Research (INRA) in 2011 during the Caribbean Food Crops Society (CFCS) conference in Barbados.

The rejuvenation of Caribbean agriculture is a core issue insofar as small family farming is well developed and sows the seeds of resilience despite a lack of support.

Have you faced any challenges in the design and development of this project? How have these been overcome?

VA & HOL: To begin viability analysis, it was necessary to establish a cross-disciplinary consortium with economists, life scientists (agronomy, ecology and zootechnics) and

mathematicians specialised in viability theory. All researchers found a common interest through the cross-cutting themes addressed by the project and the application of viability theory at the farming system level.

In Gaia-Trop, the farming system represents a consistent scale of analysis (at an operational and decision-making level) that comprises three dimensions of sustainable development: environmental, economic and social. From these three dimensions, three synthetic variables are extracted to nurture the viability model. To quote Gaia-Trop members Professors Jean-Pierre Aubin and Patrick Saint-Pierre, we have to compose with 'la malédiction de la dimensionnalité' (the curse of dimensionality – ie. the mathematical algorithm runs with a limited number of variables because of time-computation costs). Professor Pablo Andres-Domenech (another Gaia-Trop contributor) has already tackled this issue in studies related to agriculture and forest management.

Can you elucidate the concept of 'adaptive governance' and its relevance in the context of agroecological transition?

VA: A favourable regulatory context is not in itself sufficient to trigger ecological transition. Its modus operandi depends on a well-coordinated and diverse stakeholder group developing collective actions that lead to this transition. This collective dynamic is achieved through trial and error owing to the heterogeneity of stakeholders, their divergent priorities, and environmental and ecological uncertainties incurred by agrosystems.

Your previous work examined the potential of biodiversity restoration to aid agricultural sustainability. What did you find through this research? How is the current project using and expanding on this?

HOL: Our previous research showed the extent to which biodiversity (mixed crops) is crucial in the efficiency of agrosystems and

focused on agricultural practices that preserve soil properties (protection of trophic chains, organic matter, etc.).

In these previous investigations, we emphasised (i) performance in terms of ecosystemic services furnished by the ecologisation of agricultural practices, which were employed as an alternative to chemical inputs, and (ii) the creation of concepts and models that simulate these complex systems at work. Gaia-Trop relies on these results to build viable trajectories for farming systems.

Gaia-Trop will create a decision-making support system to facilitate the implementation of adaptation strategies. How will this ensure that the project has impact and precipitates appropriate change in the sector?

VA & HOL: Our participatory approach is based on a mathematical viability tool (numerical simulation) that will be used prospectively to generate evolution scenarios for viable agrosystems and to determine the conditions that warrant viability. In this context, collective and participatory processes are important to facilitate the trial and future adoption of suitable agricultural practices.

Have you coordinated any events to further promote Gaia-Trop's activities?

VA & HOL: To increase the scientific visibility of Gaia-Trop, we are publishing a handbook on agroecology (*Agroecology and Global Change*, in press), coordinating an international workshop on viability theory in the Alps on 19-24 June, 2014 (www.gerad.ca/colloques/WorkshopFrance2014/indexFR.html) and organising an international symposium on the viability of agrosystems during the annual conference of the CFCS in Guadeloupe in 2016. This symposium will present the project's final results.

Evolutions in agroecology

Gaia-Trop, an ongoing research project conducted by the **French Institute for Agricultural Research** and the **University of the French West Indies and Guyana**, is exploring an original method to assess the viability of farming systems on small tropical islands in the context of global changes

The increasingly negative effects of global change on ecosystems and biodiversity require close attention. Small Island Developing States (SIDS) are particularly vulnerable to external damage and have therefore been placed high on the international political agenda. These territories are home to an exceptionally high concentration of planetary mutations, which evolve very quickly in localised areas and therefore constitute an excellent real-life 'laboratory' within which global change analysis can be performed.

The damaging impacts of global change in these areas will heavily impact the agricultural sector, which is one of the most important providers of income worldwide. Adaptation to global change covers major challenges including the preservation of agricultural activities and their contribution to wealth and food security, making agricultural viability a major concern.

As archetypes of tropical diversity, the French overseas territories represent an ideal case study and it is with a focus on this region that the Gaia-Trop project is expected to deliver practical

regulatory guidelines that guarantee the viability of farming systems.

INSIGHTS FROM THE FRENCH CARIBBEAN EXPERIENCE

The history of the French West Indies demonstrates how the productive specialisation inherited from its colonial past has contributed to its vulnerability. Based on a monoproduction of exportation, this system has, at an economic level, created external dependence, low competitiveness on the increasingly globalised markets and a debatable contribution to wealth creation. Indeed, at a social scale, this productive specialisation has reduced the distribution of incomes and left farmers poor. Moreover, in environmental terms the main damage is due to pollution linked to highly artificial farming systems.

Combined with the effects of globalisation, the rise of committed consumerism, disengagement of public institutions in matters of protection (market liberalisation), and societal demand for

full transparency about the means of production and environmentally friendly production processes fundamentally impact robustness and efficiency in conventional production systems. These observations call for the renewal of agriculture – via alternative crops and supply chains – a fact that encourages economic actors to substantially modify their practices, both in terms of production and conception of integrated farming systems. Led by Drs Harry Ozier-Lafontaine and Valérie Angeon, Gaia-Trop's mission is to clearly identify pathways towards creating a viable future for the agricultural sector.

VIABLE AGROSYSTEMS IN TROPICAL ISLAND AREAS

A number of agrotechnical, organisational, institutional and territorial evolutions are required in order to make agriculture a viable activity in this region, particularly at the farm level. Farms – which are considered as socio-ecosystems (agro-ecological systems inextricably connected to a socioeconomic matrix) – represent an essential component of the agricultural sector, and the



development of novel practices at farm scale is required to engender resilience and sustainability in the broader agricultural sector.

Ozier-Lafontaine and Angeon highlight that Gaia-Trop's proposed framework reflects a need to include a broad range of stakeholders in the development process: "Based on a participatory approach, we suggest a method that allows for the expression of individual preferences within a strict framework". This framework is built upon a mathematical theory of viability, which employs scientific rigour to determine viable trajectories of agrosystems in an uncertain context related to global risks and reveal the rules that govern their durability. The algorithm extensions of viability take into account recognised but non-foreseeable disturbances and specify the objectives that must be met in order to achieve sustainability.

The results will help to (re)define favoured adaptation options. Agreement can then be made on the modalities and forms of intervention most suitable to the objectives of the studied systems. "In cases where this is not feasible, our framework also provides an opportunity to minimise the vulnerability of these systems," Ozier-Lafontaine and Angeon highlight. As it derives from a collective decision-making process, Gaia-Trop's participatory approach endorses the principles of adaptive governance. The methodological applications may also be applied to other contexts as the agricultural activities under examination cover a large range of actors and farming systems.

A CROSS-SCALE, DYNAMIC APPROACH

Global change undoubtedly has a fundamental influence on the functioning, dynamics and durability of agrosystems. Gaia-Trop's basic premise focuses on the existence of reasoned adaptive practices that articulate their organisational, institutional and technical foundations. This can occur in a variety of forms (eg. support functions; soil and productions health; and intensification and management of biodiversity in farming systems), and may take place in the wider landscape of the agricultural supply chains and territories within which these farms exist.

To improve operational efficacy, viability theory will be used to enlighten decision making and strategies. The options produced by Gaia-Trop's framework may address policies necessary to guarantee the viability of the agricultural systems in question, as well as the farmers' practices themselves (eg. technical choices and organisational methods). Viability theory provides consistent and generic methodological material, the robustness of which is being tested through implementing calculations aimed at assessing the durability of farming systems. Even though there is neither congruence between situations, nor uniqueness of trajectories, predictions are made possible by defining the whole initial state from which at least one evolution remains viable and specifying the position from which all evolutions are viable. "Modelling the best agricultural approaches to implement in response to global change scenarios constitutes a major outcome of

AT A GLANCE

Gaia-Trop's efforts to analyse the viability of farming system components revolve around six key steps:

- Analysis of agro-ecological and socioeconomic indicators
- The team uses these results to examine the evolution trajectories of farming systems in the face of global change (ie. the characterisation of the future state of the farming systems)
- The adaptive capacities of the farms are then estimated
- Reactive capacity in light of stress is analysed and, more generally, agricultural governance in the chosen territories is questioned
- The adaptation options that should be favoured by the various stakeholders are discussed
- Viability theory will be developed into a local governance instrument to better clarify the choices in terms of farming speculations, systems of production and distribution of the production, considering the fragility and/or scarcity of exploited resources, economic returns and expected social effects
- The expected benefits of this 42-month research programme will focus on modelling possible agricultural outlooks according to the evolution of global changes and their consequences.

this research programme," Ozier-Lafontaine and Angeon underline.

COLLECTIVE CAPACITY FOR INNOVATION

The sheer level of interdisciplinarity represents an innovative aspect of Gaia-Trop's approach – combining social sciences (economy, geography and management), life sciences (agronomy, ecology and zootechnics) and exact sciences (mathematics, digital analysis and computer science). The collective learning process this approach promotes is a fundamental strength, as Ozier-Lafontaine and Angeon explain: "This sentiment is part of a general research, training and action outlook, which aims not only at providing stakeholders with guides and benchmarks for action, but allows us to co-build knowledge with them".

The Gaia-Trop project will satisfy a real societal demand; inviting stakeholders to rethink and rebuild their community project around agriculture. By defining stakeholder action in this way, governance frameworks can be developed in a manner that allows for effective evolution of public policy.

INTELLIGENCE

GAIA-TROP

VIABILITY AND ADAPTIVE GOVERNANCE OF TROPICAL ISLAND AGROSYSTEMS

OBJECTIVES

Analysing the key determinants of the viability of farming systems in the small island territories in the context of global changes.

PARTNERS

The Tropical Agrosystems Research Unit; The Tropical Animal Production Unit, French National Institute for Agricultural Research (INRA) • Centre for Study and Research in Economics, Management, Modeling and Applied Computing, University of French West Indies and Guyana • Applied Tychastic Regulated Systems Laboratory • Université Paris Dauphine, PSL Research University • Innovation and Development in Agriculture and the Agrifoods Sector, Cirad/INRA • Agroecological Functioning and Performance of Horticultural Cropping Systems, Cirad

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CONTACT

Dr Harry Ozier-Lafontaine
Project Coordinator

INRA - ASTRO Agrosystèmes tropicaux
INRA Domaine Duclos
Prise d'Eau 97170 PETIT-BOURG
Guadeloupe

T +590 590 25 59 65
E Harry.Ozier-Lafontaine@antilles.inra.fr

Dr Valérie Angeon
Project Coordinator

Ceregmia-Martinique
Campus de Schoelcher
BP 7209 97275
Schoelcher Cedex
Martinique

T +596 596 72 74 00
E valerie.angeon@martinique.univ-ag.fr

www.Gaia-Trop.fr/en

HARRY OZIER-LAFONTAINE is an agronomist who holds a PhD and HDR (accreditation to lead research) in Agronomy and Environmental Sciences. He is a senior scientist at INRA.

VALÉRIE ANGEON holds a PhD in Applied Economics and is an associate professor at the University of French West Indies and Guyana.





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