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"Reality and Potential of Food Security and Agricultural Diversification in Small Island Developing States"

"Realidad y Potencial de la Seguridad Alimentaria y la Diversificación Agrícola en Pequeños Estados Insulares en Desarollo"

"Sécurité alimentaire et diversification agricole dans les petits états insulaires en développement: réalisations et perspectives".

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INVASIVE SPECIES SAFEGUARDING: IMPERATIVE FOR CARIBBEAN REGIONAL AGRICULTURAL DIVERSIFICATION AND FOOD SECURITY

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DEVELOPMENT OF PLANT EPIDEMIOLOGICAL SURVEILLANCE NETWORKS, DATA EXCHANGES AND JOINT RESPONSE STRATEGIES IN THE CARIBBEAN: THE FRENCH EXPERIENCE

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ABSTRACT. Plant pests and pathogens have the potential to emerge and spread rapidly, cause severe losses, and threaten food security worldwide. Such a threat is increased by the rise of commercial exchanges of germplasm and fresh produce and by global warming. This threat is particularly high under island or archipelago habitat conditions. Hence the need to anticipate sanitary crises by developing appropriate surveillance and response systems for the control of pests and pathogens, especially those affecting crops important to food security and economic balance. Such systems are being developed in the Caribbean, and in particular in the French West Indies, through the PANDOeR (**PA**thologies **N**ouvelles: **D**étection, **O**bservations, **eR**adication / New pathologies: diagnoses, observations and eradication) Project. An overview of this project is provided. Components of pest and pathogen control strategies, such as surveillance networks, data exchanges and joint response strategies, are discussed.

KEY WORDS: Invasive species; crops; vigilance; surveillance; control; eradication, PANDOeR

INTRODUCTION

Insular habitats are particularly vulnerable to pests and pathogens, especially emerging ones (Crump et al., 2001) because island biotopes and socio-economic conditions deeply influence pest and pathogen dynamics, adaptive evolution and epidemic expansion (Mayer, 2000). This particularly applies to fragmented habitats separated by short distances, like the Caribbean islands. Indeed, the Caribbean region is a crossover for humans and food commodities, with short distances between countries favouring rapid exchanges of not only agricultural goods, but also that of pests and pathogens. Several factors contribute to this situation, of which one of the most important remains the difficulty to control island-to-island movements. This results in illegal importation of plants and plant products. Once introduced, pests and pathogens are difficult to control and almost impossible to eradicate because their populations grow fast and because established insect vector species (e.g., aphids) promote the rapid spread of introduced vector-borne diseases.

Therefore, preventing the entry of harmful pests and diseases must remain a constant priority. To this aim, vigilance networks and eradication programmes are instrumental. They must rely on national, regional and international epidemiological surveillance networks and data exchange systems, and lead to the implementation of strategies for preparedness to combat emerging or re-emerging diseases through collaborative surveillance networks and regionally harmonized disease control policies. Such programmes exist for the control of several human diseases such as AH_1N_1 and H_5N_1 influenza, or that of animal diseases such as bluetongue. In the

Caribbean region, a similar network has been successfully developed for animal health, i.e., the Caribbean Animal Health Network (CaribVET), which involves Caribbean veterinary services, research institutions, universities, regional and international organisations focused on animal diseases. CaribVET aims at fostering the exchange of information and collaboration among people involved in animal health, promoting a regional approach for emergency preparedness and disease control, developing and harmonizing regional veterinary diagnostic capacities, and strengthening national epidemiological surveillance systems through training and capacity building. CaribVET relies on important surveillance activities in member countries. Although several initiatives exist in plant health at the regional scale, a similar network still has to be established for plant pests and pathogens in the Caribbean.

1. Important Factors for the Success of a Plant Epidemiological Surveillance Network

1.1. Organisational factors

Organisational factors are crucial for the success of a network. In particular, it is essential for associate participants from all organisations involved in agriculture and plant protection, such as growers, research institutes, ministries and technical organisations. It is also critical to involve pathologists with good knowledge of the epidemiology and dispersal process of the targeted pests and pathogens. Using pre-existing structures, such as a technical unit in charge of the chemical control of diseases, can speed up the network-building process. Yet one should bear in mind that the most critical organisational factor is the motivation and committed engagement of the partners. This highlights the necessity to involve the partners in the network building process itself. Last, but not least, an active and undisputed network manager originating from a neutral organisation, such as a ministry or plant protection services, is also an important factor. The level and consistency of funding is also very important. In particular, appropriate funding must be secured prior to the beginning of activities, since the acquisition of funding for increased needs usually proves challenging.

1.2. Technical factors

The success of an epidemiological surveillance network relies heavily on diagnostic techniques that must be fast, easy to use, robust and cheap. These techniques must also be accessible to the services in charge of surveillance. To this aim, technology transfers can be achieved through workshops, leading to the exchange of technical information and know-how in regard to strategic components such as sampling, and diagnostic or statistical analysis of data. Information and data exchanges can also be supported by appropriate data exchange systems such as sections of a website with restricted access to network members (see below). In the end, technical data are collected in order to support control strategies that must be implemented at the appropriate geographical level in order to prevent the spread of pests and pathogens. When implementation is to occur at a regional (i.e., sub-national) scale, it is important to set up compatible legal procedures for plant health between countries, in particular eradication plans.

1.3. Communication

Beside surveillance activities themselves, a successful network has to provide the general public with information and decision-makers with accurate data. Therefore, a communication plan is essential. Information campaigns targeted towards large audiences including agriculture technicians, politicians, decision makers and general public, should be planned, especially when

the implementation of control methods and prevention strategies involve the public at large. Information can also be delivered online; therefore, a website with unrestricted sections should be planned.

2. Research and Epidemiological Surveillance Activities must Fuel Each Other

Research and surveillance activities depend deeply on each other. Research activities lead to technical improvements that ultimately benefit several domains linked to surveillance, such as diagnostics. Conversely, data collected through surveillance networks are useful to scientists, especially for understanding pathogens' or vectors' dispersal processes and population dynamics and for setting up predictive models that can be used for assisting decision makers in the implementation of prevention strategies. Such a "mutual benefit approach" is being developed by the Centre de coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and by the Service Régional de la Protection des Végétaux (SRPV) in the French West Indies (Figure 1).

For example, diagnostic techniques developed or optimized at CIRAD (Le Provost *et al.*, 2006; Teycheney *et al.*, 2007) have been transferred to the French Plant Protection Services (SRPV) and are now used routinely for diagnostic purposes. On the other hand, SRPV has established surveillance networks firmly in place whose activities fuel CIRAD's research activities on the epidemiology of plant diseases such as Black Sigatoka.

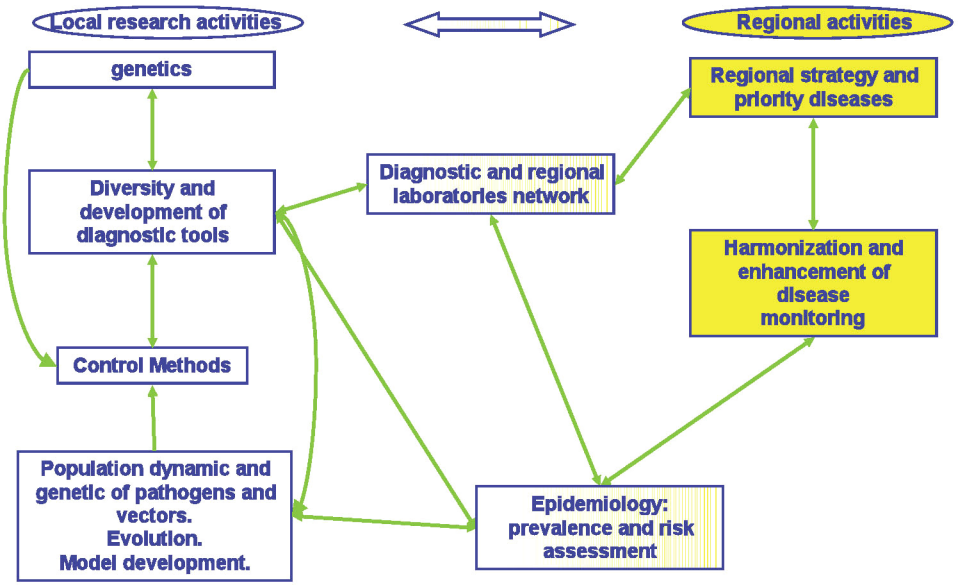

Figure 1: Interdependence of research and epidemiological surveillance activities in the French West Indies. Research and development conducted by CIRAD provides techniques implemented by SRPV and its partners.

3. PANDOeR, a Surveillance Network for Plant Pests and Pathogens in the French West Indies

The PANDOeR network (PAthologies Nouvelles : Détection, Observations, eRadication / New pathologies: diagnoses, observations and eradication) was established in 2007 by SRPV in Martinique (Iotti *et al.*, 2008) in collaboration with CIRAD, the Fédération Régionale de Défense contre les Organismes Nuisibles (FREDON), the Laboratoire Départemental d'Analyses (LDA), and professionals from the agricultural sector, such as growers. This network serves several purposes:

- Early detection of the introduction of plant quarantine pests or pathogens. This is achieved by observations (for symptoms and insects) on sentinel plots and sampling (including random insect trapping) on a regular basis from control fields (Figure 2). The samples are analysed in disease diagnostic laboratories and the trapped insects are identified by experts in the French National Plant Health Laboratory or in the French Natural History Museum.
- Implementation of appropriate eradication or containment measures.
- Increased collaboration between agriculture, plant protection and research sectors.
- Training of farmers in symptom recognition.
- Training of technical staff in diagnostic techniques.
- Public awareness campaigns targeted on potential damage caused to agriculture and environment by quarantine pests and pathogens.
- Data mining for fighting strategies developed elsewhere, and information updates for network members.

The PANDOeR network currently covers several quarantine pests and pathogens that are present in the Caribbean area but still absent from the French West Indies:

- Black Sigatoka disease, caused by the fungus *Mycosphaerella fijiensis* (Figures 2A and 2B), and Moko disease, caused by the bacteria *Ralstonia solanacearum* race II. Both diseases are devastating for banana and plantain.
- Coconut lethal yellowing disease (Dollet *et al.*, 2009), caused by a species of phytoplasma (specialised bacteria that are obligate parasites of phloem), is transmitted by an insect vector, *Myndus crudus*. Both the phytoplasma and this vector are absent from the French West Indies. This disease causes the death of coconut palm trees.
- Fruit flies
    - *Anastrepha* sp., *Bactrocera* sp., *Dacus* sp., *Ceratitis* sp. cause important yield losses on fruit trees [citrus, mango, guava (*Psidium guajava)*, starfruit (*Averrhoa carambola*), etc.] on several Caribbean islands; only *Anastrepha obliqua* is present in the FWI.
    - Species *Raoiella indica* is present in the French West Indies, and biological control by natural predators is being investigated (Figure 2D).

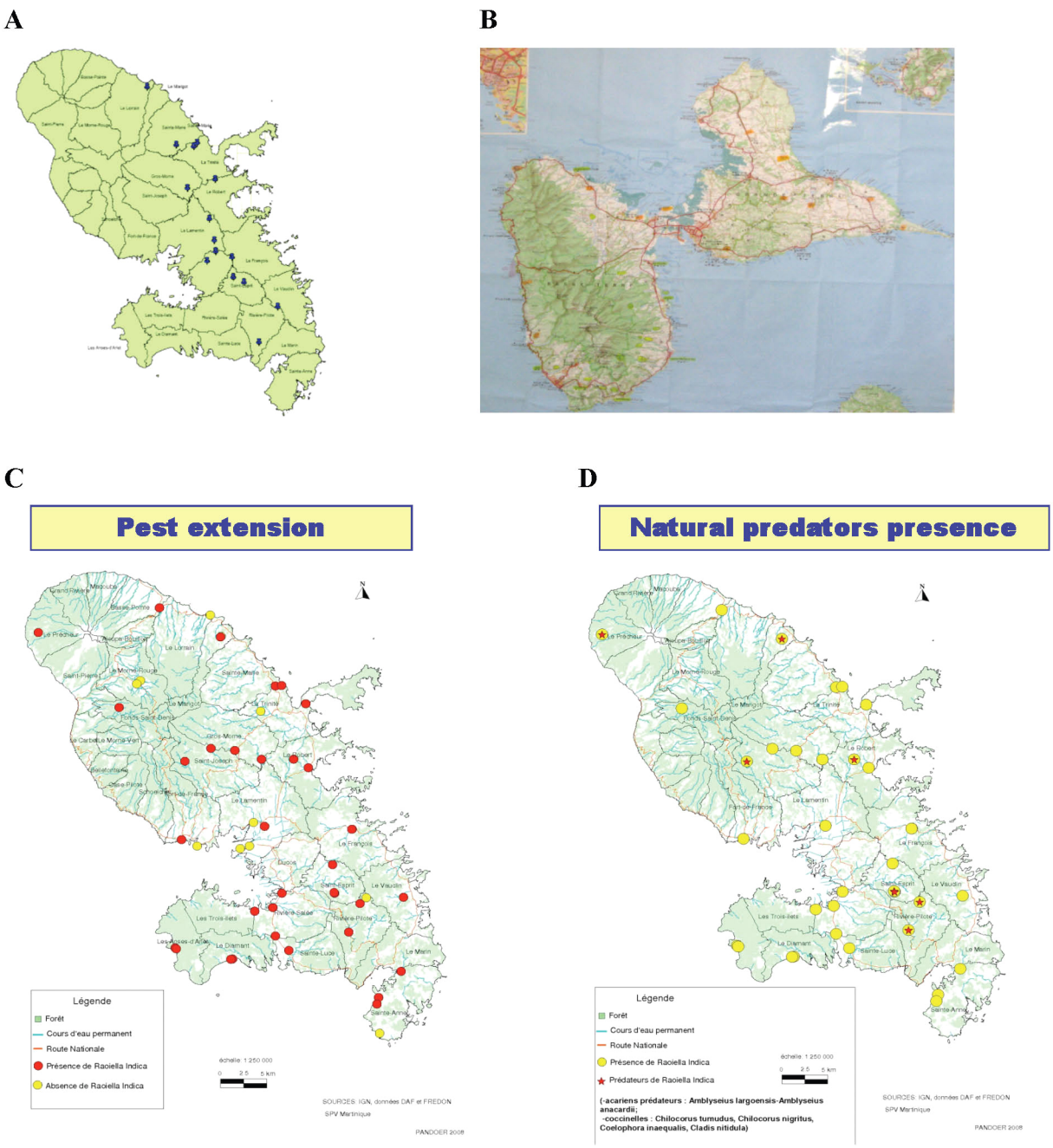

Figure 2: Location of control fields used for monitoring Black Sigatoka disease in Martinique and Guadeloupe and *Raoiella indica* mites in Martinique. Sentinel fields used for monitoring Black Sigatoka disease in Martinique (A) and Guadeloupe (B); control fields used for monitoring *Raoiella indica* in Martinique showing locations where the insect is present or absent (C) and where its natural predators have been reported (D).

CONCLUSIONS

Although the Caribbean Region currently lacks a Region-wide epidemiological surveillance network for plant pests and pathogens, several initiatives such as CRISIS, CISWG, or the more recent Caribbean Plant Health Directors Group and its Technical Working Groups have laid the foundation for such a network. In particular, the latter initiative has achieved important goals in just a couple of years, such as a priority pest list, which is updated yearly, and the establishment of several technical working groups focused on specific pests and pathogens such as red palm mite, palm pests, giant African snail, fruit flies and lethal yellowing. Several additional Technical Working Groups are being established on additional pests and pathogens such as cocoa frosty pod rot, citrus canker and greening. The members of these Technical Working Groups are meeting on a regular basis and exchanging data through email discussion groups hosted by CARDI.

On a more local scale, the French Plant Protection Services have developed a network for the surveillance of several important pests and pathogens of important crops. This network is being extended to additional important pests and pathogens that threaten strategic crops in the Caribbean, such as Huanglongbing (citrus greening). It could be extended to other countries within the region.

These initiatives could serve as the backbone of a future Caribbean Plant Health Network, whose roles would include the networking of institutions and professionals involved in plant protection, the dissemination of information on plant protection to producers, stakeholders and researchers, and recommendations to government agencies regarding plant protection and food security in the Caribbean.

However, the key aspects for the successful development and implementation of such a Region-wide network are numerous and include:

(i) appropriate staff, infrastructures and equipment in participating institutions, especially local diagnostic laboratories and enhanced transnational cooperation and partnerships,

(ii) updated schemes for staff training in participating institutions, in order to benefit from the most recent advances in disease and pest surveillance, and

(iii) political will of government agencies to implement and enforce disease and pest control strategies.

Currently this issue ranks high on the political agenda because it is compulsory under the WTO/SPS Agreement that Caribbean countries meet the required sanitary and phytosanitary standards, measures and guidelines for trading agricultural goods.

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