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The European PLANTFOODSEC project: framework for a national approach to analyse and prioritise plant health risks

P. Reynaud [Philippe.Reynaud@anses.fr] (1), C. Le Fay-Souloy (1), B. Moignot (1), F. Suffert (2)
(1) ANSES, Laboratoire de la santé des végétaux (LSV), Unité expertise des risques biologiques, Angers, France
(2) INRA, UR1290 BIOGER-CPP, Campus AgroParisTech, Thiverval-Grignon, France

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The expert unit on biological risks at the ANSES Plant Health Laboratory (LSV) has been partnering INRA—the French National Institute for Agricultural Research—since 2011 for the European PLANTFOODSEC project supported by the European Union under its Seventh Framework Programme (http://www.plantfoodsec.eu/). This project addresses the issue of the biosecurity of crops and other products of plant origin for food consumption. One of its main aims is to set up a network of excellence within Europe. This five-year project has been allocated six million euros of EU funding. Kicked off in February 2011, it now boasts a dozen European and international partners (see box).

The theme of crop biosecurity was already examined by the European research project CROP BIOTERROR from 2005 to 2008. Agroterrorism in its widest meaning, including biological warfare, bioterrorism, biocrime and sabotage, was defined therein as the deliberate and malevolent use of pathogens by an individual, organisation or State in order to damage the health of plants (crops, trees or agricultural commodities) or animals, or even affect the use able to be made of them in terms of production, marketing, processing or consumption (Madden & Wheelis, 2003; Suffert *et al.,* 2008; Stack *et al.,* 2010; Waage & Mumford, 2007). A small group of INRA scientists analysed the potential consequences of such acts within Europe using an assessment method designed firstly to characterise the various threats and risks, and then to assess and analyse them (Figure 1; Latxague *et al.,* 2007; Suffert *et al.,* 2009). The first, forward-looking, step entailed together imagining all the possible objectives of perpetrators and selecting for each one a well-suited plant pathogen. The second step entailed documenting this approach so as to develop it into an operational assessment method. This meant drawing up a list of potential pathogens that could be a threat to European crops and forests then detailed description and analysis of different scenarios and finally, design and application of a risk assessment procedure.

The fact that numerous decision-makers take this threat seriously, even though they consider it unlikely, is a paradox that may be explained by the fog surrounding components of risk, euphemistically described as manmade risks. Characterising such risks has required reconciling a broad range of knowledge that no one public institution is capable of either collecting or structuring on its own. The "hybrid" nature of the threat is one of the main findings of this characterisation. The risk is not a simple combination of factors able to be analysed independently, which is a far too reductionistic view. Improving the ability of France and the European Union to prevent a malevolent act implies the cooperation of all the parties involved in agricultural biosecurity, from national bodies responsible for plant health to customs authorities, law enforcement agencies, the bio-industry sector, farming and agrifood professionals, higher education facilities and research institutes. ANSES and INRA are deliberately positioned upstream of any epidemiological surveillance.

One of the aims of the PLANTFOODSEC project is to develop a Europewide capability in order to prevent or, if necessary, respond to malevolent acts likely to affect crop biosecurity. One of the tasks of the INRA-ANSES group is to analyse the risks posed by pests harmful to agricultural ecosystems (whether cultivated or natural landscapes), whether the threats are natural (well-known and emerging pests), accidental (introduction of an exotic pest justifying international plant quarantine measures) or intentional (malevolent acts and agroterrorism). What do these three types of threat have in common? One common point is their diffuse nature, difficult to predict mainly because events may be various, rare, hidden or even unknown. They cannot therefore be subject to experiments in the conventional sense of the term; another is the need for expert appraisals and assessments from different government players, including those in research, agricultural or defence sectors, and certain professional agricultural activities. The work carried out by

Liste des partenaires du projet PlantFoodSec

1. Centro di competenza per l'innovazione in campo agro-ambientale (AGROINNOVA) of Turin University, Italy.
2. National Institute for Agricultural Research (INRA) and the ANSES Plant Health Laboratory (LSV), France.
3. National Institute of Agricultural Botany (NIAB), United Kingdom.
4. Food and Environment Research Agency (FERA), United Kingdom.
5. Institute for crop sciences and resource conservation, University of Bonn, Germany.
6. Regional Environmental Centre (REC), Hungary.
7. Imperial College London, United Kingdom.
8. Middle East Technical University (METU), Turkey.
9. United Nations Crime and Justice Research Institute (UNICRI).
10. Agricultural Research Organization, Israel.
11. National Institute for Microbial Forensics & Food and Agricultural Biosecurity (NIMFFAB) of Oklahoma State University, United States.
12. Great Plains Diagnostic Network of Kansas State University, United States.

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the INRA-ANSES group calls for a multidisciplinary approach, involving epidemiology, entomology, risk science, management sciences and agronomics. PLANTFOODSEC's original feature lies in the decision to use a variety of approaches, which reveal today's difficulties in identifying and prioritising certain plant health risks.

The PLANTFOODSEC project focuses on eight tasks:
1. epidemiology of plant disease applied to crop biosecurity;
2. food biosafety;
3. risk analysis related to the deliberate introduction of pests (regulated or not);
4. detection and diagnostic systems;
5. pest eradication and containment;
6. training on crop biosecurity and food biosafety;
7. raising awareness and communicating with stakeholders;
8. project management and coordination;

The LSV's Expert unit on biological risks is most deeply involved in tasks 1 and 3, mainly through the following activities:
- drawing up a list of strategic crops based on criteria specific to agroterrorism. This list is actually a shortlist of a longer list of about 500 plant species currently in the final drafting stages; it constitutes one of the preliminary results;
- drawing up a list of harmful organisms such as insects, fungi, bacteria, viruses and nematodes likely to reduce crop biosecurity. This list is again a shortlist of a longer list of about 500 pests also in the final drafting stages and based on a previous list established during the CROP BIOTERROR project. It is being finalised under the terms of an ongoing study to devise a method for prioritising pests requiring quarantine measures awarded to the LSV by the French Agriculture Ministry in order to allocate resources rationally. This study proposes an analytical method for identifying priority pests on the basis of scientific and technical data (MacKenzie *et al.,* 2007; Parker *et al.* 2007) then for prioritising the methods developed for their management (Russell *et al.,* 2006);
- implementing a simplified approach to prioritise the risks posed by plant pests in the framework of agroterrorism;
- contributing to a precise analytical procedure developed in cooperation with Imperial College (UK). Part of the methodology being developed is based on research for the CROP BIOTERROR project. The method will be applied to the list of pests drawn up for the second point above. This work will be led by INRA in close cooperation with the LSV as concerns mobilising the results acquired during the European PRATIQUE project (Baker *et al.,* 2009). The LSV participated in this recently-finished project, which led to the development and improvement of plant health risk analysis tools. Significant progress was made for example in (i) the choice of mathematical models for the potential distribution of pests depending on the quality of data (Dupin *et al.,* 2011) using as a model the corn root worm (*Diabrotica virgifera virgifera*) or (ii) mapping techniques for areas in danger of invasive pests (Baker *et al.,* 2011);
- contributing to the definition of primo-detection challenges: detection of atypical symptoms or rare events, monitoring quality and detection of "signals", unbiased search protocols (not specific to agroterrorism);
- contributing to a multi-player simulation named "Crop Biosecurity Real Game Experience" organised and conducted by INRA. The exercise aims to involve all the French role-players concerned by a plant health emergency caused by a malevolent act. It will be based on the analysis of scenarios developed during task 3 (Risk analysis), which complements the national biological risk assessment that INRA and the French Agriculture Ministry's Defence Mission have been participating in since 2011. This kind of approach does not

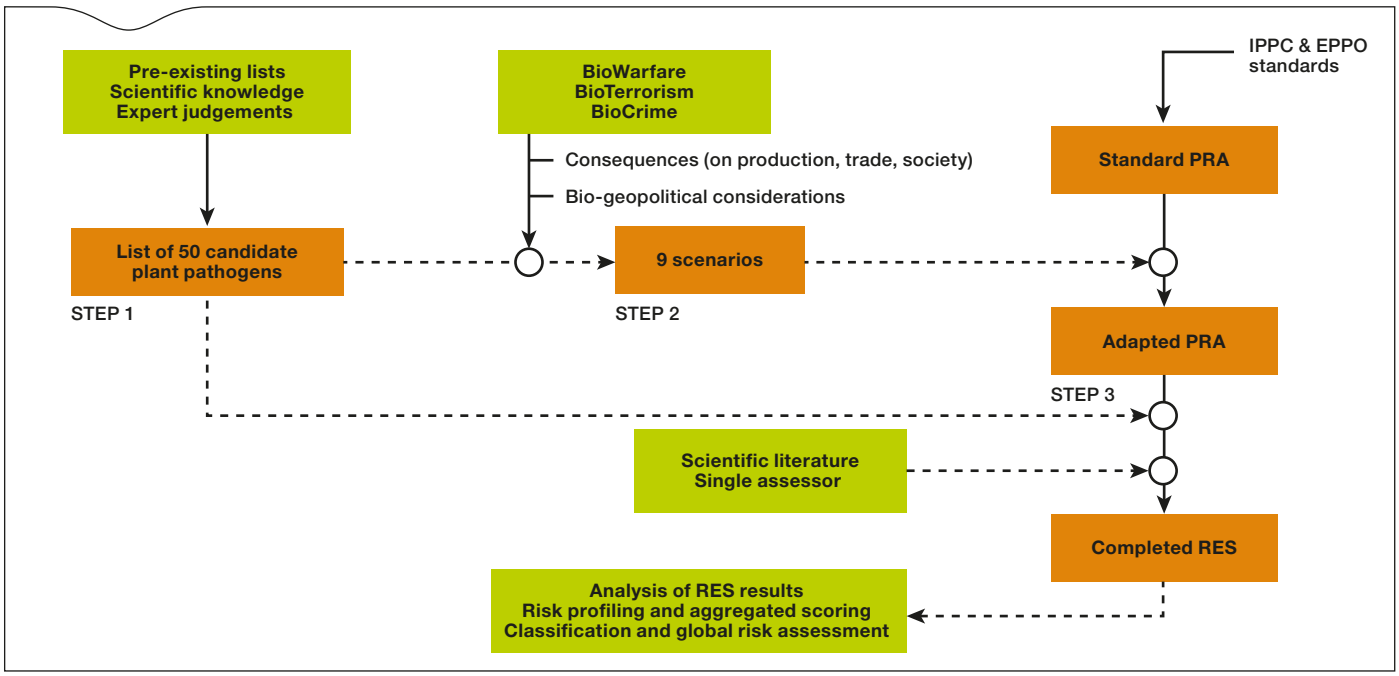

Figure 1. Diagram of the methodology used for assessing the risk posed by the deliberate and harmful use of plant pathogens (agroterrorism) within Europe, including the Risk Evaluation Scheme (RES) as per Latxague *et al.*, 2007.

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make an event that is unlikely to occur more predictable, but anticipates its impact in terms of vulnerability and the response required to control it.

The LSV's Unit on development of analytical methods will focus on task 4 (Detection and diagnostic systems) and in particular:

- gathering information on the French and European surveillance and diagnostic system (structure of the current surveillance network, list of laboratories, list of skills), together with a review of Europe's capabilities conducted by the National Institute of Agricultural Botany (NIAB), United Kingdom;
- the setting up of a European diagnostic network to foster international cooperation between laboratories and focusing on laboratory practices, equipment, analytical methods and training.

The LSV's involvement in this project grants ANSES, as INRA's partner, recognition as a contact point within any European system to be mobilised in response to an agroterrorism threat.

In keeping with its main research tasks, INRA's fundamental research will focus on acquiring and analysing epidemiological data for task 1 (Disease epidemiology). Septoria leaf blotch (*Mycosphaerella graminicola*) and wheat leaf rust (*Puccinia triticina*)—two diseases with a major economic impact in Europe—were chosen as experimental pathosystems to simulate the emergence of a disease (harmless to the environment) and propose a relationship between epidemiology—a discipline using experimentation—and biosecurity, which is an issue that in its very principle excludes studying a pest in unconfined conditions. This research is designed to:

- shed light on the multi-annual recurrence of septoria leaf blotch outbreaks (Suffert *et al.,* 2010), with a particular focus on assessing *M. graminicola*'s ability to survive. The initial findings of a multi-annual trial have shown that septoria leaf blotch outbreaks occurred earlier in fields containing debris from the previous wheat crop (local source of ascospores); this difference was cancelled out within a few weeks, however, probably when the mobilisation of a more distant source of inoculum exceeded that of the local inoculum. An ongoing PhD thesis funded by the PLANTFOODSEC project aims to develop methods to determine the nature of the inoculum, its effectiveness during the contamination process and the origin of the contamination responsible for initiating an outbreak (trapping of ascospores in the field in conjunction with quantification through qPCR; Figure 2);
- elucidate the survival of P. triticina from one year to the next both quantitatively (population) and qualitatively (structure of the populations). P. triticina is a biotrophic parasite which only develops in living leaf tissue. The goal is to test out the hypothesis that volunteer wheat is a local source of primary inoculum (Sache *et al.,* 2009). The epidemiological data from the first three years of monitoring, collected in South-West France in cooperation with DRAAF-SRAL Midi-Pyrénées, are currently being analysed. Volunteer wheat contaminated by *P. triticina* (Figures 3 and 4) is distributed sporadically and heterogeneously throughout the landscape. Only models can be used to reconstruct initial contamination. The specific challenge of this research in terms of biosecurity is to develop a method to detect the emergence or introduction of *P. triticina* as early as possible.

Beyond concerns of agroterrorism, the issue of agricultural biosecurity raises several scientific questions and offers an opportunity to reactivate a national or European epidemiological surveillance system to protect crops. Thus, the skills to be acquired and meaningfully organised will help pinpoint risks and lead to proposals for improving current biosecurity systems. The PLANTFOODSEC project is also helping to consolidate the relationship between INRA and ANSES, two complementary public scientific bodies.

Most of the considerations and issues raised by the CROP BIOTERROR project have been taken up nationally, some being


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Figure 2. Volumetric spore trap (Burkard) in an experimental plot of wheat at INRA, Grignon, during the early winter phase of a septoria leaf blotch epidemic.


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Figure 3. Wheat debris and volunteers in a field during the autumn.


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Figure 3. Pustules of *Puccinia triticina* (wheat leaf rust) on volunteer wheat during the autumn.

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particularly topical e.g. "Which risk analysis methodologies for which decisions?" The world of research is now clearly involved in the development of expert systems for biosecurity needs. The very recent creation of an ANSES Expert Committee on plant health, with significant participation of scientists from INRA, CIRAD and various universities, may advance collective biosecurity expertise. The development of new research capacities, such as strain collections and reference specimens, detection and identification systems, technology portability and geo-referenced databanks, is further proof.
The formulation of these new issues is fostering partnerships between public bodies so as to map out and implement biosecurity policies. Ethical issues remain at the forefront. They are unavoidable both for ANSES, in relation to the general framework of risk assessment procedures, and other role-players concerned with the “dual use” issue of not only resources and technologies, but also scientific knowledge and expert networks, which now has multiple facets (Kuhlau *et al.,* 2008).

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