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EDITORIAL Security Panel review



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The vast majority of plant-derived foods that are produced for human or animal consumption are safe and wholesome. However, the often complex production and distribution systems are not immune to a range of potential threats in the “seed to salad on the plate” food chain. There are a wide range of protective systems in place to prevent the adverse consequences of natural, accidental or malicious contamination, including disease outbreaks affecting both food plants and consumers.

Many of these protective measures have been established either following significant outbreaks in the plants themselves, or because of an adverse effect on consumers. The strong science base that exists in this field builds on the need to prevent and respond to such events and has made major contributions to the prevention and control of disease and contamination at all stages of this part of the food chain.

The PLANTFOODSEC project is part of a wider programme of studies funded by the EU to enhance resilience to malicious, accidental and deliberate releases of infectious agents, and there is little doubt that a number of capability and capacity gaps have been filled at its conclusion. The project has brought together key members of the international scientific community who understand plant production methods and who have experience in developing, establishing and using tools to enhance biosecurity and safeguard the plant food chain.

As part of the project team, a small group of specialists (the Security Panel) provided internal review and guidance on areas where there is potential for misuse for malicious purposes. In reality, this function provided reassurance to the project team regarding the value of publishing and disseminating their work, since their outputs serve to reinforce protective measures rather than highlight major gaps in knowledge and vulnerabilities in the food chain. The panel also encouraged collaboration with other

agencies and promoted project outputs to those engaged in emergency response, in particular with the protection of agricultural food production systems.

As we live in an ever-changing world, vigilance is essential in order to identify new and emerging issues that could have an impact on production capacity, plant biosecurity or food safety and food chain resilience. The PLANTFOODSEC project developed tools and datasets to support an appropriate response to predictable issues. With a project team encompassing major European countries and candidate EU member states, Israel and the USA, perhaps the key gap that this project has filled is in developing a shared understanding of the topic at an international scientific level. Further work is needed in order to reinforce the successes of this project, and one way of doing this is the development of a virtual centre of competence. The PLANTFOODSEC consortium is working to make the virtual European Centre of Competence on Plant and Food Biosecurity a sustainable reality by building the capability to ensure the broad implementation of the project results.

This might also be a model for closely related topics, for example in the area of animal health.

Christian Patermann
Fausto Pedrazzini
Paul Robb

PLANTFOODSEC Security Panel

PLANTFOODSEC FINAL REVIEW



Harvesting project outcomes

New strategies for responding to and recovering from both intentional and unintentional biosecurity threats to EU agriculture, developed by the PLANTFOODSEC project, were presented in Brussels at the Permanent Representation of the Piedmont Region on January 19, 2016.

The workshop “Tools for Plant and Food Biosecurity” focused on the results of the five-year project that was launched in February 2011 with the support of the European Commission under the Security area of the Seventh Framework Programme. The project was established specifically with the aim of creating a virtual centre of competence at international level in the field of biosecurity.

The considerable amount of research promoted by the European Union – which has also involved non-EU countries such as the United States, Israel and Turkey – has made possible the development of a comprehensive set of tools to enable end users to respond rapidly in the event that pathogens are accidentally or deliberately introduced into crops and the agro-food supply chain.

The PLANTFOODSEC toolbox includes the following features:

- **Assistance in the identification of target crops and target pathogens.** A list of 555 target plants and crop products relevant to Europe was drawn up, and in addition 570 pests were identified. Criteria for prioritisation were also identified.
- **A tool for the prioritisation of target human pathogens on plants (HPOPs).** Human enteric pathogens such as Shiga toxin-producing *Escherichia coli* and *Salmonella* spp. were analysed in order to provide

guidance on the prioritisation of the risks involved in any future HPOP incident.

- **Analytical methods for the identification of microbial or toxin contamination.**
- **A decision tool to determine whether a foodborne illness was introduced intentionally.** The tool has been supplemented with example scenarios for training purposes.
- **A forensically valid microbial strain discrimination technology, based on multilocus variable tandem repeat assessment (MLVA).** The technology was developed for non-O157:H7 *E. coli*, a foodborne pathogen of increasing EU concern.
- **A risk assessment tool.** The tool was developed to enable rapid assessments of agro-terrorism scenarios. The tool is based on pest risk assessment (PRA) schemes but includes agro-terrorism threats. It has been demonstrated on almost 100 scenarios. The results indicate how the threat posed by different scenarios might be reduced and how responses might be improved.
- **The PLANTFOODSEC web-based virtual diagnostic network.** The network allows information to be gathered, searched and reported, and also makes possible information flow between experts and field workers. The network provides a unique tool for the community and allows member countries to access summary information on disease outbreaks in Europe.
- **Management programmes against various outbreak scenarios.** The measures to be taken in order to prevent the establishment and spread of harmful crop pathogens have been established by identifying activities and responsibilities following pathogen introduction.

Besides the toolbox, project achievements include the identification and regulatory analysis of biosecurity challenges; experimental and modelling approaches applied in plant disease epidemiology; advanced molecular diagnostics; and, more generally, training, dissemination and networking activities to increase awareness of plant biosecurity and food safety among agronomists and food producers and within the scientific, policy and inspection sectors.

More than 30 peer-reviewed papers; almost 200 press articles; 20 dissemination events; 88 courses on diagnostics, plant pathogen forensics, transnational multi-sector training on responding to outbreaks, legislation and contained-use licensing, and the dual-use consequences of bioresearch; 4 summer schools and 1 winter school; and 8 PhD exchanges/internships among project participants. These are some of the numbers that convey an idea of the activities carried out by the project partners over the last five years.

WORK PACKAGE LEADERS' QUOTES

Seeds of success. Work package leaders reflect on PLANTFOODSEC's past and future



Frederic Suffert
 Institut National de la Recherche Agronomique (INRA)
 Epidemiology group leader (INRA BIOGER)
 WP 1 coordinator

"PlantFoodSec was a great opportunity to develop epidemiological investigations on two wheat diseases (leaf rust and leaf blotch), which are considered case studies in the context of crop biosecurity. Our collaboration with colleagues from Imperial College on agro-terrorism risk analysis was very interesting and fruitful, and the questions we sought to answer were complex and original."



Jacqueline Fletcher
 Oklahoma State University (OSU);
 National Institute for Microbial Forensics and Food and Agricultural Biosecurity (NIMFFAB)
 Researcher and Regents Professor
 WP2 coordinator

"Assuring plant and food biosecurity is a high priority for all nations, and the development of effective and reasonable strategies for doing so requires international cooperation and collaboration. Robust food production and food safety practices must be supported by practical, goal-oriented research and local and global communication. PLANTFOODSEC offered an opportunity for true synergism among partners from multiple European and associated countries to blend their expertise

and experience toward such goals through targeted research projects and the development of an international plant disease network."



John Mumford
 Imperial College of Science, Technology and Medicine
 Professor
 WP 3 coordinator

"This project has developed a risk assessment scheme for the range of threats from bio-crime to bio-terrorism and bio-warfare that is consistent with the wider European plant health risk assessment process. Additional factors related to motivation and opportunity complement the analysis of ecological and market factors. The PLANTFOODSEC approach ensures that security risks can be measured on a comparable scale with other plant health risks."



Jane Thomas
 National Institute of Agricultural Botany (NIAB)
 Head of Pathology Group
 WP 4 coordinator

"Our involvement in PLANTFOODSEC has facilitated the development of a 'virtual diagnostic network', constructed with the flexibility to be used internationally between partnering organisations in agreement, and privately by individual organisations. Uniquely, the network offers the means to share information on plant disease outbreaks across Europe. During the creation of this network, we received

highly valued support from Kansas State University, illustrating just part of the very productive interaction between American and European partners in this project."



Abraham Gamliel
 The Agricultural Research Organisation of Israel – The Volcani Centre
 Researcher
 WP 5 coordinator

"PLANTFOODSEC opened a wide window of cross-continent cooperation with intensive and productive collaboration on mutual theoretical and practical aspects and experiments. It advanced our performance and skills in the integrated mitigation of invasive pathogens. We also stepped into new topics such as forensic plant pathology and established new technologies for applying these within the PLANTFOODSEC objectives."



Christine Henry
 Food and Environment Research Agency (FERA)
 Team leader
 WP 6 coordinator

"Frequent exchanges of staff between partners promoted the integrity of the network of excellence so that we now have a coherent approach to a contingency plan for preventing and mitigating threats to the food supply chain in Europe."



Anita Kocic
 Regional Environmental Center for Central and Eastern Europe (REC)
 Expert, Environmental Policy Directorate
 WP 7 coordinator

"PLANTFOODSEC raised nationwide awareness about plant and food biosecurity in all participating countries. While cooperating over the past five years, the project encouraged us to identify and open up new platforms for further collaboration. The partnership was dynamic and open, with a multi-track approach."



Maria Lodovica Gullino
 Center of Competence for Innovation in the Agro-environmental Field (AGROINNOVA), University of Turin
 PLANTFOODSEC coordinator

"As biosecurity risks transcend national and regional boundaries, it is essential to monitor, assess and manage them in a coordinated way across the EU. In the period 2011–2016, PLANTFOODSEC took the first steps needed to set up the virtual Centre of Competence on Biosecurity, which it is hoped will become the backbone of the EU plant and food biosecurity scientific community."

WORK PACKAGE RESULTS 1/2



WP1 Plant disease epidemiology applied to crop biosecurity

The goal of the WP1 was to establish a framework of scientific knowledge and appraisal tools in relation to deliberate contamination, the outbreak of epidemics, the spread of disease, and patterns of propagation.

In Task 1.1 a short list of 21 target plants and trees important for Europe (among 451) was drawn up ; 61 pests (among 522) were identified as harmful organisms likely to threaten crop biosecurity.

In Task 1.4. the INRA group assessed the build-up, persistence and release of primary inoculum and the early stages of epidemics of selected pathogens to differentiate between the consequences of natural and deliberate field contamination.

Two important pathogens of wheat, *Puccinia triticina* (the cause of leaf rust) and *Zymoseptoria tritici* (the cause of septoria leaf blotch) were used as cases of study. By combining experimental and modeling approaches, we increased knowledge on the build-up, persistence and release of primary inoculum of the two pathogens. Initially developed in the context of biosecurity and analysis of agroterrorism threat, our research also produced knowledge of practical interest to growers, who have to control the two diseases every year. For the study of primary inoculum in leaf rust epidemics, which was postulate to survive on wheat volunteers during the interepidemic season, fungal isolates collected on volunteers in the field were pathotyped for virulence using a set of differential wheat varieties that

differed by their resistance factor. The genetic diversity was far greater than expected from previous knowledge of the fungal populations. An original model, which takes into account the relative small size and high diversity of the sample, was developed and used for tracking the early onset of leaf rust epidemics (*P. triticina*) in a rural landscape as a case study. This model take into account the relatively small size and high diversity of the sample.

Plant debris are a known source of inoculum for many plant pathogenic fungi. Primary inoculum of *Z. tritici* was the core topic of David Morais's PhD thesis ("Components of the early stages of septoria tritici blotch epidemics (*Zymoseptoria tritici*): Quantity, efficiency and origin of primary inoculum") successfully defended in April 2015. The amount, efficiency and origin of primary inoculum was established (please refer to the three papers listed at the end of this note for more details).

The INRA scientists participating in this WP are J Berder, V Garreta, H Goyeau, J Moinard, D Morais, I Sache, S Soubeyrand, F Suffert and V Laval.



WP2 Food biosecurity

Following an outbreak of microbially caused foodborne human illness, investigators must assess whether it was caused intentionally in order to determine the need for a criminal investigation. PLANTFOODSEC scientists are creating a decision-making tool for use by investigators to assess the likelihood that an outbreak of foodborne illness was caused naturally, accidentally or intentionally. The decision helps investigators to determine the most appropriate outbreak response. The tool will be supplemented with a training exercise, in which participants will be guided to apply the tool to evaluate a fictitious example scenario of a foodborne illness. Partners at ARO, UNIBONN and OSU examined current standards for mycotoxin analysis in food with an emphasis on minimum assay requirements for applications in a biosecurity context. A position paper on this topic is under review. All WP2 partner groups are reviewing lessons learned in previously completed WP2 activities, tasks and deliverables, which will serve as the basis for a final project review paper on food safety and security in the EU.



WP3 Analysis of risks posed by the intentional introduction of new pests and disease agents

WP3 partners have demonstrated the PLANTFOODSEC risk assessment tool on almost 100 scenarios covering a wide range of potential motivations, biological agents, pathways and receptor systems. The scenarios were selected for analysis through a systematic review of risks of varying significance, and are representative of threats potentially faced in Europe. PLANTFOODSEC has built on previous reviews in the CROPBIO-TERROR project. It takes the work a stage further by providing a risk assessment tool that is also consistent with conventional plant health assessments protocols. The assessment uses 15 criteria related to the feasibility of agent use, agent introduction and spread, receptor vulnerability, perpetrator motivation, and stakeholder reaction. The threats from the various bio-crime, bio-terrorism and bio-warfare scenarios were assessed for currently prevailing conditions, and the results provide a ranking of these threats. The tool allows the effects of potential prevention and mitigation measures to be assessed by re-evaluating the ratings of appropriate criteria to reflect a managed situation. The results indicate how the threats posed by the different scenarios could be reduced and provide a means to improve responses by comparing approaches to risk reduction for the scenarios concerned.

WORK PACKAGE RESULT 2/2



WP4 Diagnostic and detection systems

The main outcome of WP4 is the construction of a diagnostic network that contains the following elements: a database of diagnostic laboratories and expertise in the EU28; a community resource detailing plant pathogen news, updates on diagnostic techniques, training and workshop information; and a structure to allow the uploading of diagnostic records and their interrogation. The network thus provides a tool for the community that is not available elsewhere, and a means for member countries to access summary information on disease outbreaks in Europe. The system may also be used privately by laboratories, and different permission levels can be set by users. Facilities include the potential for agronomists and field walkers to upload unconfirmed disease reports so that outbreaks can be followed in real time, while retaining scientific robustness for final, validated and confirmed reports. The network structure will be maintained at NIAB after the end of the project. WP4 has also delivered reports on food and produce traceability systems, a handbook on approaches to biosecurity, and an inter-laboratory validation of a molecular approach to detect new pathotypes of *Leptosphaeria maculans*, a fungal disease of oilseed rape with EU-wide significance. Throughout WP4, the cross-cutting study of the *Fusarium proliferatum* onion pathosystem has provided generic principles for approaches to the characterisation of emergent diseases that constitute a threat to crop biosecurity.



WP5 Response systems for eradication and containment

The objective of WP5 was to prevent the establishment and spread of deliberately introduced invasive pathogens within EU countries by delineating the steps and measures to be executed at European level, and by enhancing the available response measures.

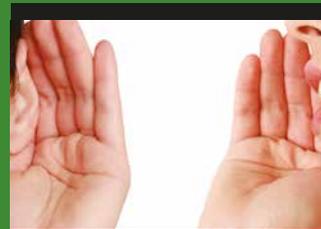
The main outcomes of WP5 are:

- Three white papers, the first reviewing regulations across countries; the second proposing a flowchart of possible cooperative inter-linkages among countries and agencies for mitigation in threat situations; and the third highlighting legislation issues among the countries that may cause difficulties in responses to deliberately introduced pathogens.
- A database of European and international expertise for contingency plans.
- A flowchart of activities and responsibilities related to interdisciplinary action following pathogen introduction, together with comparative containment eradication protocols for pathogens and a practical protocol for the list of pathogens.
- An experimental model for testing and validating containment eradication protocols (the *Fusarium proliferatum* – Allium cepa pathosystem). This pathosystem also served for the development of technologies for the forensic study of an outbreak, and specifically for assessing the source of the occurrence of a disease.



WP6 Training on plant and food biosecurity

WP6 aims to build up a strong culture of awareness and compliance in terms of plant and food biosecurity among those with responsibilities in all sectors of agriculture and food production by harmonising expertise across the network and by organising regular trans-national and multi-sector training courses on preventing, containing and responding to bioterrorism and/or naturally occurring disease outbreaks, taking into account ethics and the dual-use consequences of bioresearch. The implementation of activities under this work package was related to the training of network partner personnel in order to ensure a network that has the practical skills to deliver the overall project aims. The work package also had a role in the dissemination of information and the training of non-network actors in order to promote understanding of plant and food security, particularly among students, who are the scientists of tomorrow. To date, project partners have delivered 23 courses on diagnostics, 37 courses on plant pathogen forensics, 21 transnational multi-sector training courses on responding to outbreaks, two courses on legislation and contained-use licensing, five academic courses on the dual-use consequences of bioresearch, and four summer schools and one winter school on topics such as field diagnostics, mycotoxin analysis and human pathogen forensics. Eight PhD exchanges/internships among project participants have been completed in order to cement relationships within the network.



WP7 Dissemination, awareness and communication on plant and food biosecurity

WP7 was part of a comprehensive strategy to enhance knowledge among target groups and to inform relevant stakeholders throughout the project. Among the deliverables, several materials have been produced, a website developed and constantly updated, workshops and dissemination events organised, and scientific publications produced. A network of stakeholders in the project countries was identified by means of the creation of a project database, which corresponds to the short-term and long-term objectives of PLANTFOODSEC. A two-fold plan for interacting with the identified stakeholders was developed, focusing on both passive and active collaboration. Passive collaboration involves adding the network of stakeholders to the project mailing list and regularly disseminating PLANTFOODSEC project deliverables. Active collaboration involves direct communication with the identified stakeholders, followed by personal invitations to project meetings and events. This interactive communication will lead to an effective dissemination policy, increase the exchange of knowledge, and contribute – in the long term – to the creation of a “real” network. The efforts of WP7 contributed to achieving the final project goals – namely, to improve awareness among stakeholders and the general public by networking with other projects and institutions, and to ensure the availability of results to a wide public of end users.

WORK PACKAGE RESULT 2/2



WP8

Management and monitoring

The activities of WP8 included enhancing networking, overcoming the fragmentation of partners' research, and facilitating and coordinating cooperation within and among the WPs.

Besides administrative tasks (organisation of project meetings, reporting), specific efforts were devoted to network sustainability, with the setting up of a special team to deal with the search for funding sources. While funding opportunities for research on food biosecurity and intentional threats to plant biosecurity are still under investigation, the sustainability of network research on unintentional threats to plant biosecurity has been ensured to date via two initiatives, approved under Horizon 2020 Societal Challenge 2 (Food Security, Sustainable Agriculture and Forestry, Marine and Inland Water Research and Bioeconomy):

- "Effective Management of Pests and Harmful Alien Species – Integrated Solutions (EMPHASIS)" (2015–2019) www.emphasisproject.eu. This project has been approved within topic SFS3-2014, "Practical Solutions for Native and Alien Pests Affecting Plants", scope (A) "Native and Alien Pests in Agriculture and Forestry".
- "EU–China Lever for Integrated Pest Management Demonstration (EUCLID)" (2015–2019) www.euclidipm.org. This project has been approved under scope (B) "EU–China Cooperation on Integrated Pest Management in Agriculture" of topic SFS3-2014.

THE PROJECT IN NUMBERS

- 13 project partners
- 8 work packages
- EUR 6 million in EU funding
- 5 years of project implementation
- 3 continents

- More than 150 press clippings (web and print articles) published in the general press
- 37 courses on plant pathogen forensics
- Over 30 presentations at several scientific congresses
- 23 courses on diagnostics
- 21 transnational multi-sector training courses on responding to outbreaks
- 20 peer-reviewed publications quoting the project
- 33 papers in proceedings of scientific congresses
- 10 consortium meetings with internal, face-to-face dialogue and group discussions
- 3 articles in edited books published by the scientific press at the end of the project
- 10 issues of the newsletter
- 8 PhD exchanges/internships completed among project partners
- 7 press releases
- 6 external dissemination events and exhibitions on biosecurity and research
- 5 academic courses on the dual-use consequences of biosecurity
- 4 summer schools on field diagnostics, mycotoxin analysis and human pathogen forensics
- 3 leaflets published
- 3 workshops (launch, mid-term, closing)
- 3 posters
- 2 courses on legislation and contained-use licensing
- 1 winter school on field diagnostics, mycotoxin analysis and human pathogen forensics
- 1 roundtable with high-level participants from the EU
- 1 promotional activity on Italian television
- 1 video developed by DG ENTR
- 1 project website, including a public area, a "partners only" area and a press area

THE PROJECT // Five years, EU funding of EUR 6 million, 13 partners, eight work packages and three continents: these are the numbers that sum up the project “Plant and Food Biosecurity, Network of Excellence” (PLANTFOODSEC), launched in February 2011. The aim is to build a virtual centre of competence in order to increase the quality and impact of plant and food biosecurity training and research in Europe, thus enhancing preparedness and response capabilities to prevent, respond to and recover from biological incidents or deliberate criminal activity threatening the European agri-food system.



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