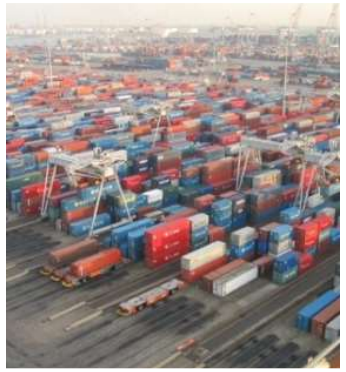
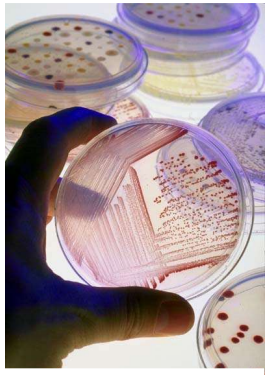
Biosécurité des cultures et agroterrorisme : caractériser la menace pour mieux gérer le risque





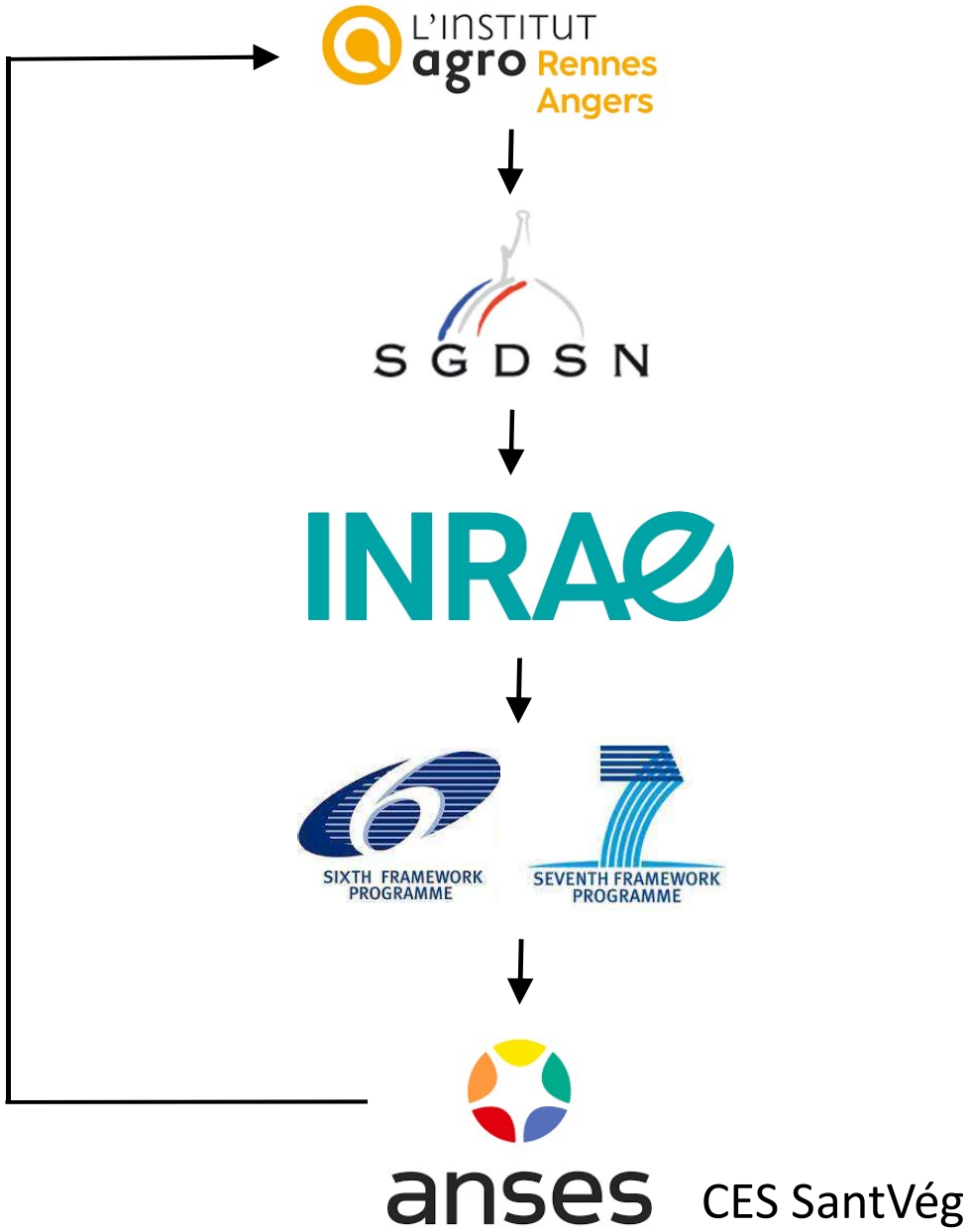



Frédéric Suffert

UR BIOGER

INRAE

Colloque AgroBioTech, campus AgroParisTech, 8 février 2024
« Risques biotechnologiques et biovigilance »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Impacts of plant diseases in agriculture

Fungi - Bacteria - Viruses

Pathogenic for plants
but not for human or animal

Direct yield losses = 20-40%

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Impact on global **food security**
(great famines, e.g. Ireland 1845)

Consequences
in the **modern bioeconomy**

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Several pathogen are **worldwide** and cause epidemic **every year**
→ cultural practices, resistant varieties, fungicides

Other pathogens are **localized**
→ phytosanitary measures (quarantine)

Plant pathogens are a geopolitical issue

Plant pathogens could be weaponized for malicious purposes

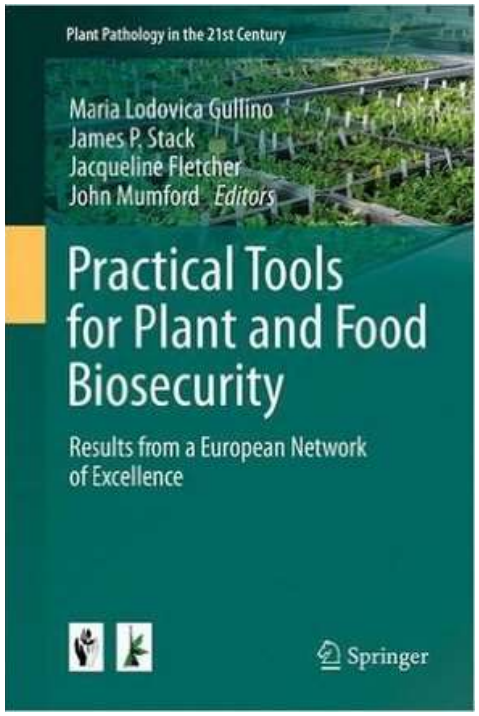
Agroterrorism = “utilisation délibérée et malveillante de bioagresseurs par un individu, une organisation ou un État, dans le but de provoquer des dommages aux plantes (cultures, arbres, denrées agricoles) ou d’affecter leur emploi (production, commercialisation, transformation, consommation)”

(Latxague et al., 2008)

There has never been a proven act of agroterrorism

How to characterize the threat?

Starting point = historical review



Typology of acts:

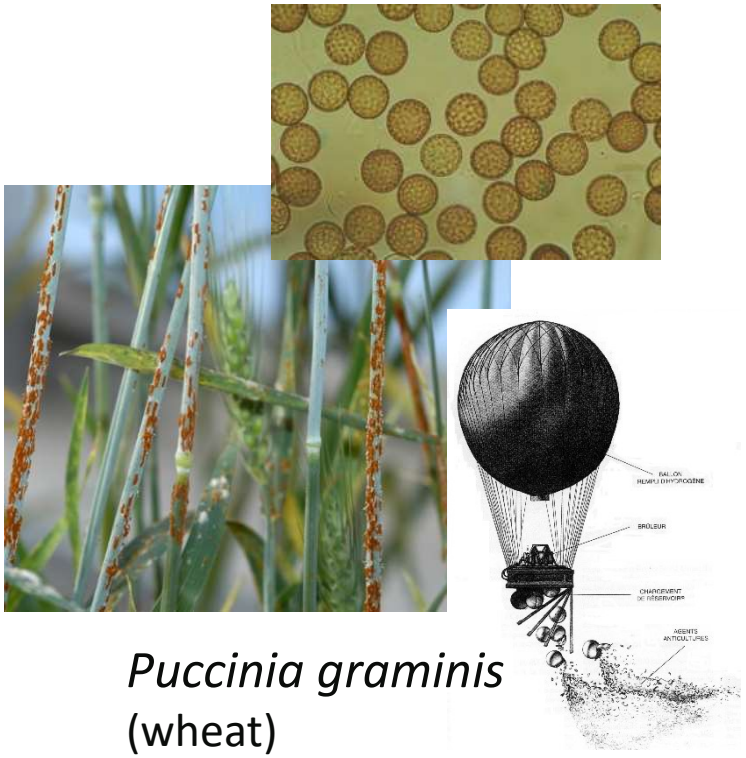
1. **State military programs**
2. **'Rogue state' hidden programs** and **agroterrorist attacks**
3. **Biocrime**, **sabotage**, but also **allegations** and conspiracy theories
4. **Misuse of phytosanitary standards**
to justify protectionist measures

Type 1

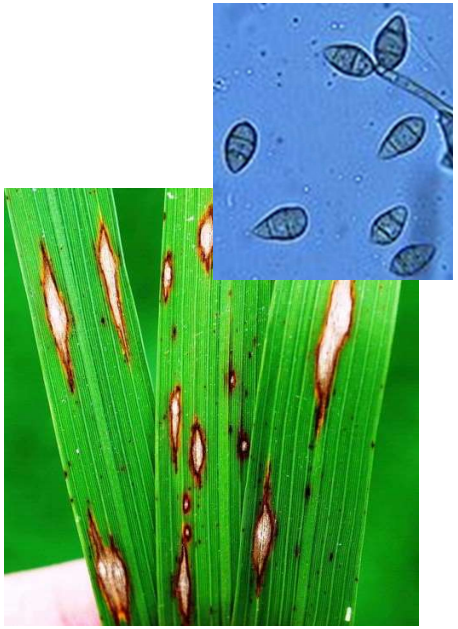
True military state programs and allegations of attacks

e.g. WW2 and cold war

Phytophthora infestans
(potatoes)



Puccinia graminis
(wheat)



Pyricularia oryzae
(rice)

Type 1

True military state programs and allegations of attacks

e.g. WW2 and cold war

GDR propaganda campaign during the Cold War
depicting the potato beetles (*Leptinotarsa decemlineata*) as US soldiers.

Type 2

‘Rogue state' programs and international terrorism

Program of weaponization of wheat smut fungi (*Tilletia caries* and *T. tritici*) by Iraq during the 1980s.

Type 2

‘Rogue state' programs and international terrorism

Mycotoxins potentially affecting human or cattle health

Penicillium expansum

Claviceps purpurea

Fusarium sp.

Type 3

Biocrime, sabotage, private allegations and conspiracy theories on social media

Annual Review of Phytopathology

The Geopolitics of Plant Pathology: Frederick Wellman, Coffee Leaf Rust, and Cold War Networks of Science

Stuart McCook[1] and Paul D. Peterson[2]

[1]Department of History, University of Guelph, Guelph, Ontario N1G 2W1, Canada; email: sgmccook@uoguelph.ca

[2]American Phytopathological Society, St. Paul, Minnesota 55121, USA

Hemileia vastatrix
(Guatemala, 1950s)

Type 3

Biocrime, sabotage, private allegations and conspiracy theories on social media

Peronospora tabacina
and *Thrips palmi*
(Cuba, 1996)

Cuban Allegations of Biological Warfare by the United States: Assessing the Evidence

Raymond A. Zilinskas

To cite this article: Raymond A. Zilinskas (1999) Cuban Allegations of Biological Warfare by the United States: Assessing the Evidence, Critical Reviews in Microbiology, 25:3, 173-227, DOI: 10.1080/10408419991299202

To link to this article: http://dx.doi.org/10.1080/10408419991299202

Type 3

Biocrime, sabotage, private allegations and conspiracy theories on social media

Allegation of deliberate introduction of
Diabrotica virgifera maize fields
(Europe 1990s)

Type 4

Misuse of phytosanitary standards by a state to justify protectionist measures (“overzealous” application or deliberate introduction of a regulated pest?)

THE CONVERSATION

L'expertise universitaire, l'exigence journalistique

Culture Économie Éducation Environnement International Politique + Société Santé Science Podcasts

La Russie et la Chine instrumentalisent-elles la réglementation phytosanitaire à des fins géopolitiques ?

Publié: 25 avril 2022, 23:28 CEST

Type 5

Programs against narcotic crops: warfare or biological control?

Papaver

Pleosora papaveracea

Coca

Fusarium oxysporum

Risk assessment

Human dimension

Which malevolent **scenario**?
- **perpetrator**?
- **objectives**?
- biotechnical **capability**?

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Which **target**?
(crop, landscape area)

Which **pathogenic agent**?
(species / biotype)

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(species / biotype)

Typology of acts
- Biowarfare
- bioterrorism
- biocrime

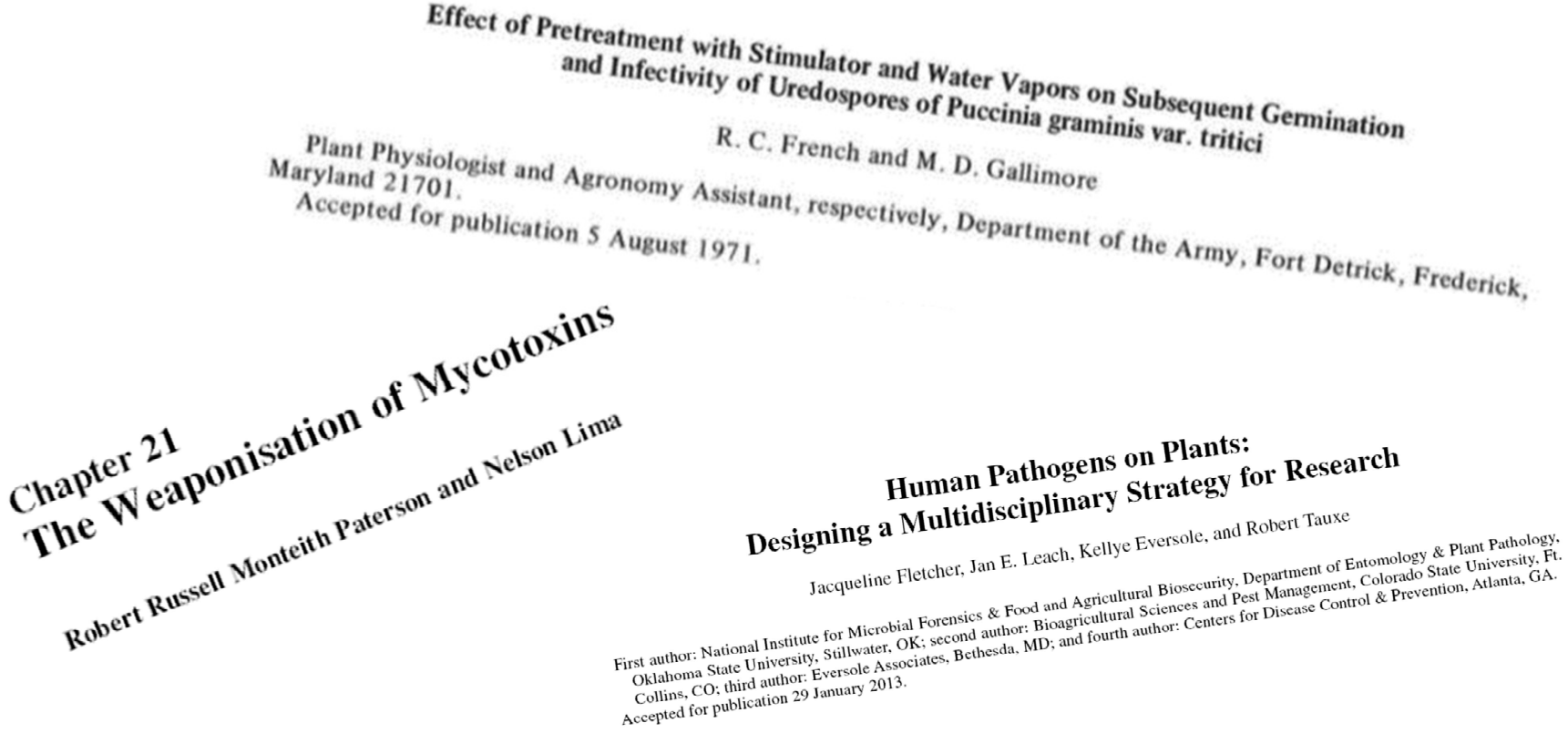
↓

Impacts
- yield production
- trade/market
- human or animal health
- patrimonial

How to limit the risk?

Vigilance on:

Dual knowledge



Effect of Pretreatment with Stimulator and Water Vapors on Subsequent Germination and Infectivity of Uredospores of Puccinia graminis var. tritici

R. C. French and M. D. Gallimore

Plant Physiologist and Agronomy Assistant, respectively, Department of the Army, Fort Detrick, Frederick, Maryland 21701.

Accepted for publication 5 August 1971.

Chapter 21
The Weaponisation of Mycotoxins

Robert Russell Monteith Paterson and Nelson Lima

Human Pathogens on Plants:
Designing a Multidisciplinary Strategy for Research

Jacqueline Fletcher, Jan E. Leach, Kellye Eversole, and Robert Tauxe

First author: National Institute for Microbial Forensics & Food and Agricultural Biosecurity, Department of Entomology & Plant Pathology, Oklahoma State University, Stillwater, OK; second author: Bioagricultural Sciences and Pest Management, Colorado State University, Ft. Collins, CO; third author: Eversole Associates, Bethesda, MD; and fourth author: Centers for Disease Control & Prevention, Atlanta, GA.
Accepted for publication 29 January 2013.

How to limit the risk?

Vigilance on:

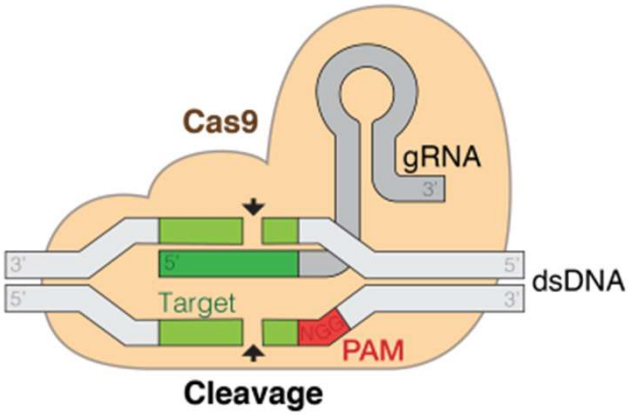
Dual technologies

How to limit the risk?

Vigilance on:

Dual technologies

Genome editing (GMO, CRISPR-Cas9)
→ pathogen agressiveness, vectors



POLICY FORUM

DUAL-USE RESEARCH

Agricultural research, or a new bioweapon system?

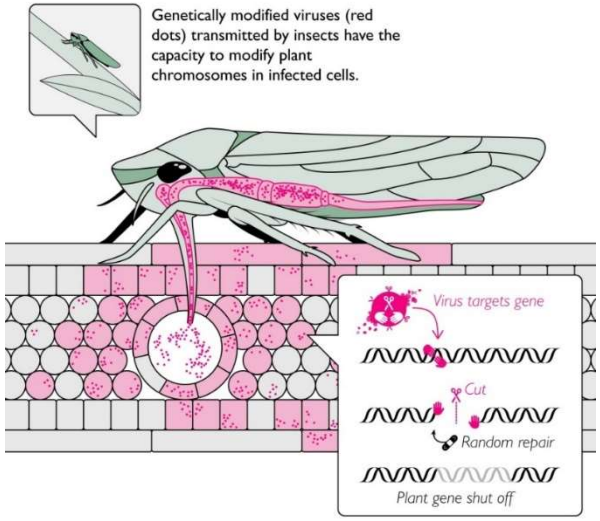
Insect-delivered horizontal genetic alteration is concerning

By **R. G. Reeves[1], S. Voeneky[2], D. Caetano-Anollés[1], F. Beck[2], C. Boëte[3]**

Agricultural genetic technologies typically achieve their agronomic aims by introducing laboratory-generated modifications into target species' chromosomes. However, the speed and flexibility of this approach are limited, because modified chromosomes must be vertically inherited from one generation to the next. In an effort to remove this limitation, an ongoing research program funded by the U.S. Defense Advanced Research Projects Agency (DARPA) aims to disperse infectious genetically modified viruses that have been engineered to edit crop chromosomes directly in fields. This is genetic engineering through horizontal transfer, as opposed to vertical inheritance. The regulatory, biological, economic, and societal implications of dispersing such horizontal environmental genetic alteration agents (HEGAAs) into ecosystems are profound. Further, this program stipulates that the means of delivery of these research contracts (*2*–*4*). In July 2017, the first of three consortia announced that they had been awarded a contract from DARPA to develop systems for insect dispersion of genetically modified viruses (*2*–*4*). These are contracts for completion of a 4-year work plan (*1*) that will culminate in large-scale greenhouse demonstrations of the fully functional insect-dispersed HEGAA approach. Maize and tomato plants are reportedly being used in current experiments (*2*–*4*), while dispersal insect species mentioned include leafhoppers, whiteflies, and aphids (*3*, *5*).

Since its public inception, the Insect Allies program has almost exclusively been presented as a means for farmers to address routine agricultural concerns (e.g., drought,

"...genetically modified virus to perform gene editing of...crops in...planted fields..."



How to limit the risk?

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Dual technologies

Genome editing (GMO, CRISPR-Cas9)
→ pathogen agressiveness, fungicide res

Inoculum multiplication capacity

Bioreactor (yeast-like pathogens)

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Spreading technologies

Plane, drone, balloon…

How to limit the risk?

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Spreading technologies

Plane, drone, balloon…

Export regulation

E.g. quarantine species
(not worldwide distributed)

→ Lists for control

List for export control

« Autralia group »

List of Plant Pathogens for Export Control

Core List *June 2012*

Bacteria

1. Xanthomonas albilineans
2. Xanthomonas axonopodis pv. citri (Xanthomonas campestris pv. citri A) [Xanthomonas campestris pv. citri]
3. Xanthomonas oryzae pv. oryzae (Pseudomonas campestris pv. oryzae)
4. Clavibacter michiganensis subsp. sepedonicus (Corynebacterium michiganensis subsp. sepedonicum or Corynebacterium sepedonicum)
5. Ralstonia solanacearum, race 3, biovar 2

Fungi

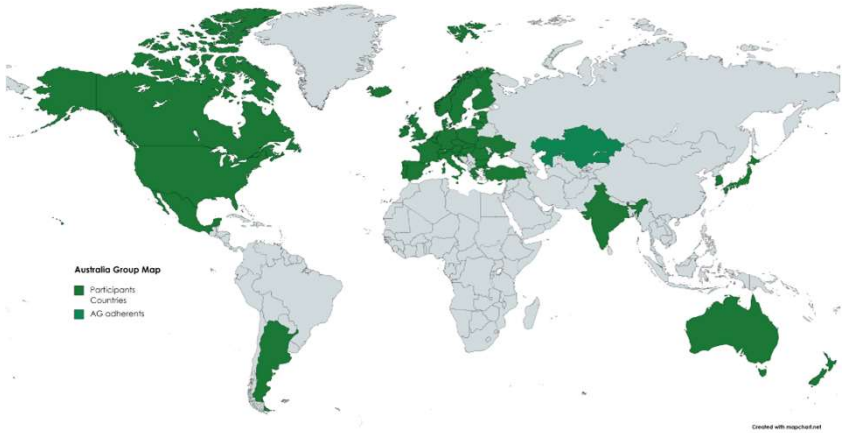
1. Colletotrichum kahawae (Colletotrichum coffeanum var. virulans)
2. Cochliobolus miyabeanus (Helminthosporium oryzae)
3. Microcyclus ulei (syn. Dothidella ulei)
4. Puccinia graminis ssp. graminis var. graminis / Puccinia graminis ssp. graminis var. stakmanii (Puccinia graminis [syn. Puccinia graminis f. sp. tritici])
5. Puccinia striiformis (syn. Puccinia glumarum)
6. Magnaporthe oryzae (Pyricularia oryzae)
7. Peronosclerospora philippinensis (Peronosclerospora sacchari)
8. Sclerophthora rayssiae var. zeae
9. Synchytrium endobioticum
10. Tilletia indica
11. Thecaphora solani

Viruses

1. Andean potato latent virus (Potato Andean latent tymovirus)
2. Potato spindle tuber viroid

Genetic Elements and Genetically-modified Organisms:

1. Genetic elements that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Core List.
2. Genetically-modified organisms that contain nucleic acid sequences associated with the pathogenicity of any of the microorganisms in the Core List.



Possible evolutions?

IN / OUT

Present in historical reviews, but difficult to use

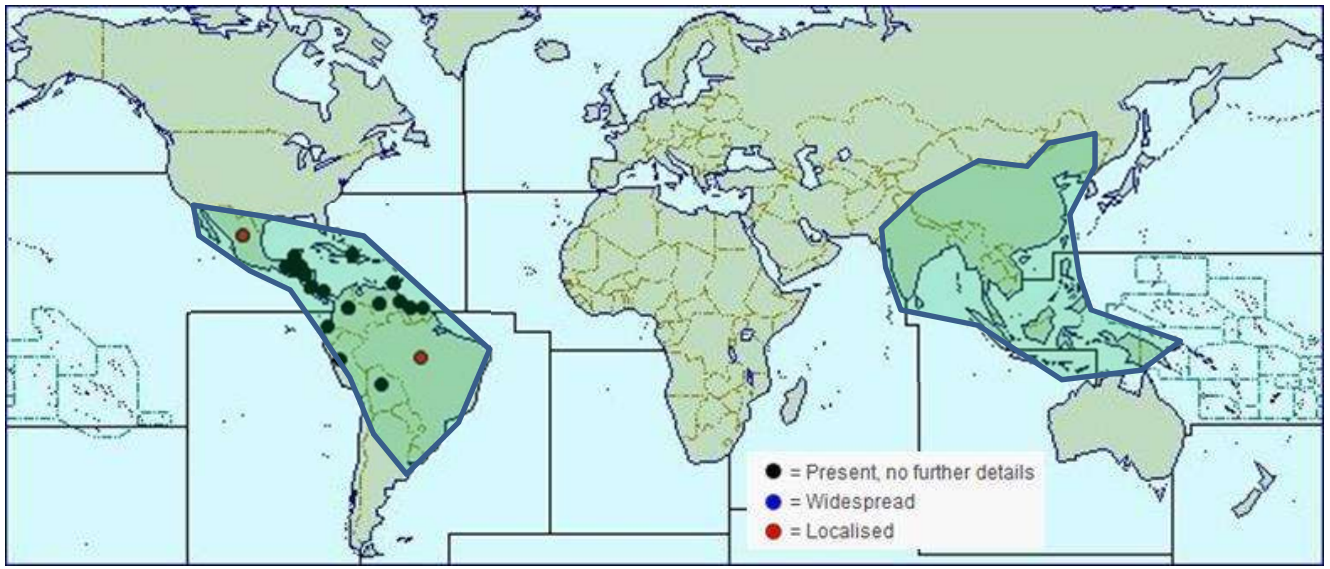
Widely distributed, easy to collect in natural area

List for export control

***Microcyclus ulei* (hevea)**

→ latex, a strategic commodity for industry

Present in South America, but not in Asia



Key messages

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→ **dual dimension (human, biological)** + **diversity of threats**

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→ **dual dimension (human, biological)** + **diversity of threats**

4. Agroterrorism is **NOT "low-tech, high impact"**

5. The risk is dependant of both agronomic and geopolitical contexts
→ **evolving vigilance posture and countermeasures is imperative**

Merci de votre attention !

frederic.suffert@inrae.fr

bit.ly/wheatpath

@wheatpath