Tracking the spread of plant diseases

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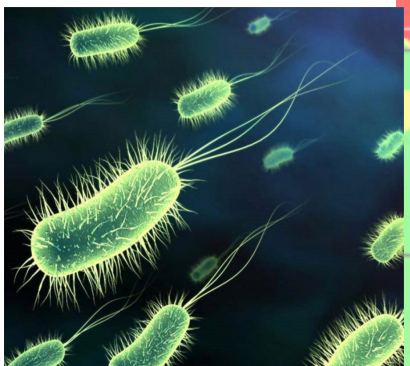
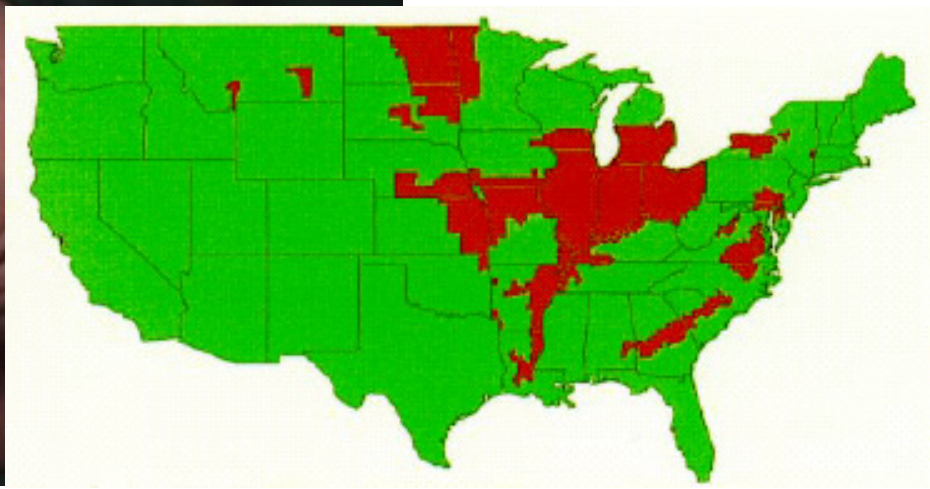
VirginiaTech

NSF

MultiSTEPS



Fusarium head blight



Caused by fungal spore *Fusarium graminearum*

$3 billion in losses to US economy over past decade

Economic costs of invasive species: ***$130 billion*** **per year in U.S.**

Plant pathogens:

Viruses

Fungal spores

Bacteria

Spread by air, water, humans

Food supply concerns, bioterrorism

Wheat scientists seek to slow crop fungus in Africa, Asia

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Thu Aug 30, 2012 10:00pm EDT

* Stem rust, originating in Uganda, spreads to Yemen, Iran

* Fears that it could sweep eastwards in Asia

By Alister Doyle

OSLO, Aug 31 (Reuters) - Wheat experts are stepping up monitoring of a crop disease first found in Africa in 1999 to minimise the spread of a deadly fungus that is also a threat in Asia, experts said on Friday.

A "Rust-Tracker", using data supplied by farmers and scientists, could now monitor the fungus in 27 developing nations across 42 million hectares (103 million acres) of wheat - an area the size of Iraq or California.

"It's the most serious wheat disease," Ronnie Coffman, vice-chair of the Borlaug Global Rust Initiative (BGRI), told Reuters ahead of a meeting of wheat experts in Beijing from Sept. 1-4.

"If it gets started...it's like a biological firestorm," he said. Experts will review progress in combating the disease, with fungicides and 20 new resistant varieties developed in recent years.

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THE THREAT OF PLANT PATHOGENS AS WEAPONS AGAINST U.S. CROPS

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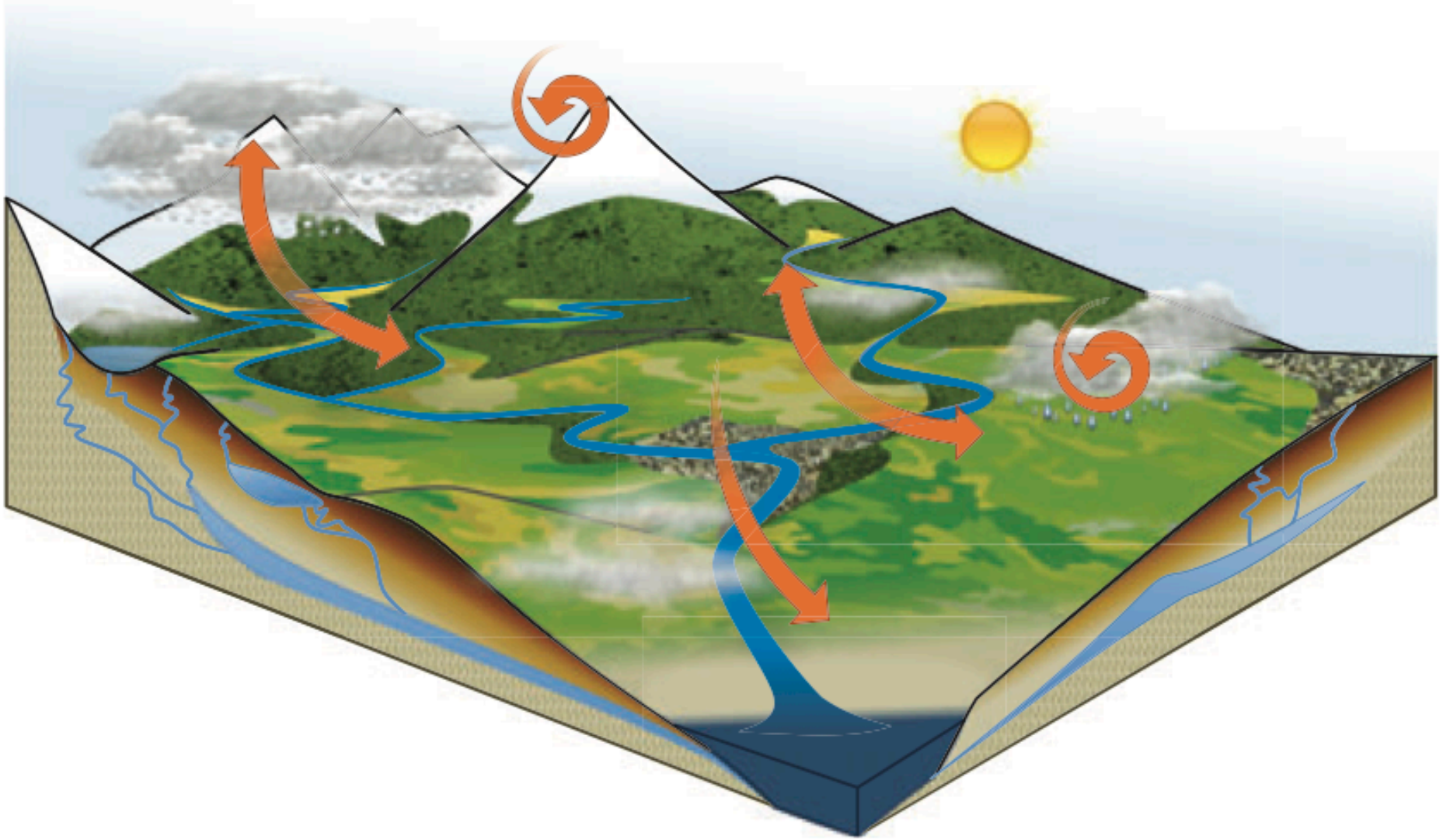
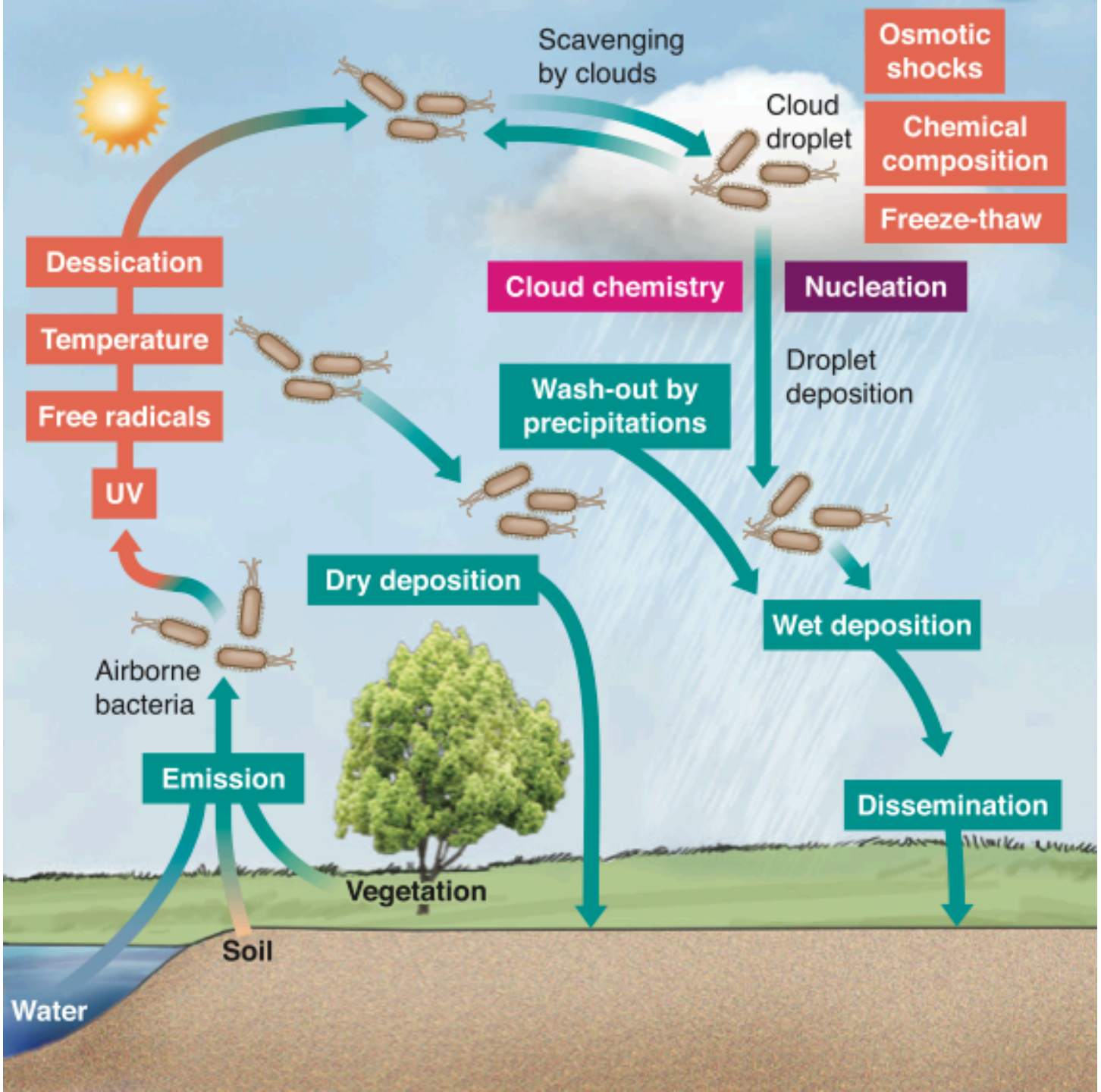
Key Words agricultural vulnerability, biological weapons, bioterrorism, crop biosecurity, plant disease invasion, plant disease persistence and spread, risk analysis

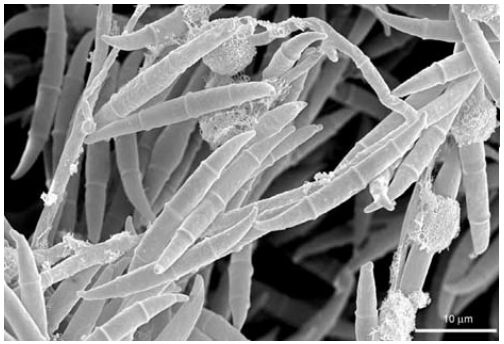
■ **Abstract** The U.S. National Research Council (NRC) concluded in 2002 that U.S. agriculture is vulnerable to attack and that the country has inadequate plans for dealing with agricultural bioterrorism. This article addresses the vulnerability of U.S. crops to attack from biological weapons by reviewing the costs and impact of plant diseases on crops, pointing out the difficulty in preventing deliberate introduction of pathogens and discovering new disease outbreaks quickly, and discussing why a plant pathogen might be chosen as a biological weapon. To put the threat into context, a brief historical review of anti-crop biological weapons programs is given. The argument is made that the country can become much better prepared to counter bioterrorism by developing a list of likely anti-crop threat agents, or categories of agents, that is based on a formal risk analysis; making structural changes to the plant protection system, such as expanding diagnostic laboratories, networking the laboratories in a national system, and educating first responders; and by increasing our understanding of the molecular biology and epidemiology of threat agents, which could lead to improved disease control, faster and more sensitive diagnostic methods, and predictions of disease invasion, persistence, and spread following pathogen introduction.

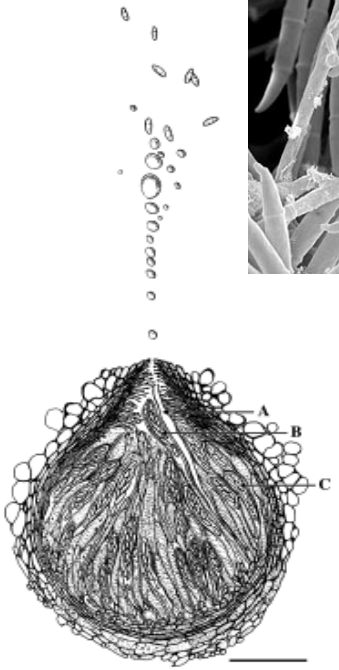
INTRODUCTION

Using [biological weapons] to attack livestock, crops, or agro... an adversary the means to...


Snowpack
Non-crop zones
Surface waters
Subsurface and ground waters
Crops
Cities
Soil and parental material
Sea


Scavenging by clouds
Osmotic shocks
Cloud droplet
Chemical composition
Freeze-thaw
Dessication
Cloud chemistry
Nucleation
Temperature
Droplet deposition
Free radicals
Wash-out by precipitations
UV
Dry deposition
Wet deposition
Airborne bacteria
Emission
Dissemination
Vegetation
Soil
Water



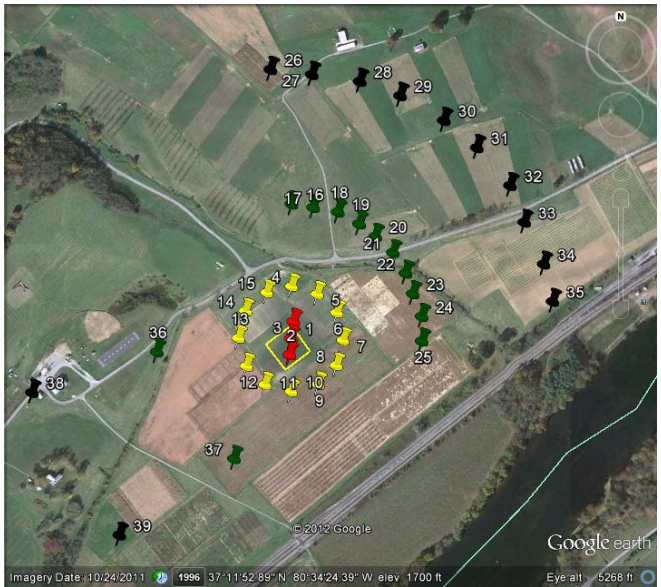


Crop debris (wheat, maize, rice, etc.) bearing perithecia and sporodochia provide primary inoculum

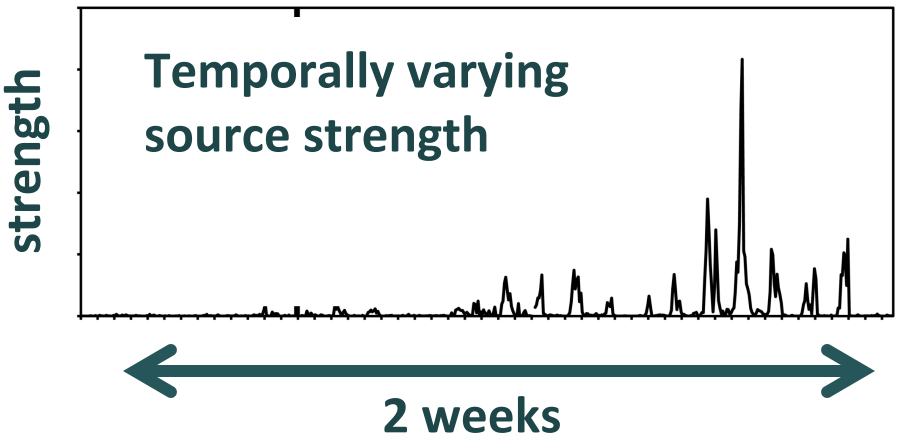
Field experiments: spread from known source

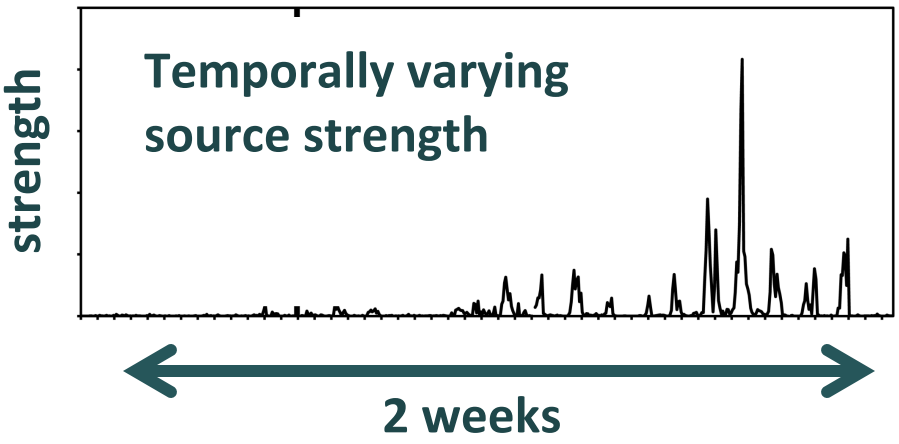
5 acres of winter wheat

Field inoculation

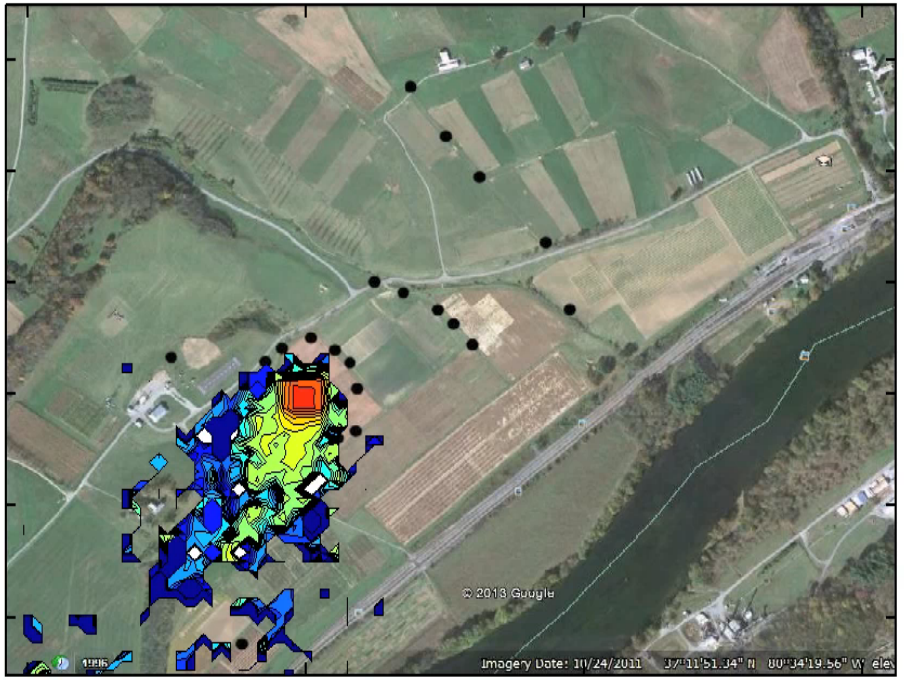


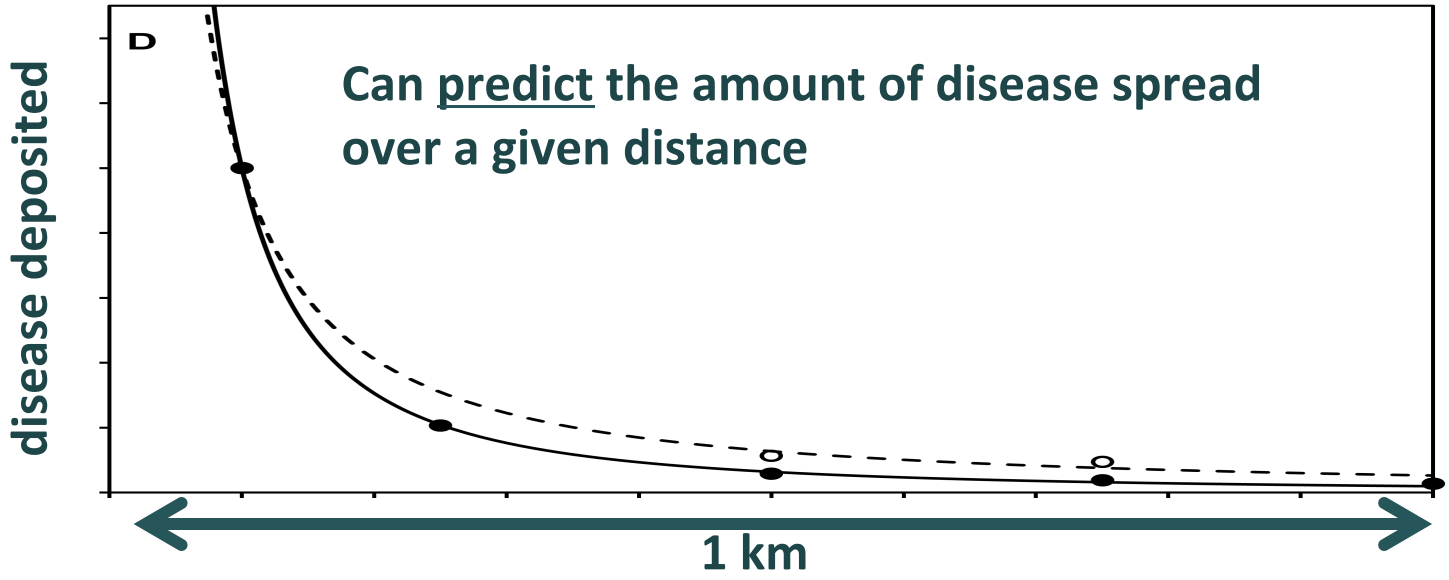
can imagine ‘invisible’ smoke plumes

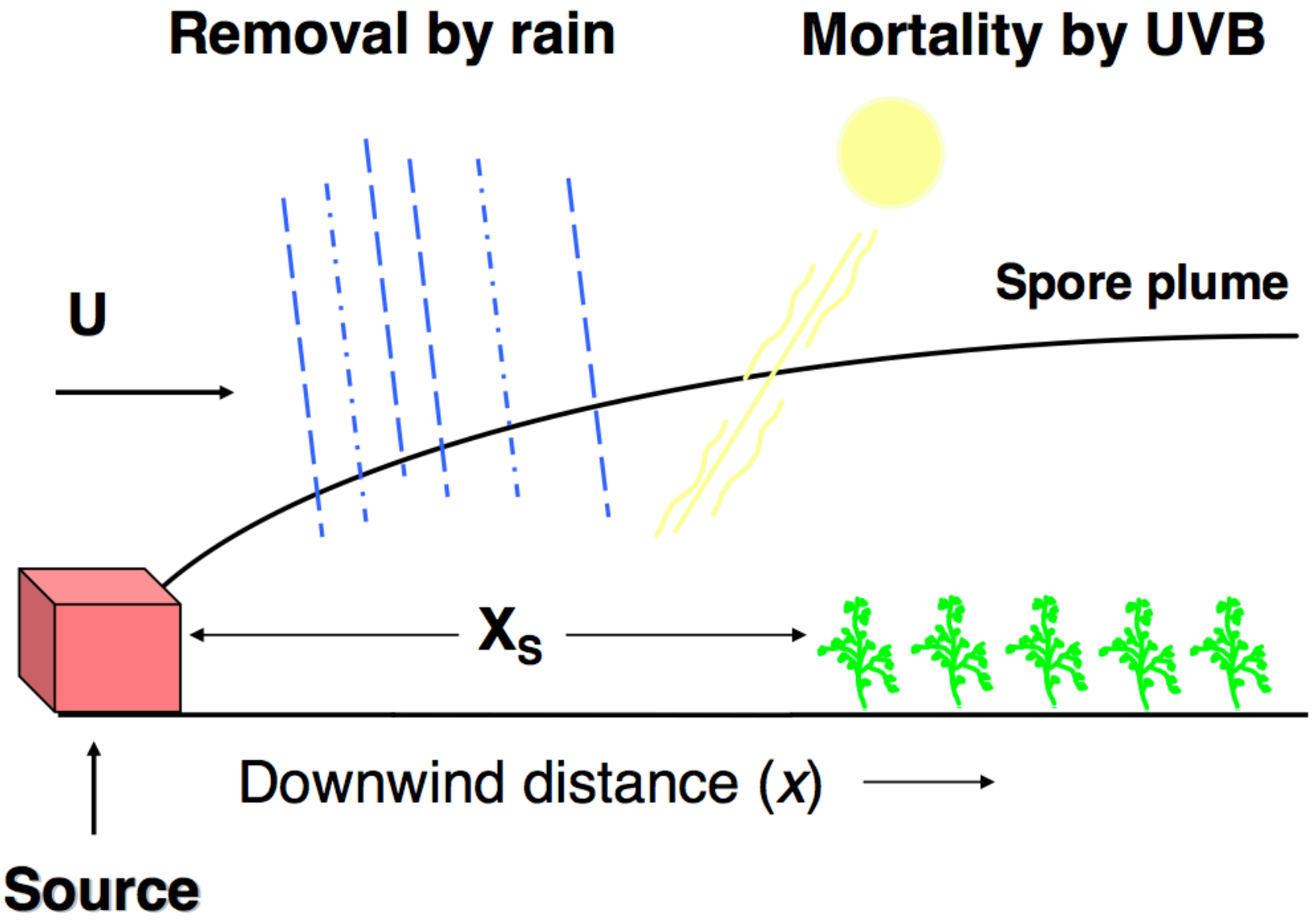

strength
Temporally varying
source strength
2 weeks



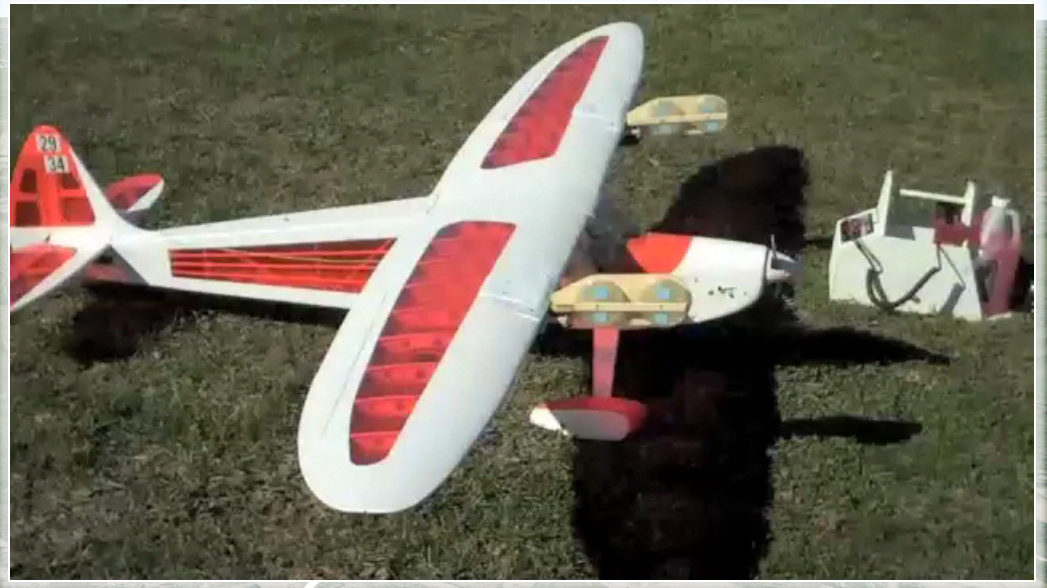
Plume follows changing wind direction






Removal by rain
Mortality by UVB
U
Spore plume
x_s
Downwind distance (x)
Source

Aerial sampling drones:
100 – 1000 ft altitude
(David Schmale's group)

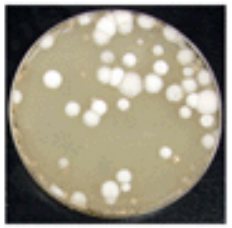


Kentland Farm

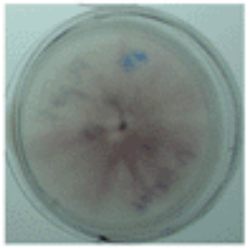
Samples collected during 10-30 minute flights at constant elevation above ground level

Collect spores, identify species

UAVs and ground-level sampler

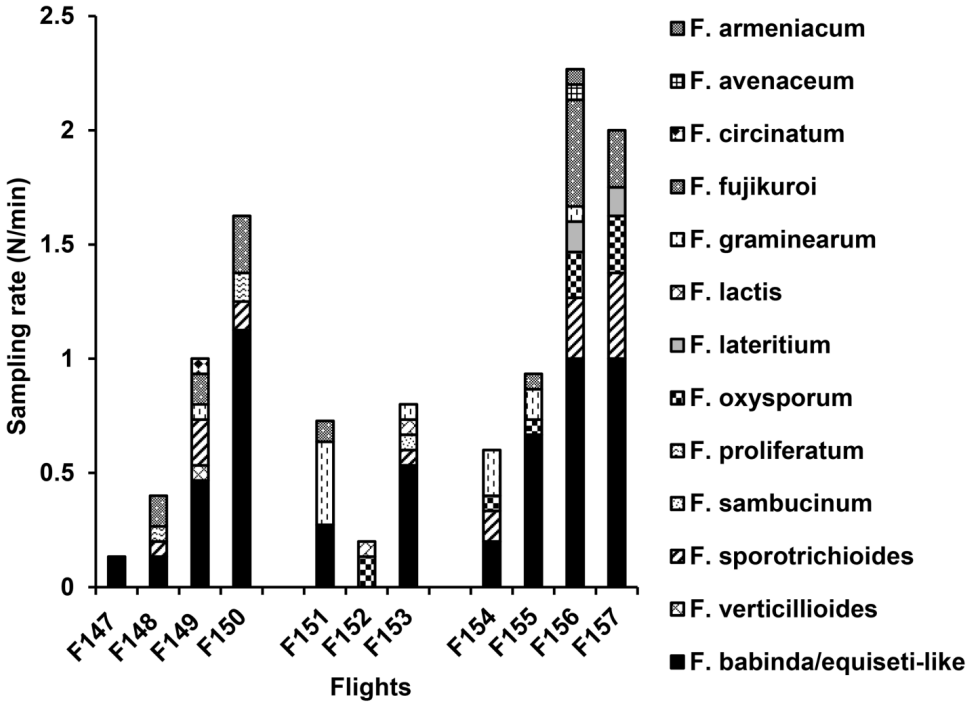


Colonies of *Fusarium*

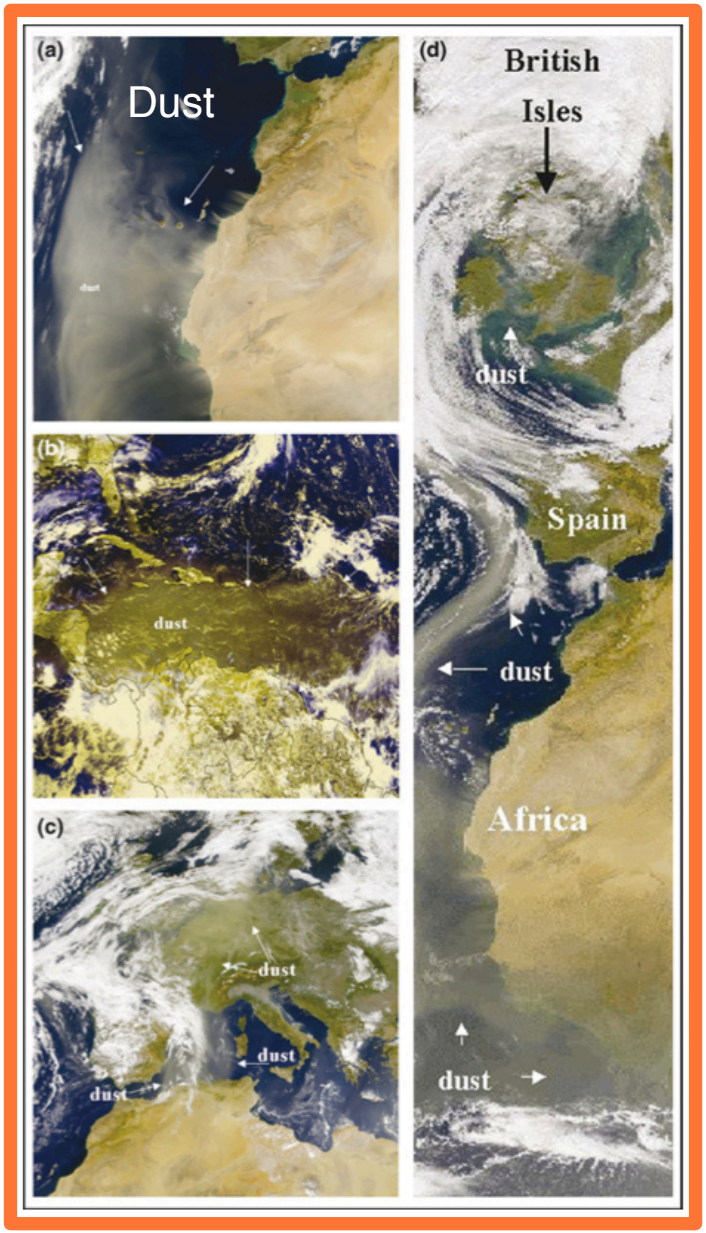


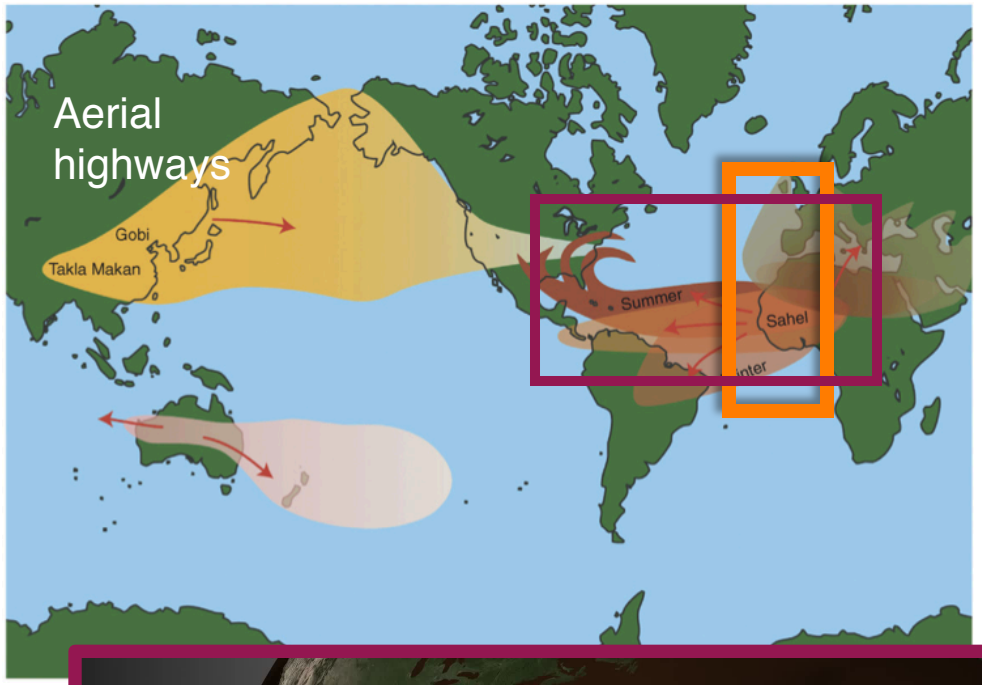
Single-spored cultures

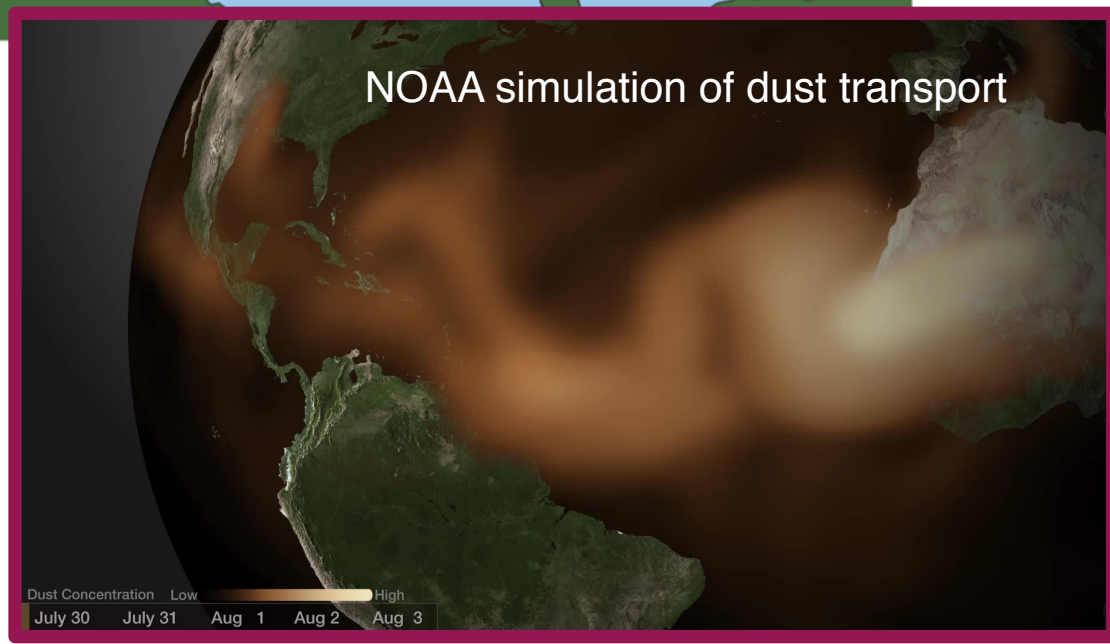
Living culture collection



The atmosphere connects distant ecosystems







Early warning systems

Internet tools to inform farmers about disease spread