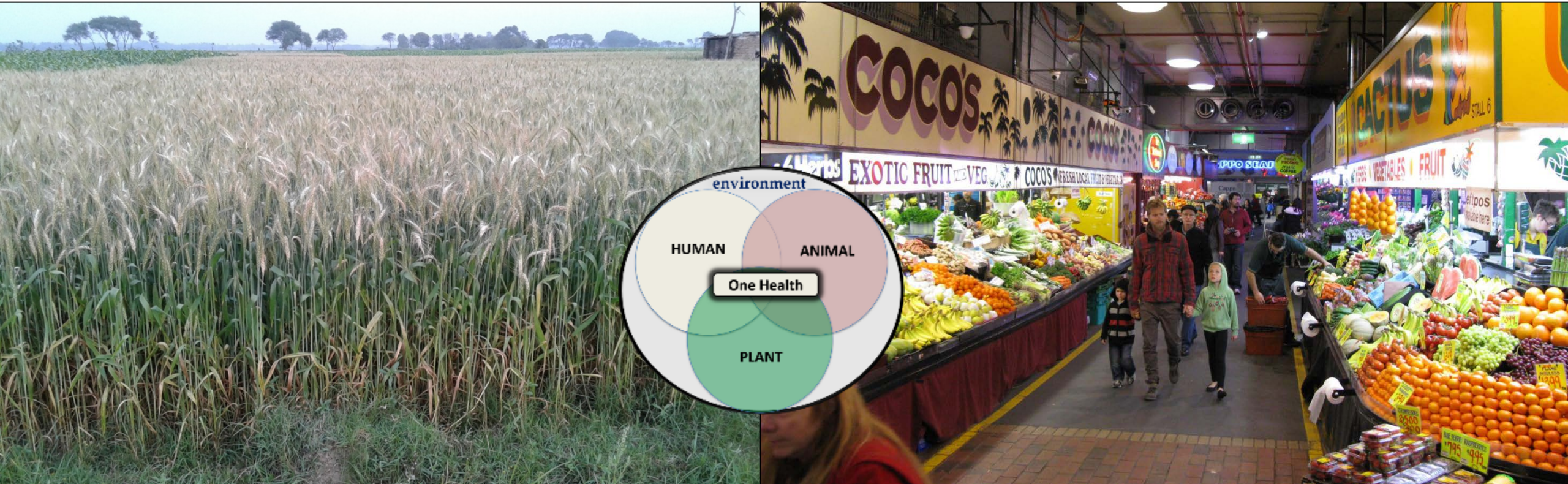


Plant Biosecurity-National Security Nexus

Changing the way we think about the way we think about change





Plant Systems: The foundation for Human Health and Wellbeing



Plants are the foods we consume directly





Plant Systems: The foundation for Human Health and Wellbeing



Plants are the feed that we provide to the animals that we consume.



Plant Systems: The foundation for Human Health and Wellbeing



Plants are the fiber that clothe us



Cotton: (*Gossypium hirsutum*)



Plant Systems: The foundation for Human Health and Wellbeing

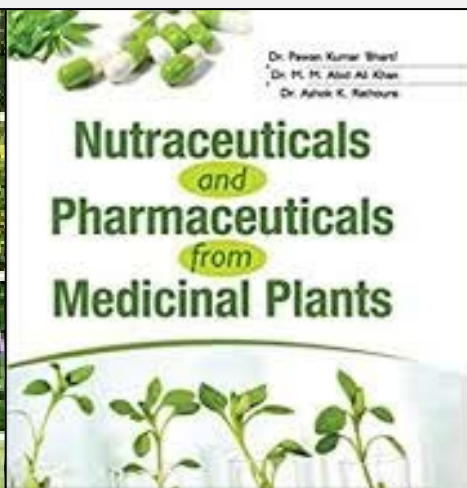


Plants are the timber that shelter us



shutterstock.com • 1054147967

Plant Systems: The foundation for Human Health and Wellbeing



Plant-based medicines and therapies





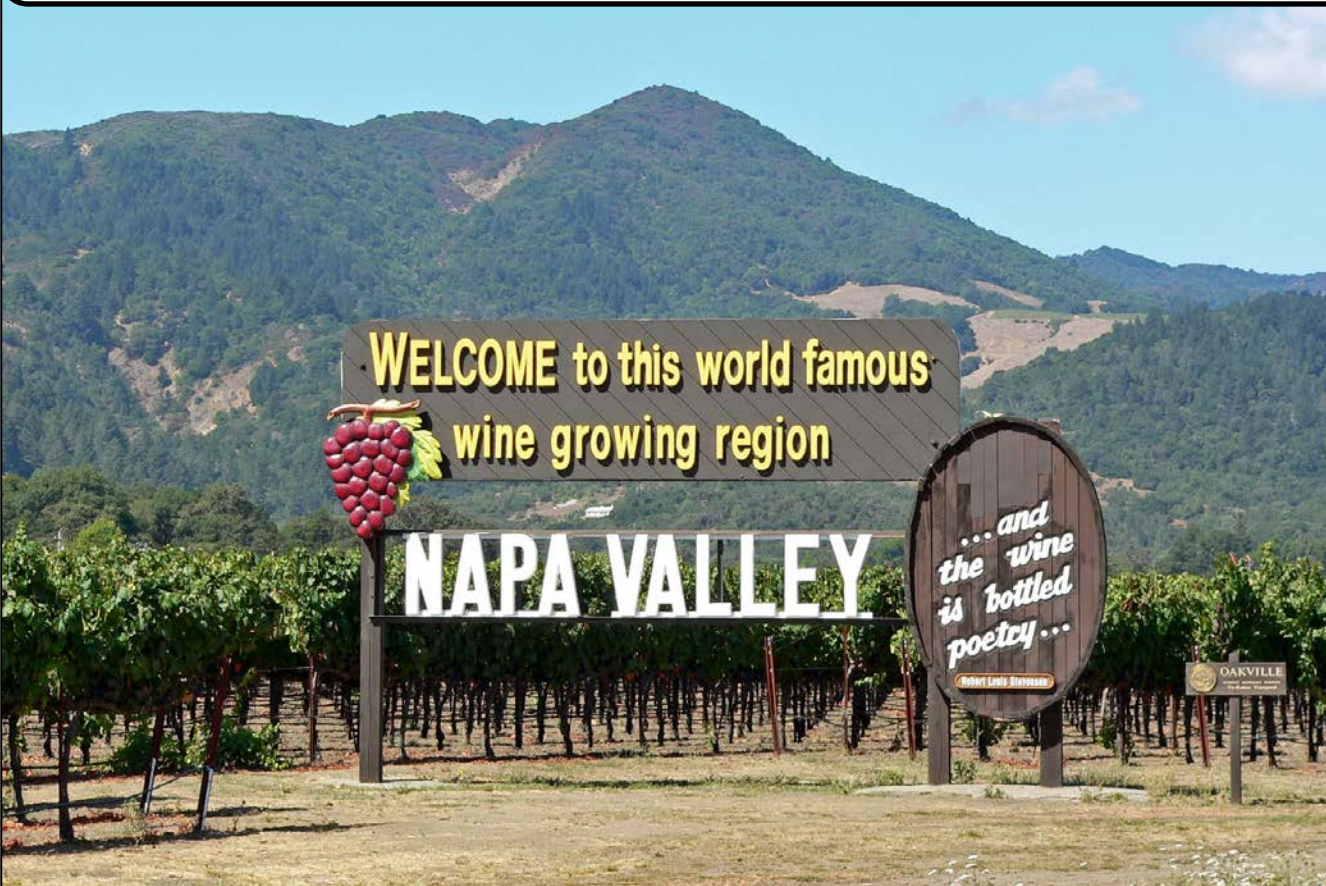
Plant Systems: The foundation for Human Health and Wellbeing



Human culture has revolved around plants and plant systems



Human communities have revolved around plants and plant systems



Grapes (*Vitis vinifera*)



Olives (*Olea europaea*)



Plant Biosecurity: Why does it matter?



Plant biosecurity is essential to food security.

We eat plants and we feed plants to the animals that we eat!

~ 59% of the world's population survives on a plant-based diet.

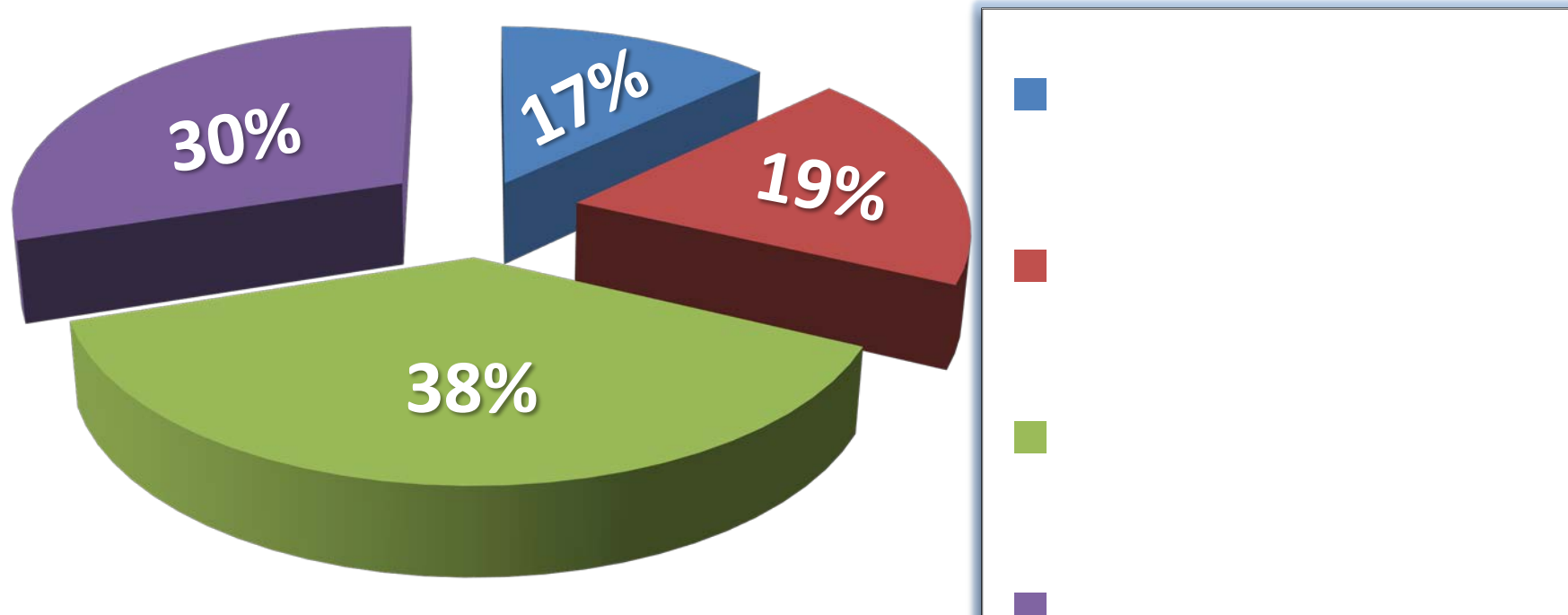
Plant Systems: Challenges to plant health



- **Climate change** – plant migrations, altered productivity, etc.
- **Land-use change** – urbanization, deforestation, etc.
- **Population growth** – impacting everything
- **Lost awareness** to human-plant connection/dependence
- **Pathogens and pests!**

Status of Plant Ecosystems

U.N. Millennium Ecosystem Assessment



Over 2/3 of the earth's plant systems are threatened or endangered.

Plant Systems: Invasive species



According to:

United Nations Millennium Ecosystem Assessment

- **Invasive species:** one of the leading and rapidly growing threats to food security, human and animal health, and biodiversity...
- ...together with **climate change**, one of the most difficult to reverse.

United Nations Millennium Ecosystem Assessment, 2005

Passenger and Commercial Air Traffic

<http://www.flightradar24.com/42.57,-100.05/3>



- Every day: >180,000 flights
- To & from >4,000 airports worldwide

Passenger and Commercial Ocean Vessels

<https://www.vesselfinder.com/>; <https://www.bbc.com/future/article/20161128-what-its-like-to-sail-colossal-ships-on-earths-busiest-sea>



- 20K-50K cargo vessels at sea - Every day!
- 5-6 million containers at sea - Every day!

The geographic boundaries that once kept organisms confined to certain areas have become irrelevant.

Plant Systems: Global Food Systems

We move plants and pathogens all over the world!





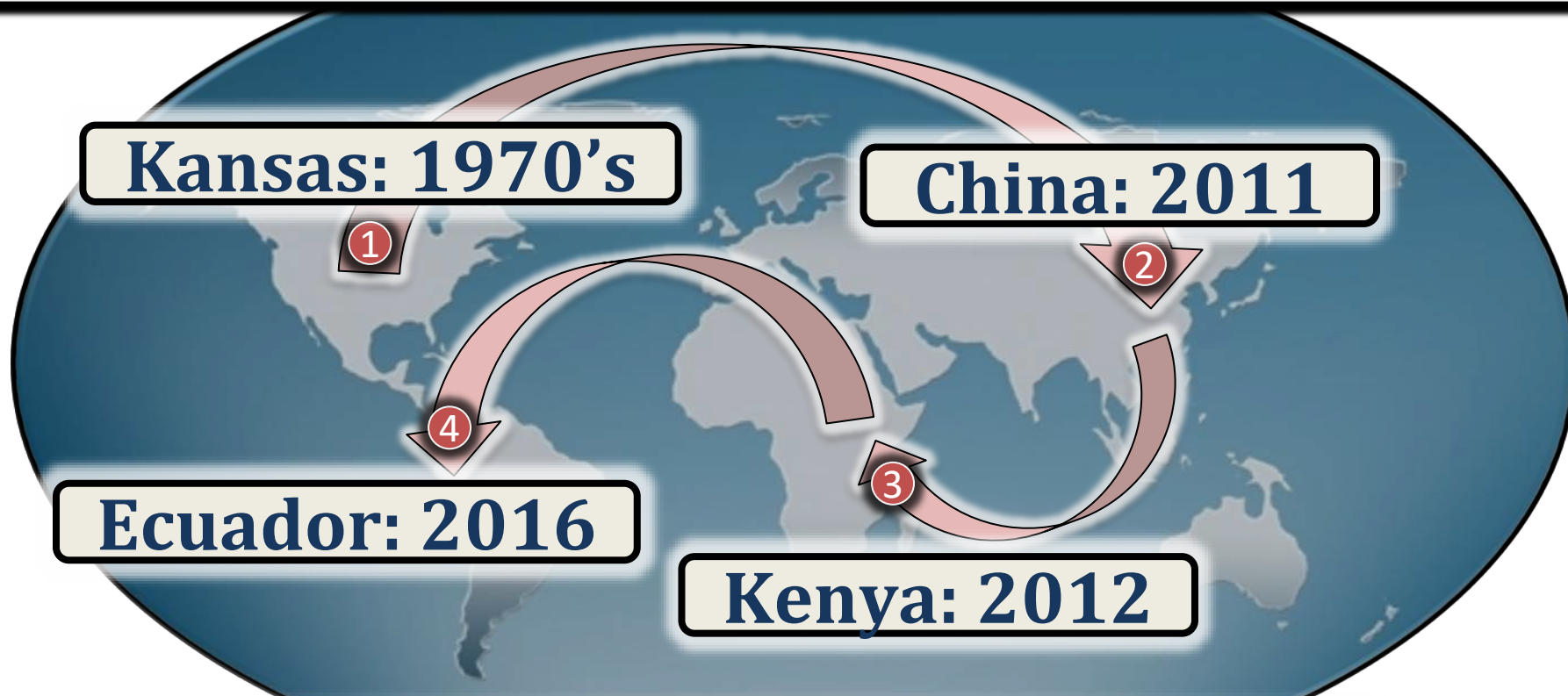
Maize Lethal Necrosis



Maize Chlorotic Mottle Virus +



Maize Chlorotic Mottle Virus – Corn Lethal Necrosis



Not an extreme weather event – it was trade.



Wheat Blast emerged in Brazil in 1985



Little or no grain



Bangladesh 2016

2016 Wheat Blast Epidemic Major impact to farmers!



- **Serious wheat blast outbreak**
 - 2000 hectares destroyed in one district
 - National yield decreased by 10-40% (?)

- **Impacts:**
 - Farmer debt increased – lost farms
 - No income, unable to purchase food

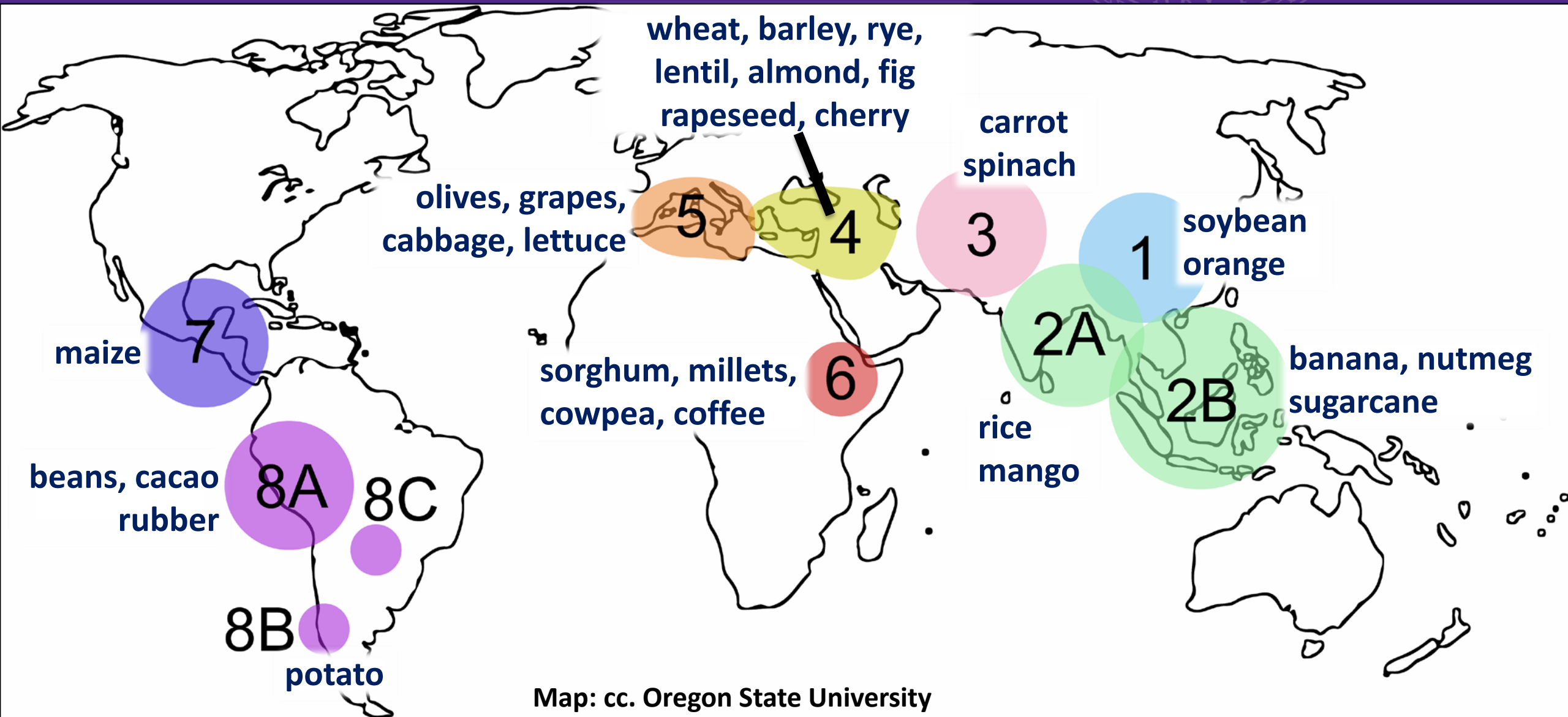
Outcome: We will continue to spread pathogens and pests around the planet as a consequence of the **way we do business!**

The plant systems of most countries are connected to the plant systems of most other countries by trade and travel networks.

Consequently:

the **plant pathogens and pests** of most countries are connected to the **plant systems** of most other countries by **trade and travel networks!**

Centers of origin and genetic diversity for world's important food crops



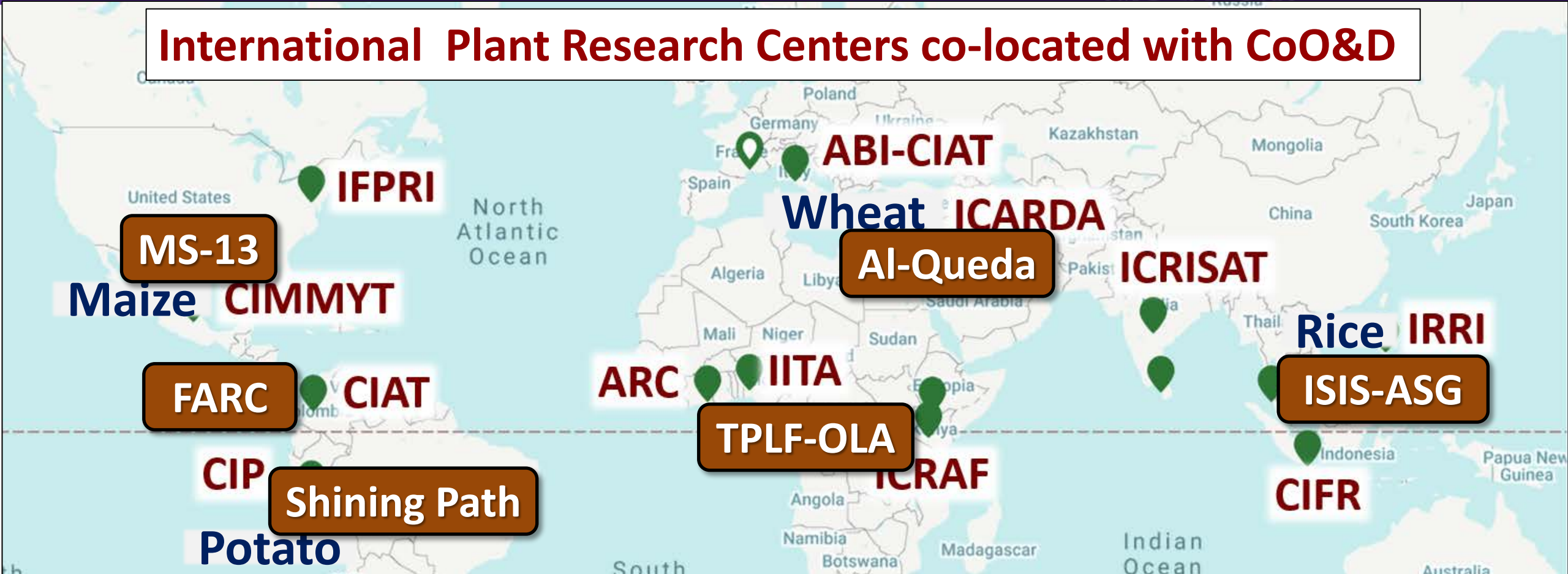
Map: cc. Oregon State University

Wild Relative Species of Cultivated Plants

- **29% of wild relative plant species missing from world's gene banks.**
- **>70% of all crop wild relative species.. in urgent need of ..collecting to increase representation in gene banks.**

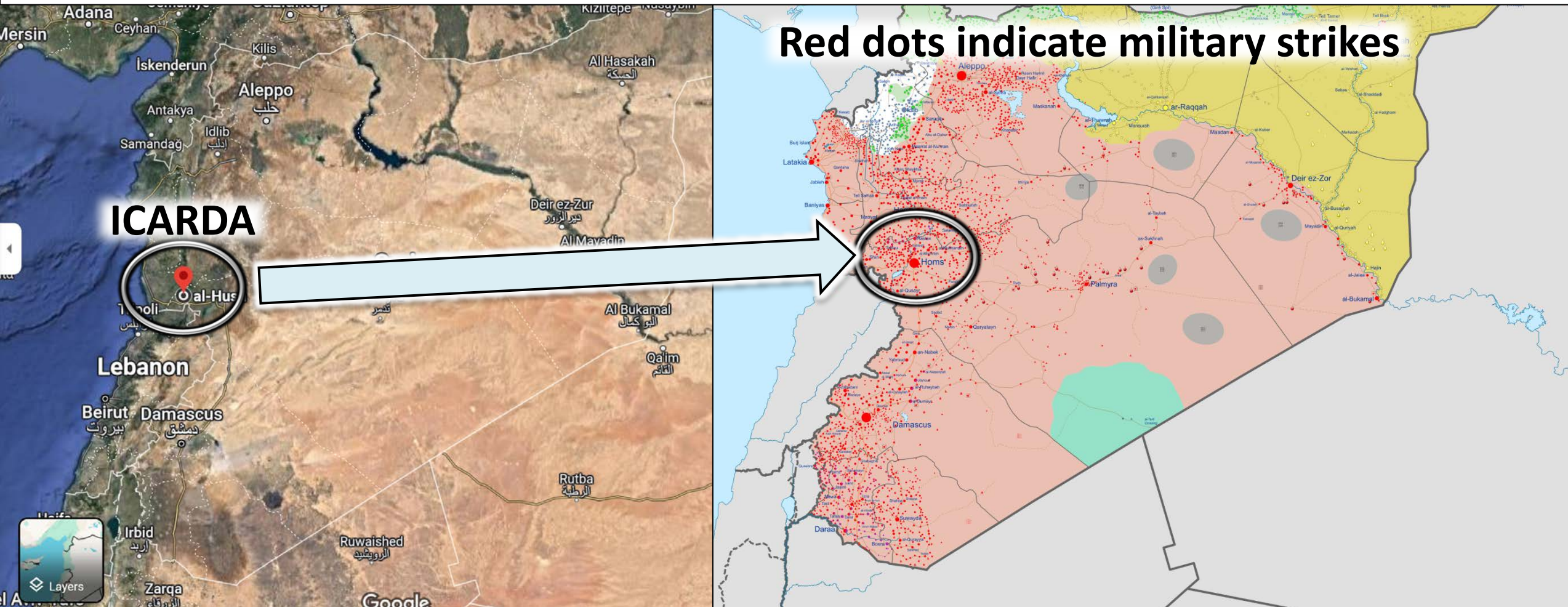
Wikipedia: https://en.wikipedia.org/wiki/Crop_wild_relative

International Plant Research Centers co-located with CoO&D



Centers of origin and Research Centers are also co-located with conflicts

International Center for Agricultural Research in the Dry Areas (ICARDA)





Where will go for new genetic resources to improve food crops?

Ukraine-Russia War Impacting Food Security

Food riots & civil unrest elsewhere

rising food and fuel prices, Lima, Peru 2022



RESOURCE
TRADE
EARTH

Data Publications About

Ukr **CNN BUSINESS** Markets Tech Media Calculators Videos

Russia's war in Ukraine sparked a historic food crisis. It's not over



By Julia Horowitz, CNN

5 minute read · Updated 1:06 PM EST, Tue January 17, 2023

Exporter

Ukraine

Measure

Value

Weight

...current global hunger and malnutrition crisis is enormous. WFP estimates – ... more than 333 million people are facing acute levels of food insecurity in 2023, and do not know where their next meal is coming from.

Scale

\$500m

\$1bn

\$2bn

Exporter

Importer



*power, food and medicine shortages
Sri Lanka 2022*

- ***“Food insecurity is both a consequence and a driver of global instability.”***

**Rich Leach, President & CEO
World Food Program USA**



Haiti April 2008



Increase in fuel costs, and a rapid spike in food prices

Pakistan March 2008



Some believe this will repeat often over the next 50 years.

2008



Kenya 2008

AFP / Getty



Argentina 2008



Arab Spring

The sudden increase in the cost of food.

What was the driver – the last straw?

Governments were overthrown and civil wars started





~59% of world's population survives on a plant-based diet.

- ***Plant Health underpins human health and wellbeing***

Climate change, land use change, conflict and wars undermine plant health

- ***Plant biosecurity is essential to food security***

Global trade and climate change undermine plant biosecurity and food security

- ***Food security is essential to national security***

Food insecurity foments civil unrest leading to instability and threats to national security

There is a plant biosecurity – food security –national security nexus

Plant Systems: Plant biosecurity – food security



“Solve world hunger by morning.”

Eat More Bugs!

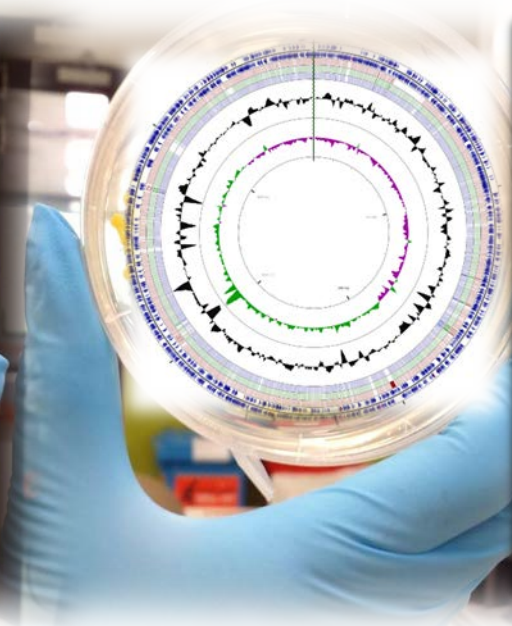
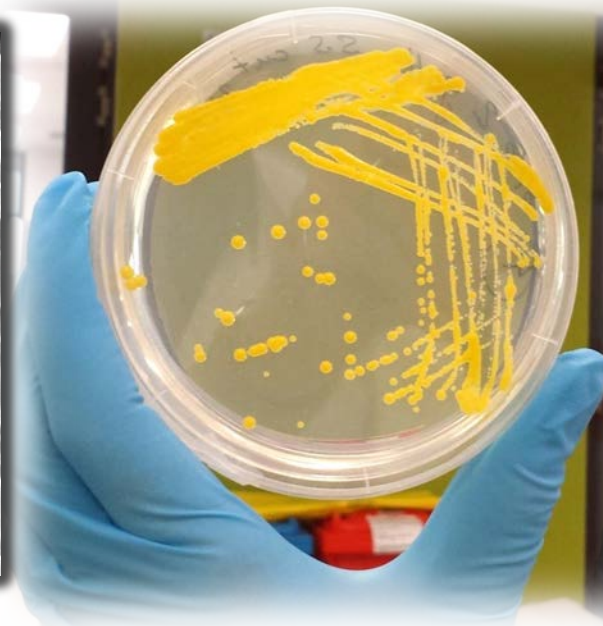
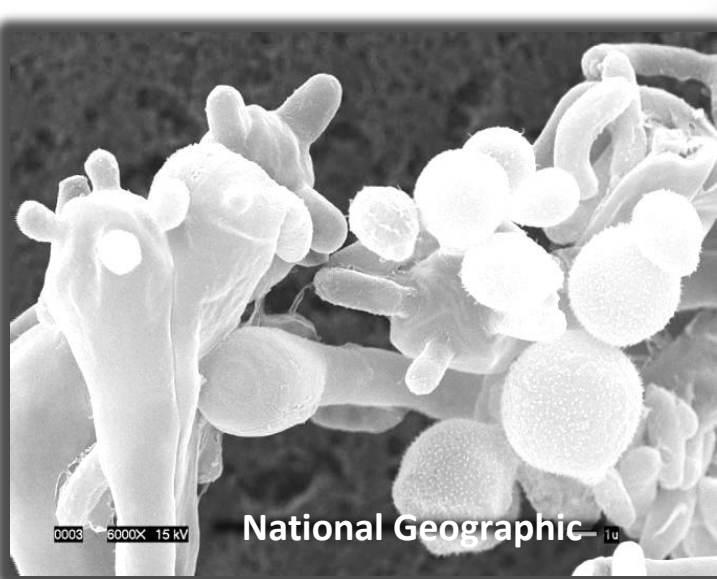
YUM!



<https://www.nycfoodpolicy.org/edible-insects-why-arent-we-eating-more-bugs/>

Plant Health in the One Health Concept

– *The nature and rationale for inclusion* –



James P. Stack

Department of Plant Pathology

Kansas State University, Manhattan, KS-66506



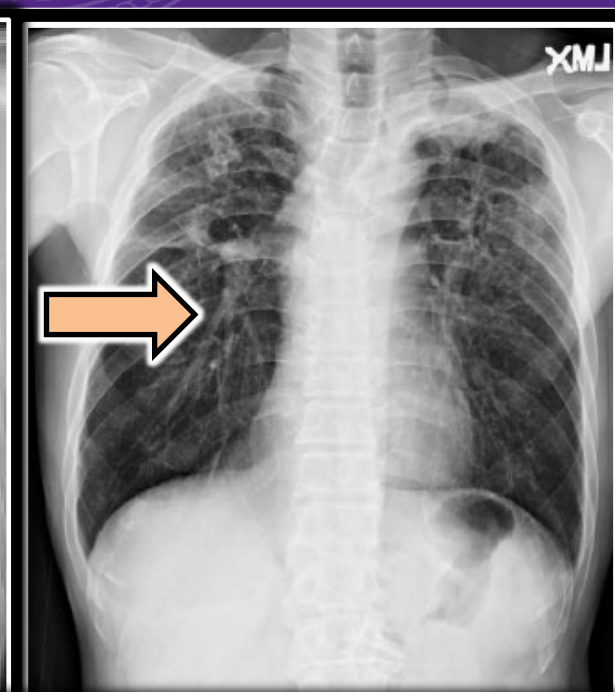
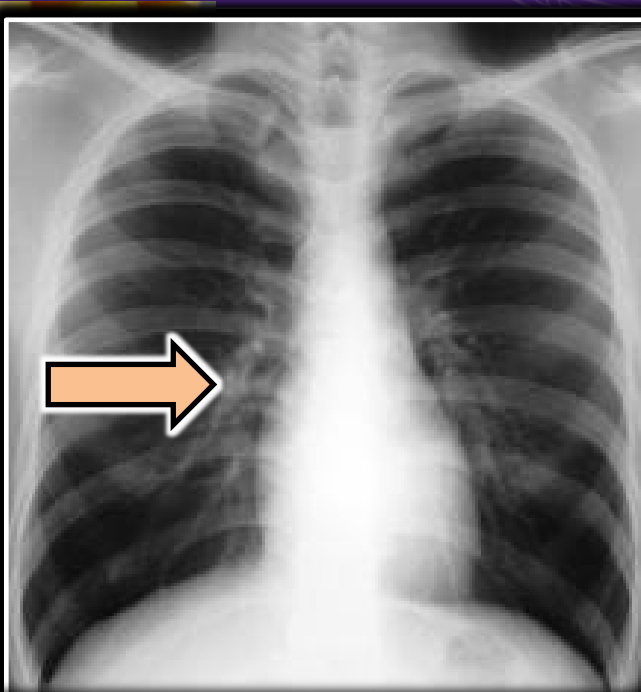
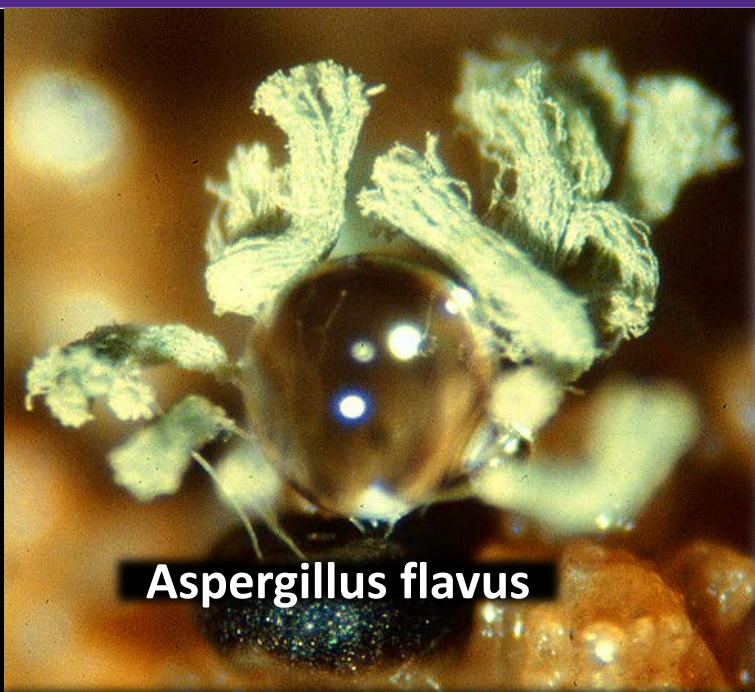
One Health questions:

- 1. Can plant pathogens cause disease in humans?**
- 2. Can human pathogens cause disease in plants?**
- 3. Can plants be reservoirs of human pathogens?**
- 4. Can plants vector human pathogens or vectors?**
- 5. Can humans vector plant pathogens or vectors?**



***Cryptococcus gattii* ... isolated from Canary Island pine, New Zealand Pohutukawa tree, and American sweet gum trees ...**

almost exact match with ... *C. gattii* isolated from infected patients .



Multiple papers published on *Aspergillus flavus* mycoses in humans over the past few years, including, recently:

Wan et al., 2023. International Journal of Infectious Disease

OXFORD

G3 
Genes | Genomes | Genetics


G3, 2022, 12(2), jkab427

<https://doi.org/10.1093/g3journal/jkab427>

Advance Access Publication Date: 13 December 2021

Fungal Genetics and Genomics

Evidence for the agricultural origin of resistance to multiple antimicrobials in *Aspergillus fumigatus*, a fungal pathogen of humans

S. Earl Kang,^{1,†} Leilani G. Sumabat,^{2,‡} Tina Melie,^{2,§} Brandon Mangum,^{1,2} Michelle Momany ,^{1,*} and M

¹Fungal Biology Group and Plant Biology Department, University of Georgia, Athens, GA 30602, USA and

²Fungal Biology Group and Plant Pathology Department, University of Georgia, Athens, GA 30602, USA

*Corresponding authors: Emails: mmomany@uga.edu (M.M.); mtbrewer@uga.edu (M.T.B.)

[†]Present address: Fungal Team, Ginkgo Bioworks, Boston, MA 02210, USA.

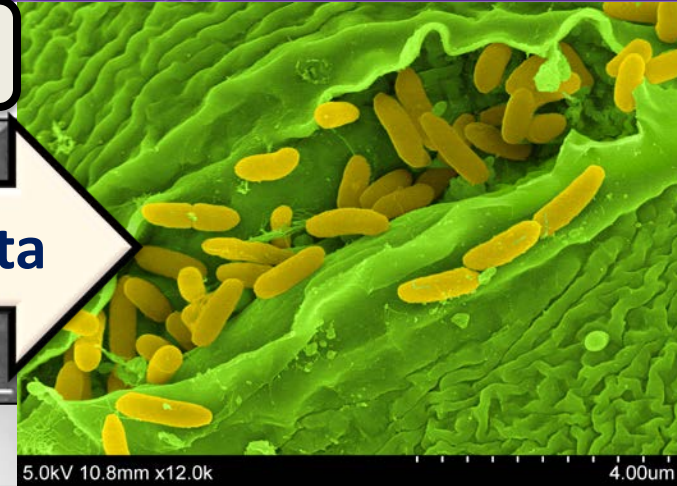
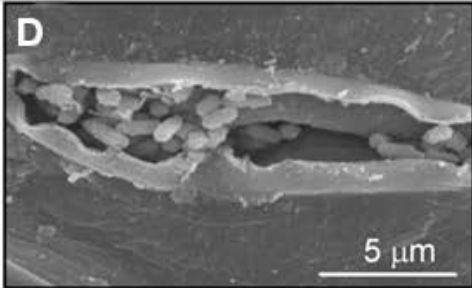
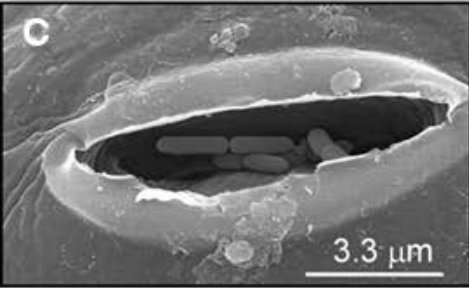
[‡]Present address: Institute of Biology, University of the Philippines Diliman, Quezon City, Philippines.

[§]Present address: Ecology and Evolutionary Biology Department, University of Colorado, Boulder, CO 80309, USA.

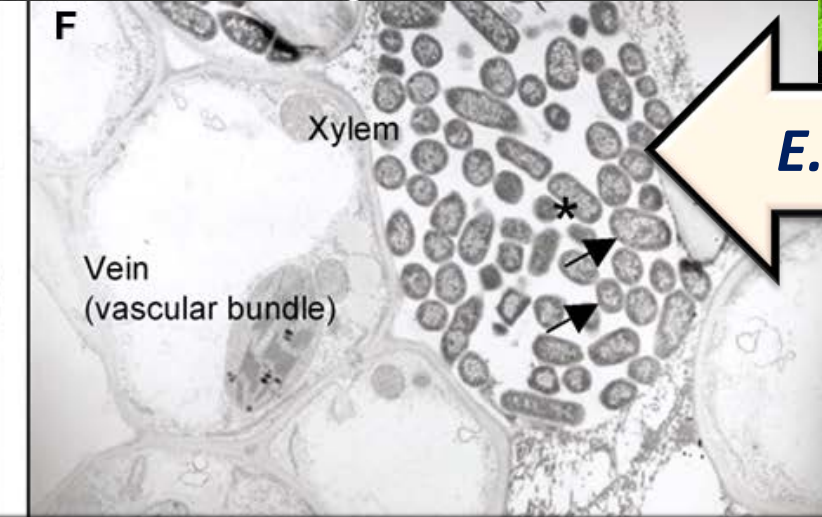
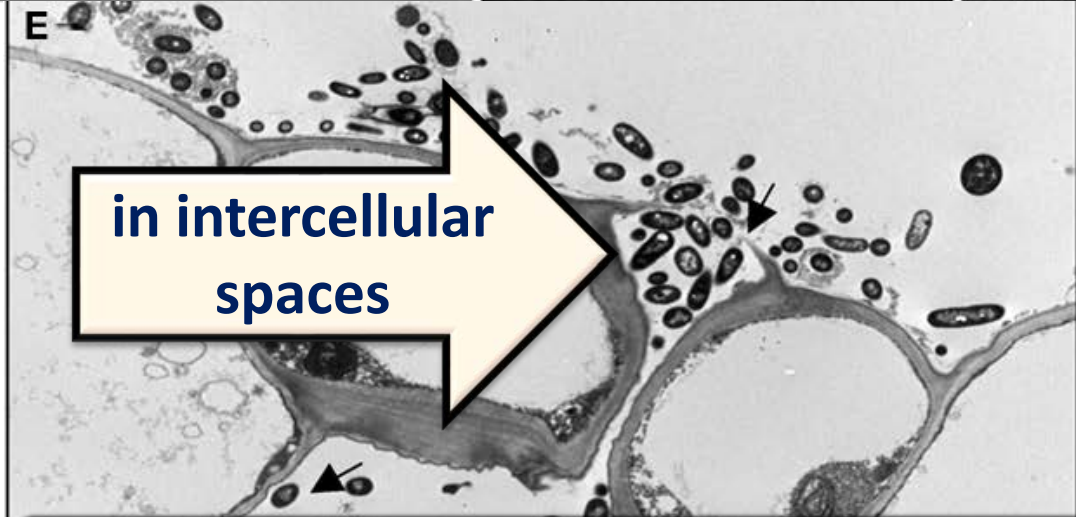


Need a comprehensive One Health approach to develop and deploy fungicides.

Shiga toxin producing *E. coli* colonization of plant tissues



E. coli in stomata



bacteria protected from effects of gentamicin, sodium hypochlorite or ozonation

Saldana et al. 2011. Front. Microbiol., 27 May 2011 | <https://doi.org/10.3389/fmicb.2011.00119>



Food Microbiology

The *Salmonella* Transcriptome in Lettuce and Cilantro Soft Rot Reveals a Niche Overlap with the Animal Host Intestine

Danielle M. Goudeau, Craig T. Parker, Yaguang Zhou, Shlomo Sela, Yulia Kroupitski, Maria T. Brandl

- *29% of genes upregulated in cilantro macerates also observed to have increased expression levels in the chicken intestine.*
- *...multiple genes induced in soft rot lesions are also involved in the colonization of mouse, pig, and bovine models of host infection*

cilantro leaves revealed a clear shift toward anaerobic metabolism and catabolism of substrates

[RESULTS](#)



Closing comments/opinion:

- **Most individual threats will not lead to catastrophic outcome**

**Catastrophic, resilience, sustainability, etc.
definitions do matter**

**Systems level challenges will require systems level
thinking and solutions.**

- **Scale matters: spatial, temporal, sector**



UCHFAR webinar:

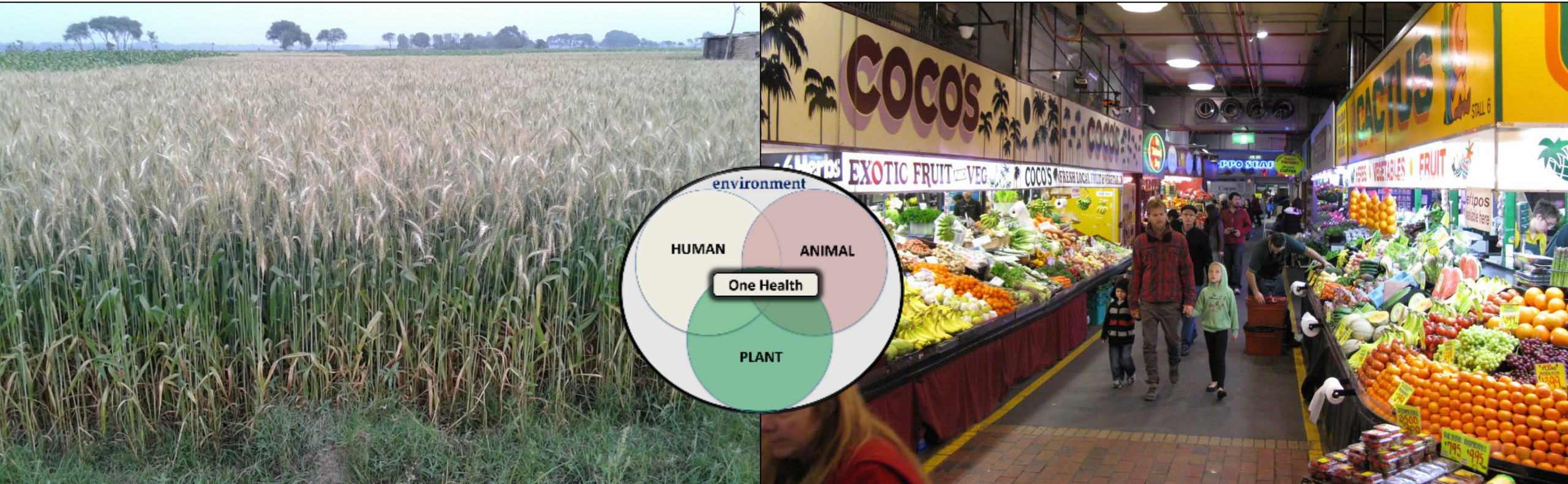
Future heat stress will dramatically reduce agricultural labor capacity, reducing food security, and disrupting global economies

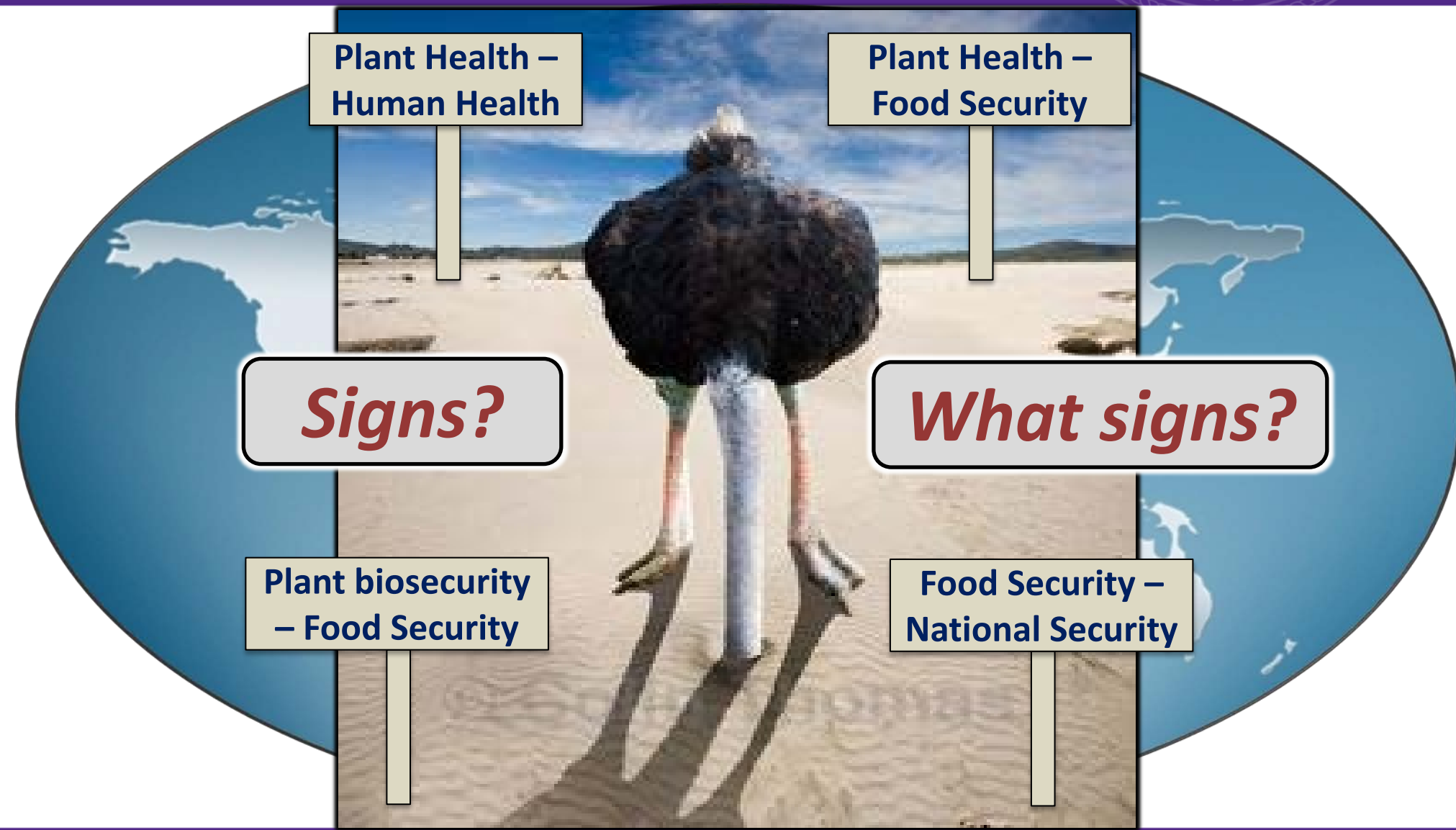


Matt Huber – 16 January 2024

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Changing the way we think about the way we think about change





- ***If we turn our backs on the world's hungry, we lay the foundation for a deteriorating and, ultimately, threatening world order. - 2017***

Senator Bob Dole

-Former Majority Leader

Senator Tom Daschle

-Former Majority Leader