The impact of plant diseases on food security

Food security

- Suitable access to safe and nutritious food
- Demand
  - One person buys more food
  - Changed dietary preferences
- Supply
  - Land degradation
  - Water shortages
  - Diseases, pests, and weeds
  - Peak fertilizer availability
  - Labor health and nutrition
  - Loss of research capacity and investment

Increase in total demand for cereals, meats, and roots and tubers, 1993–2020

Source: IRRI IMPACT simulations.

Food security - On-farm yields are low

- Global yields of wheat, rice, maize, potatoes, soybean, cotton far below potential
- 40% of world food, fiber, and biofuel production lost due to pre- and post-harvest disease, pests, and weeds
- 4 billion spent on disease management
  - Misuse of pesticides further threatens sustainability

Plant disease epidemics

- Biblical plagues, pestilence and famines
- Irish potato famine (1840s)
  - 1.5 million deaths, 2 million migrants
- Chestnut blight, Dutch elm disease
- Ukrainian wheat famine (1930s)
  - 15 million deaths
- Bengal famine (1943)
  - 1.5-4 million deaths

Impacts of plant diseases

1. New encounters
2. Genetic erosion
3. Changes in agricultural practice
4. Trade in infected plants
5. Food safety
6. Sabotage and bioterrorism

Plant pathology: The Disease Triangle

- Susceptible plant
- Pathogen that can cause disease
- Environmental conditions favourable for disease development
- Human activity

1 New encounter diseases

- Exotic pathogens
- Exotic plants
i. Phytophthora infestans

- New encounter: pathogen from Mexico met host from Bolivia/Peru in a collector’s garden in New York
- Genetic erosion: dependence on clonally-propagated host with limited diversity
- Poor nursery practice and trading infected plants
- Enemy escape: new pathogen has no natural enemies
- Irish potato famine of the 1840s, PNG Highlands in 2004

ii. Puccinia striiformis in Australia

- Spores on the clothes of a wheat farmer air passenger
- Sheridan (1989): 70,000 viable rust spores were detected on clothes over a 4-week sampling period at Wellington (NZ) airport
- Biosecurity risk modelling failed
- Pathogen was more robust than thought
- Incomplete science
- False assumptions

iii. Puccinia psidii

- Pathogen originated on Myrtaceae in South America and jumped to plantation forestry eucalypts
- Detected in Australia April 2010
- Introduced through trade in infected plants
- Poor nursery practice
- Regulatory failure

Genetic erosion:

i. Southern corn leaf blight

- Widespread plantings of T-cytoplasm hybrid genotypes in US corn belt in late 1960s
- Resilient mutant of *malvatae* appeared in 1969
- Favourable environment
- US corn belt devastated until new genotypes replaced Texas hybrids
ii. *P. graminis f.sp. tritici* Ug99

- High dependence on Sr31 in CY ø YT wheats
- 90% of the wheat crop in East Africa is susceptible
- Wind-borne dispersal towards Asia

3. Change in agronomic practice: Stubble retention

- Stubble retention allows carry-over of inoculum
  - Yellow leaf spot (Pyrenophora tritici-repentis)
  - Crown rot (Fusarium graminearum)

4. Trade in infected plant material

- Poor nursery practice, inadequate diagnostics, systemic fungicides
  - P. infestans in Europe (1845), PM2 (2004)
  - Chestnut blight, Dutch Elm Disease in early C20
  - Fireblight in apples and pears
  - P. cinnamomi in Australia
  - Panama wilt (TR4) in banana
  - P. psidii in Australia (2010)
  - Phytophthora capsici, P. ramorum in USA
  - Viruses, phytoplasmas
5. Mycotoxins

- Aflatoxin, ZEN, ochratoxin, DON, deoxynivalenol, FUM, fumonisin, OTA,
- Found in mouldy grain eaten by humans and livestock,
- Has greatest impact on rural poor.

6. Sabotage

- E. onilopht hora pernicios ($W$itches’ broom) on cocoa in $B$ahia
- Production dropped from 400,000 to $B$100,000 tonnes

New technologies

- Intensification
- Soilless growth media
- Protected cropping
- Crop surveillance
- Precision cropping

Food security depends on good farming practices

- Maintain plant health
- Maintain soil health
- Manage pests and diseases
- Sustainability
- Profitability
Farming can be a poverty trap

Good farming practice is not always possible:

- Farmers are under many pressures
  - Low prices
  - Competition with imports
  - Rising costs
  - Labour shortages
  - Pests and diseases
  - Climate change
  - Limited access to technology

What else can we do?

- Improve diagnostics, early detection and policy
- Prevent trade of infected plants
- Realign and invest in research towards achieving sustainable yields on farms
- Intensification and diversification
- Better management of microbial, host and environmental factors
- Reduced dependence on monocultures of uniform genetic material
- Improve adoption (constraints and incentives?)
- We need to support farmers to be healthy, profitable and sustainable

References