Integrated Management of the Invasive Cocoa Pathogen *Moniliophthora roreri*

Ulrike Krauss

Forestry Department
Ministry of Agriculture, Lands, Forestry and Fisheries
Union
Saint Lucia

Moniliophthora roreri causes Frosty Pod Rot (FPR) of Cocoa (*Theobroma cacao*)

- Spanish: moniliasis
- Highly invasive pathogen
- Losses up to 100%
- Crop abandonment
- Loss of livelihoods
- Change of land use with loss of biodiversity

Invasive Spread of *M. roreri* throughout Mesoamerica

Source: Phillips *et al.*, 2005

Management Cascade for Invasive Alien Species (IAS)

- **Prevention**
  - Most cost-effective approach
- **Early detection and rapid response**
  - Based on analyses of pathways and risks
- **Impact mitigation**
  - Integrated approach
  - Benefit : cost analyses

Both require:

- ✓ strategic planning
- ✓ public awareness
- ✓ training
- ✓ effective enforcement mechanisms

Prevention

- **Scope:**
  - Insular Caribbean, Eastern Venezuela, Guyanas and Bolivia:
    - Extreme alertness
    - Regional cooperation
  - Africa and Asia:
    - Strategic measures for intercontinental germplasm transfer, transport and trade
- **Public awareness and education**
  - FPR destroys livelihoods
  - Apparently healthy pods may harbour the pathogen
- **More efficient enforcement of existing regulations**
  - Ports of entry by air, sea and land

Ministry of Agriculture, Land & Marine Resources

PEST ALERT

Frosty Pod Rot of Cocoa

Fig. 1 Photo Roy P. Bateman of IPARC

Fig. 2 Photo Roy P. Bateman of IPARC

Fig. 3 ©2004 American Phytopath. Society

This disease is not present in Trinidad and Tobago

HELP KEEP TRINIDAD & TOBAGO FREE OF FROSTY POD ROT!

What is it?
Frosty Pod Rot is a disease of cocoa and is caused by the fungus, *Moniliophthora roreri*.

Origin and spread
The disease is confined to Central and South America. It first appeared in Columbia in 1917, and has spread to Ecuador, western Venezuela, Panama, Costa Rica, Peru, Nicaragua, Honduras, Guatemala, Belize, and Mexico.

Spread
The fungus produces spores that are spread naturally by wind, water and movement of the infected pod. Spores can survive up to 9 months on any carrier - tools, shoes, clothes, equipment, vehicles and shipping containers.

Impact
Frosty Pod Rot disease has been reported to be twice as destructive as Black Pod rot disease. Average pod losses is over 30%, but can exceed 90% under favourable conditions.

Description
Symptoms are seen only on cocoa pods:
- Infected young pods show light yellow swellings and distortion **(Fig. 1)**.
- Older pods ripen prematurely. Internally, the beans appear reddish brown and necrotic **(Fig. 2)**.
- In advance stages, the pod typically shows chocolate-coloured lesions and the white/creamy fungus on the pod surface **(Fig. 3)**.

Frosty Pod Rot and Black Pod Rot
These two diseases are similar in that they both cause rot of the cocoa pod. However, there are no swellings and distortions of the cocoa pod in Black Pod Rot.

What can I do?
Avoidance is the best strategy. Report any suspicious pod rot symptoms to Hotline.

DO NOT BRING COCOA PODS FROM INFECTED COUNTRIES!

Surveillance Unit,
Ministry of Agriculture Land & Marine Resources
Republic of Trinidad & Tobago

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Early Detection and Rapid Response

- **Train quarantine and survey personnel in early detection**
  - Latent infection last up to two months
  - Least visible on outside of pod

Focus on early stages

5 diseased pods

5 healthy pods

6-8 week window of opportunity

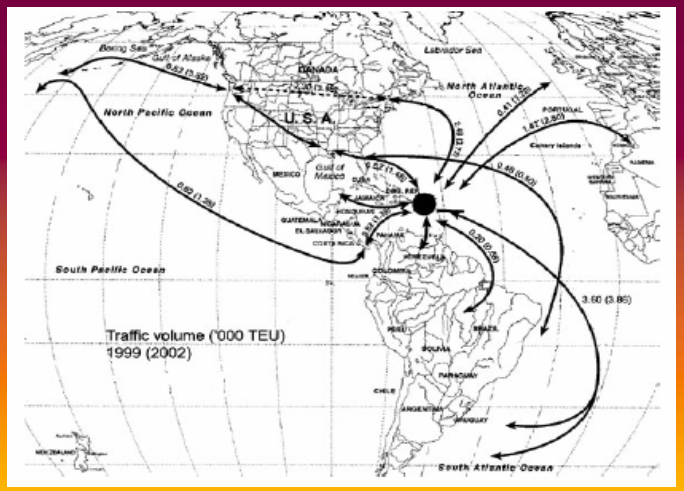
Looks like witches' broom → **Diagnostic confirmation** →

Early Detection and Rapid Response

- **Emergency plan**
  - Develop with anticipation
  - Focus on high risk pathways: the infamous "***4 Ts***"

Travel

Tourism



Trade

Transport

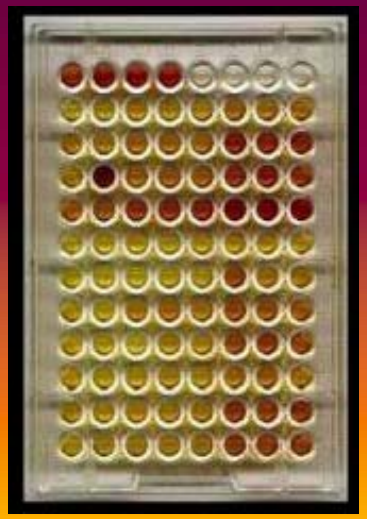
Source:
Meissner *et al.*, 2009

snails

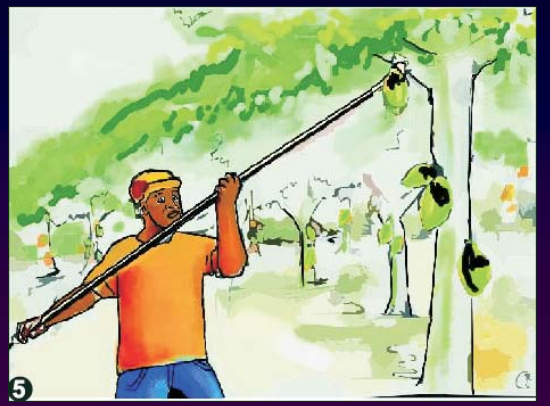
Early Detection and Rapid Response

- **Implementation and enforcement mechanisms**
  - Prompt host elimination
  - Farmer compensation scheme
  - Replanting capacity

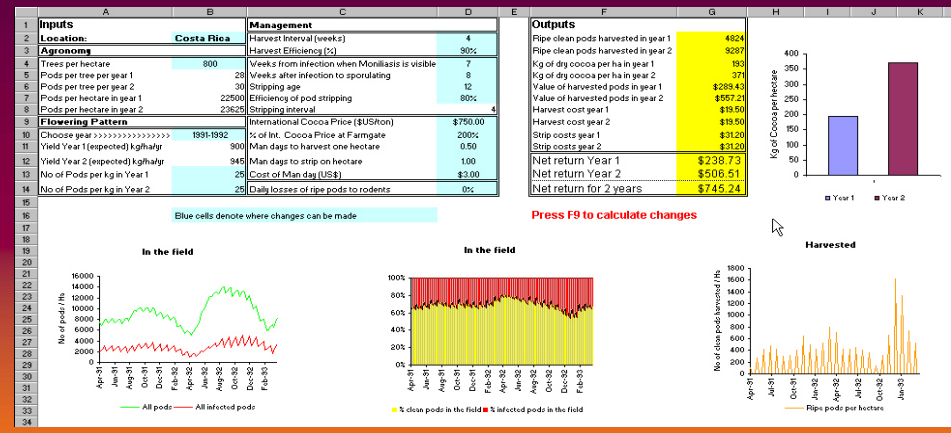
- **Early detection and rapid response have never been used successfully against FPR!**



Impact Mitigation: Integrated (IPM) Approach



- **Invariably centres around cultural control**
  - Fundamental to IPM approach: no short-cuts
  - Already available (short term)
  - Epidemiology urges weekly phytosanitation,
- **Benefit : cost analysis may highlight need to modify**
  - Frequency and combination of interventions
  - Modelling as decision- making tool
- **Complemented by**:
  - Chemical control
  - Biopesticides
  - Disease resilient agroforestry systems
  - Classical biocontrol, e.g. with endophytes
  - Genetic and induced resistance

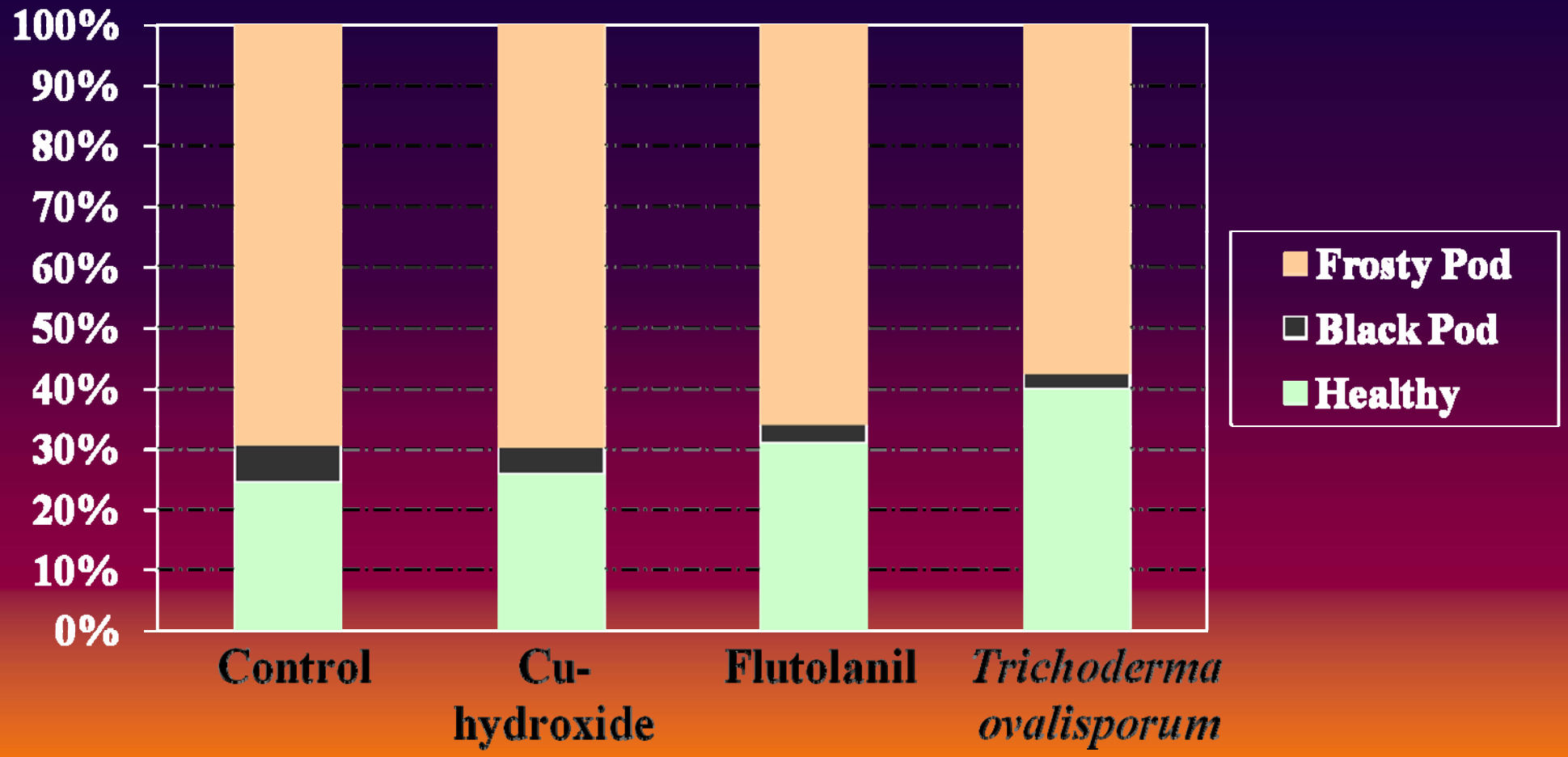


Impact Mitigation: IPM - Chemical Control

- **Already available (short term)**
- **Copper fungicides consistently most cost-effective**
  - Select low hazard class (Cu hydroxide; NOT Cu sulphate)
  - Cu still permitted in organic cocoa if $\leq$ 8 kg ha^{-1} yr^{-1}
- **Flutolanil (oxathiin: systemic, specific against basidiomycetes)**
  - Beneficial in early season
  - Best applied with a sticker
  - No measurable residue
- **Targeted application**
  - Determines %age waste and thus cost-effectiveness
  - Requires manageable tree height => CULTURAL MEASURES !

Impact Mitigation: IPM

Biological and chemical control



Impact Mitigation: IPM

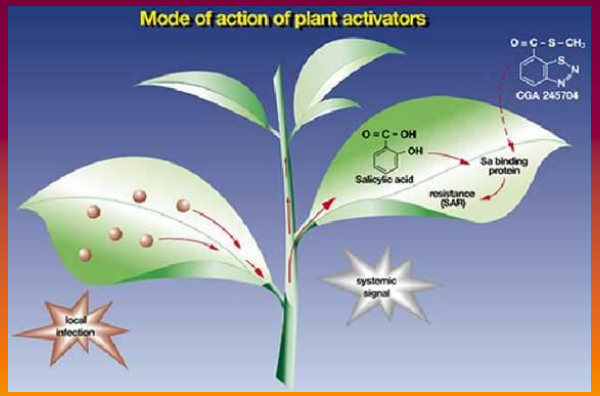
Biological control – inundative and classical

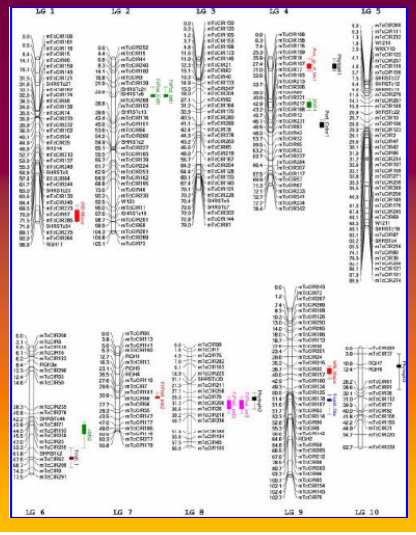
- **Short term:**
  - Inundative use of local antagonist mixtures in Peru
- **Medium term:**
  - Classical biocontrol approach in Central America
  - Using coevolved endophytes

Impact Mitigation: IPM

Resistance – genetic and induced

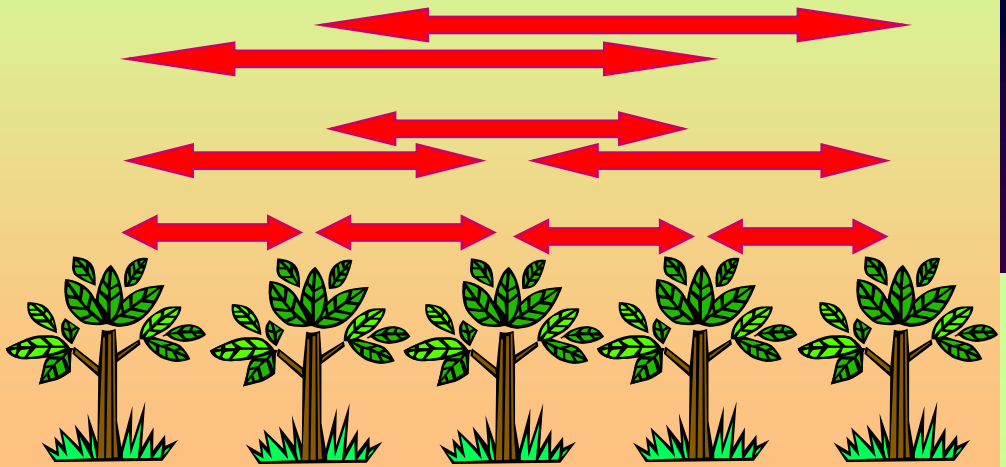
- Long term perspective
- Horizontal (multi-gene) resistance is less complete but more durable
- ICS-95 showed consistent resistance against seven isolates from four genetic groups of the pathogen
- QTL-assisted breeding under investigation
- Immunization with endophytes building on phosphonate experience?





Source: Schnell *et al.*, 2007

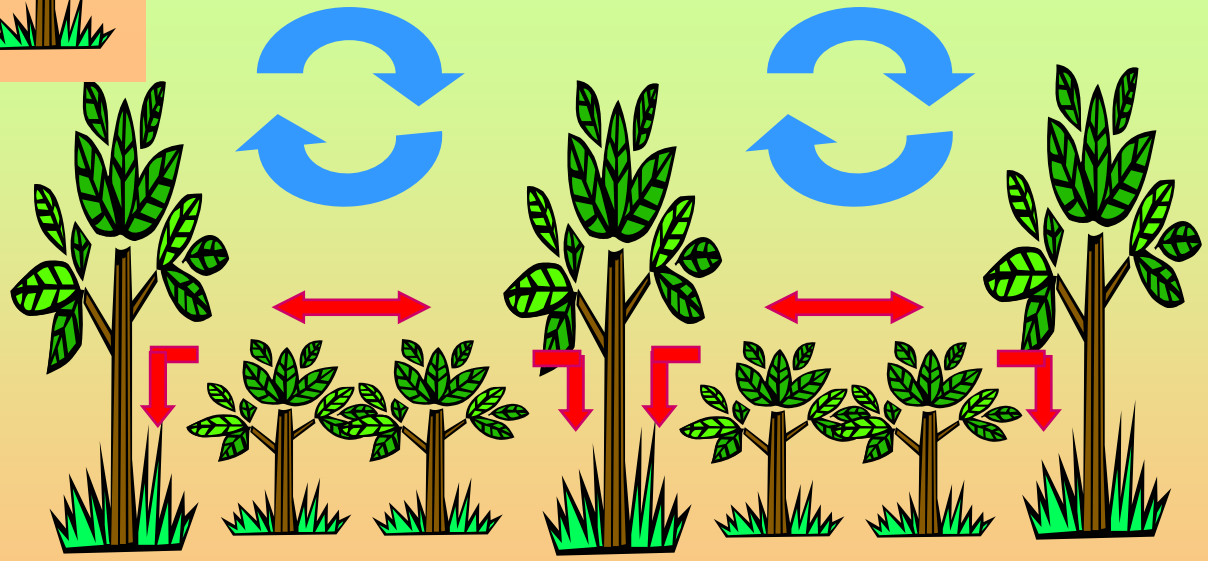
Monoculture:
Continuous cross-infection
Splash-dispersal up to 8m



Impact Mitigation: IPM

Disease-resilient agroforestry systems (AFS)

Air circulation in upper canopy



Non-hosts intercept inoculum, but increased humidity

- **AFS design to diversify risks and to regulate**
  - Temperature / Shade
  - Aeration
  - Inoculum interception

Conclusion

- **Prevention is the first choice**
- **Early detection and rapid response have never been used successfully against FPR**

  => Approach needs to be more rigorous
- **Impact mitigation must centre around sound cultural management**
- **Priority action points:**

  => Proactiveness of intervention cascade

  => Training and public awareness

  => Effective enforcement cascade, including funding

  => Regional and international cooperation

Thank you!

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