

IPM - Innovation Lab\CRSP Diagnostics Training and Establishment in Developing Countries

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Virginia Tech



NPDN's Role in Advancing Diagnostics:

**Increasing Capacity for Increased Food Security and
Economic Stability**

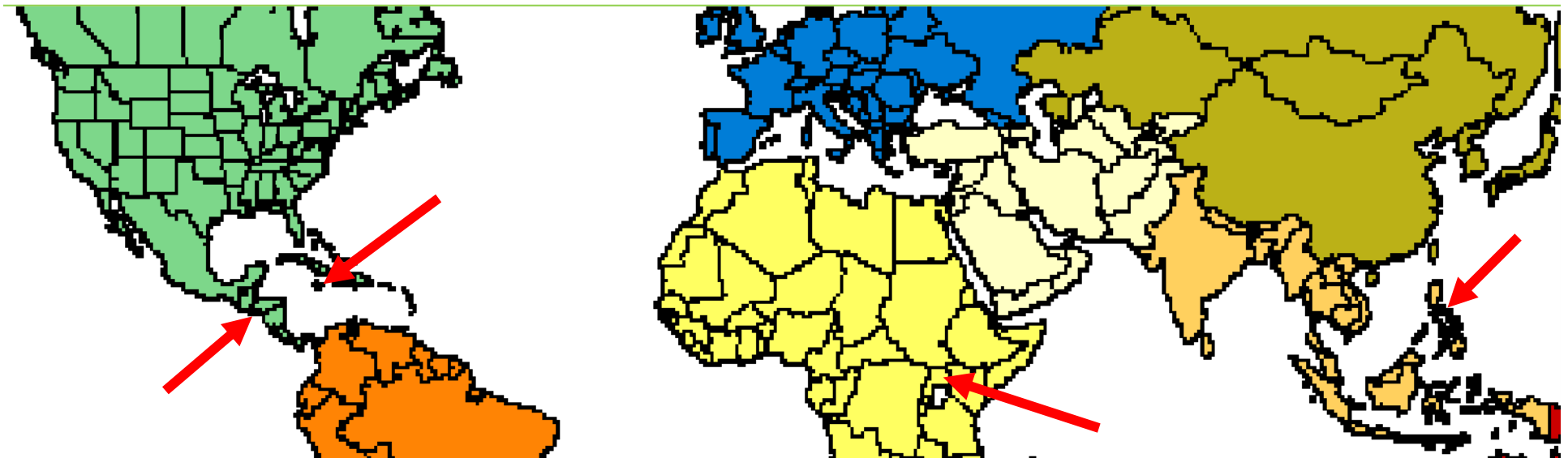
Advancing Diagnostics to Meet Plant Health Needs

March 8-12, 2016
Washington, DC

IPM CRSP US AID History



- Integrated Pest Management Collaborative Research Support Program
 - a Systems CRSP, awarded to Virginia Tech over two decades ago
 - **Phase I:** 1993-1998: Regional Sites in Caribbean (CARDI-Jamaica), Central America (Guatemala), East Africa (Uganda), Southeast Asia (Philippines)
 - IPM of non-traditional export crops, participatory appraisals



Jamaica

Scotch Bonnet pepper



Virus problems began early 1990s

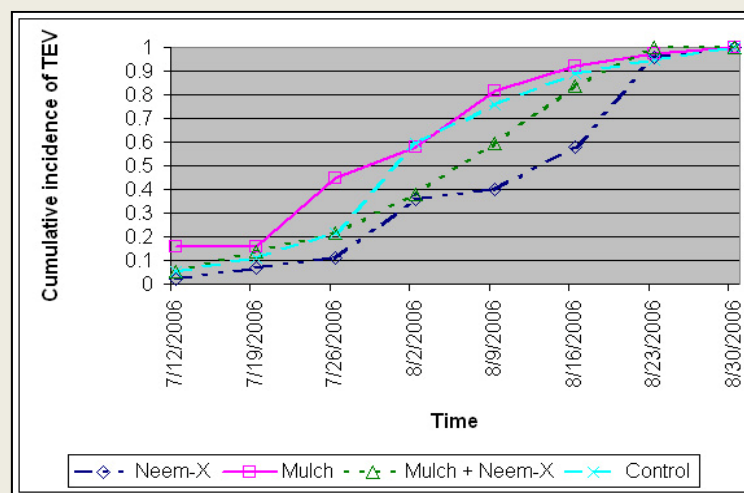
- Fruit distortion, decreased yield
- Perennial to annual crop
- Thought to be TEV, aphid-transmitted

Management practice: Tactics to delay time of infection and decrease impact of tobacco etch potyvirus on hot pepper

- Establish impact of early infection
- Identify specific aphids and phenology
- Monitor time course of infection by TBIA
- Protect plants from early aphid feeding
 - Mulch, oil sprays
 - Weeds/vectors



S. McDonald, Jamaica

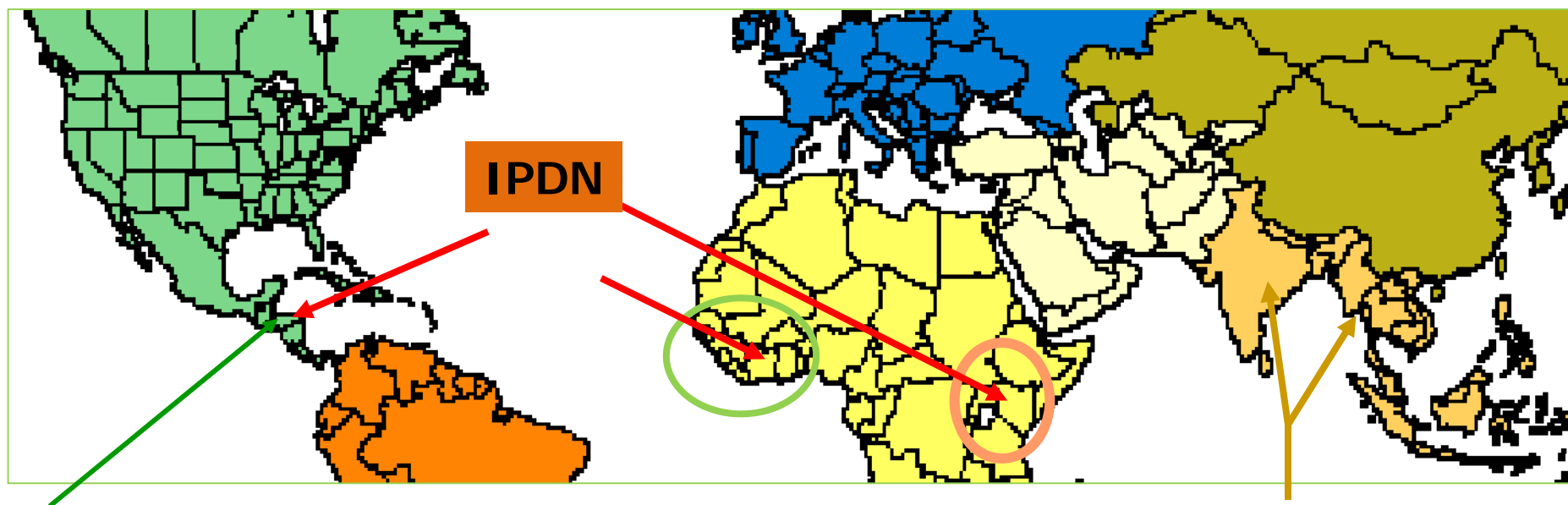


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 - **Phase II:** 1998-2004: Added Regional Sites in South America (Ecuador) West Africa (Mali); South Asia (India)
 - **Phase III:** 2004-2009: Central America, South America and Caribbean merged into one region, LAC, and added Central Asia. Formed Global Themes: **Plant Diagnostics** and **Viruses**

Phase III: IPM CRSP 2004-09 Two Global Theme Virus Projects + Diagnostic



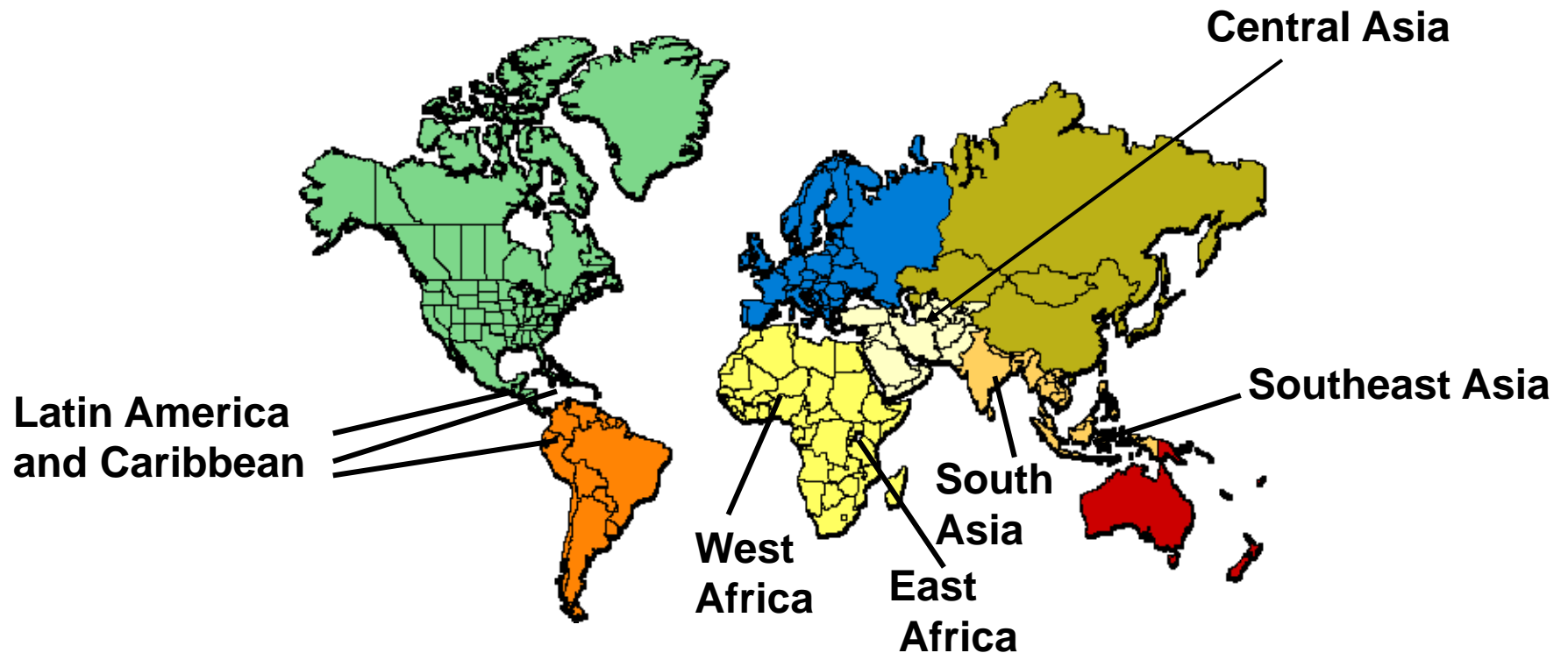
Aphid and whitefly-borne viruses in Central America, the Caribbean, and Sub-Saharan Africa

Thrips-borne tospoviruses in vegetable cropping systems in South and Southeast Asia



USAID
FROM THE AMERICAN PEOPLE

- **Phase IV:** 2009-2014 - Virus Global Themes merged. Changed to Innovation Lab in 2013. Feed-the-Future



Phase IV: IPM-CRSP 2009-2014
Virus Global Theme: International Plant Virus Disease Network
One Project - 6 Regions – 19 countries, at first

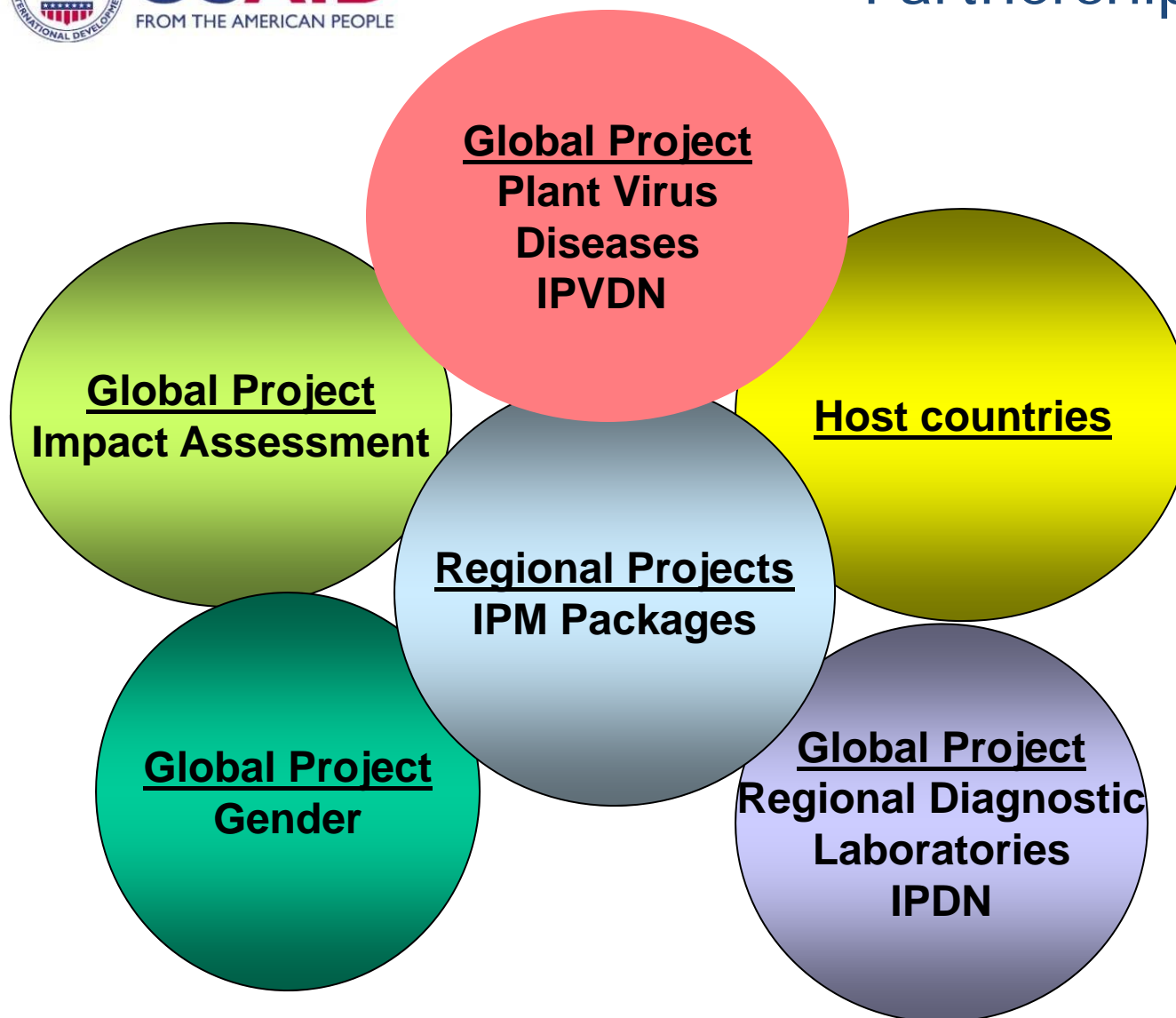




IPM CRSP-Integrated Pest Management Collaborative Research Support Program Now: IPM – Innovation Laboratory

- USAID-Funded
- Phase IV 2009-2014 www.oired.vt.edu/ipmil/
- Operated in **16** countries
- Covered **one-third** of the world population
- Collaborated with:

| | |
|--|----|
| U.S. universities | 17 |
| Host country institutions | 60 |
| International Agricultural Research Centers | 7 |
| NGOs | 10 |
| Private institutions | 5 |



Goal: Identify a network of institutions in host countries to collaborate with many activities of the IPM CRSP

Crops Addressed in the IPM CRSP

Vegetables

- Tomato
- Eggplant
- Pepper
- Potato
- Cucurbits
- Crucifers
- Beans
- Onions

=90% of crops the program focuses on

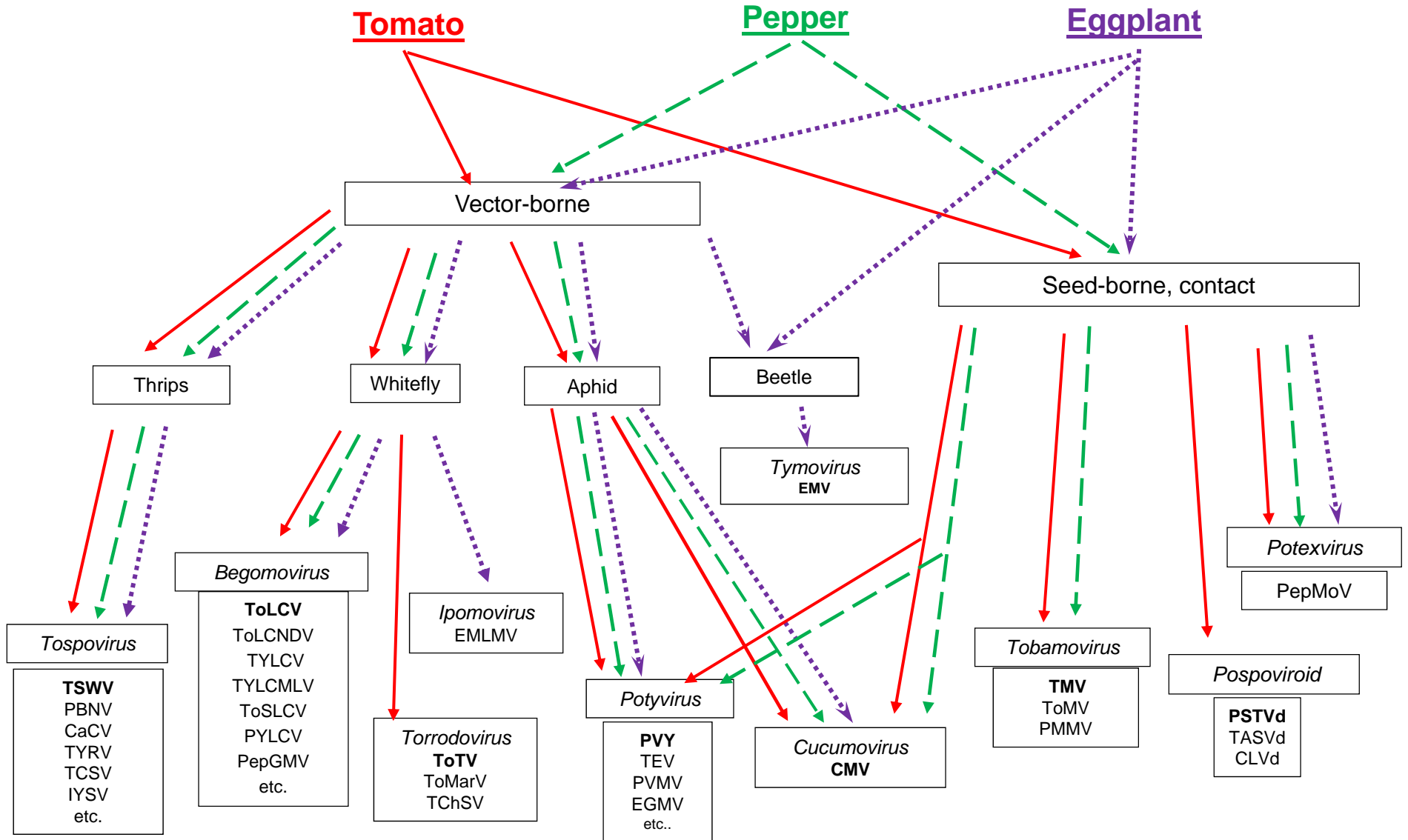


Fruit and other crops

- Coffee
- Naranjilla
- Passion Fruit
- Wheat

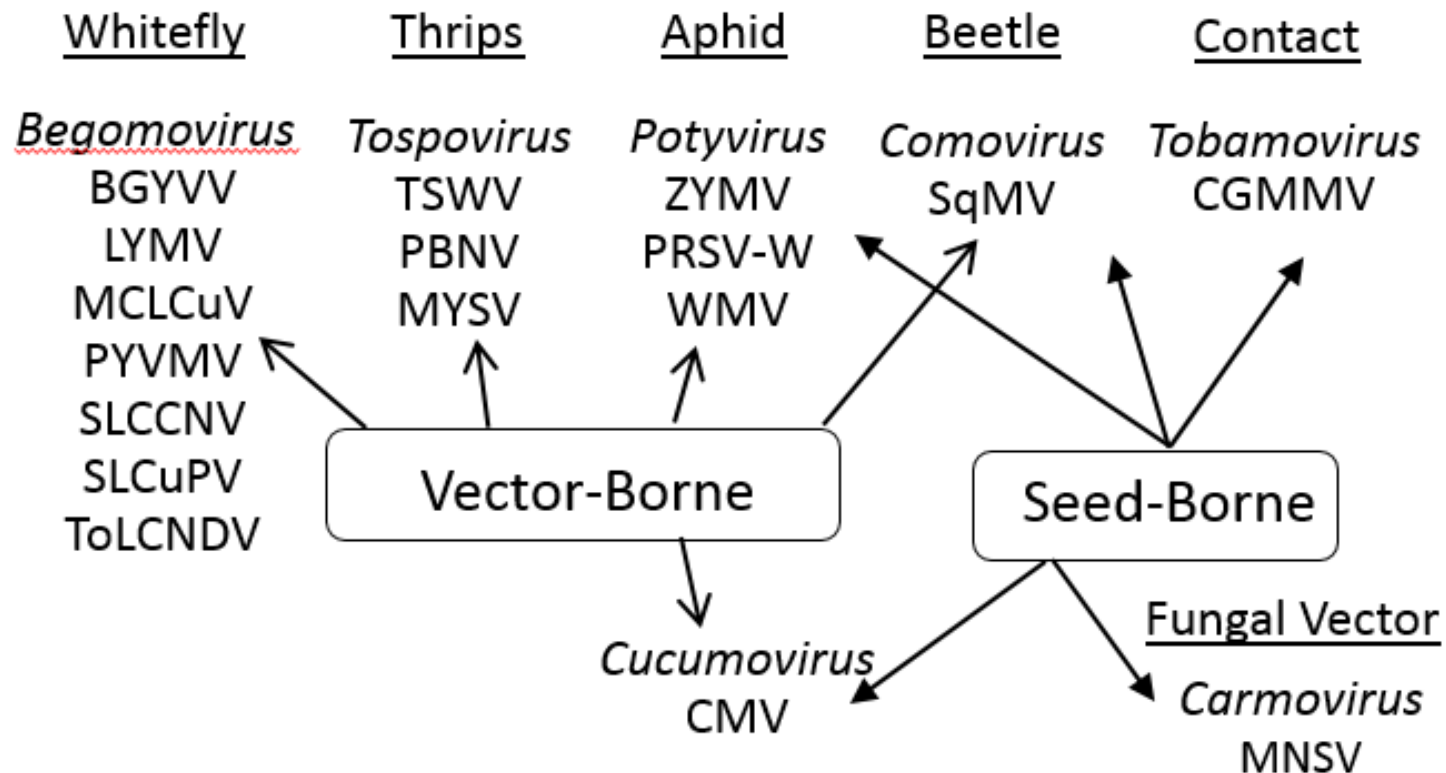
=10% of crops the program focuses on





Viruses in Solonaceous crops - IPM IL

Cucurbit viruses detected by IPM IL



Diagnostics x Crop x Region

- Southeast Asia:
 - South Asia:
 - Central Asia:
 - East Africa:
 - West Africa:
 - Latin America and Caribbean:
- Cucurbits
 - Legumes
 - Potato
 - Tomato
 - Sweetpotato
 - Tree tomato
 - Pepper
 - Okra
 - Others

The same crop in different countries often has the same viruses.
Value in observing similarities and differences in symptoms.

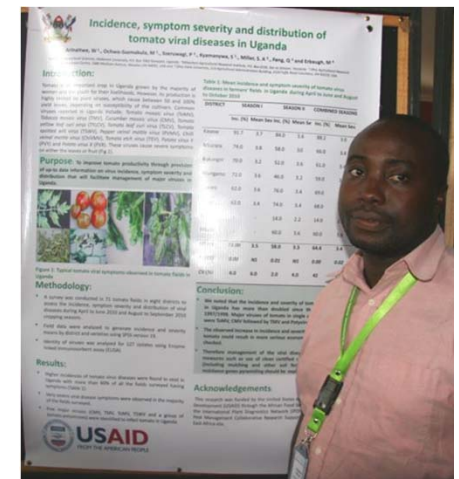
The IPVDN Approaches

- **Document** presence and prevalence of the [economically important] viruses in crops in an area
- Understand **virus and vector** complexity and dispersal in diverse ecosystems
- Design and apply **management interventions**, and monitor their **impact**
- **Collaborate** between US scientists and host country universities and national programs
 - Training and capacity building
 - Workshops and Symposia



Collaborative with East Africa Regional Site and African Food Security Initiative, **IPDN**

- Average field incidence of viruses was **64%**
- Diagnosis by ELISA and PCR: TSWV, ToLCV, PYLCV, CMV, TMV, ToMV
 - Most common: 43% ToMV and 35% CMV
 - Frequent mixed infections
- Sequence analysis indicated ToMV-Uganda was 99% identical to isolates from China, Australia, Japan and Germany
- IPDN work in EA was cooperative with MARI in Tanzania, Makerere Univ. in Uganda, and KARI in Kenya



Data from IPVE PP-114 Warren Arinaitwe: URL for IPVE 12th

Viruses spread by contact, not by insect vectors

SOLOLÁ



West Africa

Tomato Viroids and Viruses in Ghana



CMV



Begomovirus



**Gilbertson,
with West
Africa Region
and IPDN**

'Rasta' caused by
Columnea latent viroid
A new finding!

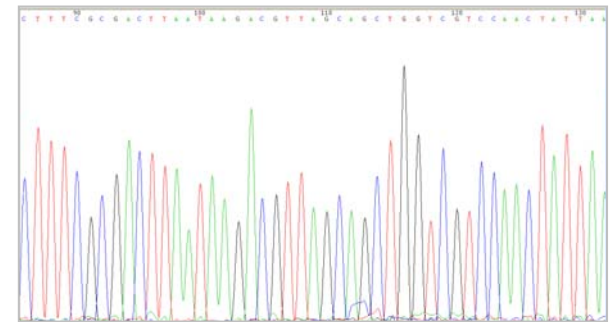
Optimized membrane-based technologies for virus identification



TBIA



RT-PCR + sequencing



DNA or RNA isolation,
cloning, sequencing

Dominican Republic – Pepper trial in Ocoa



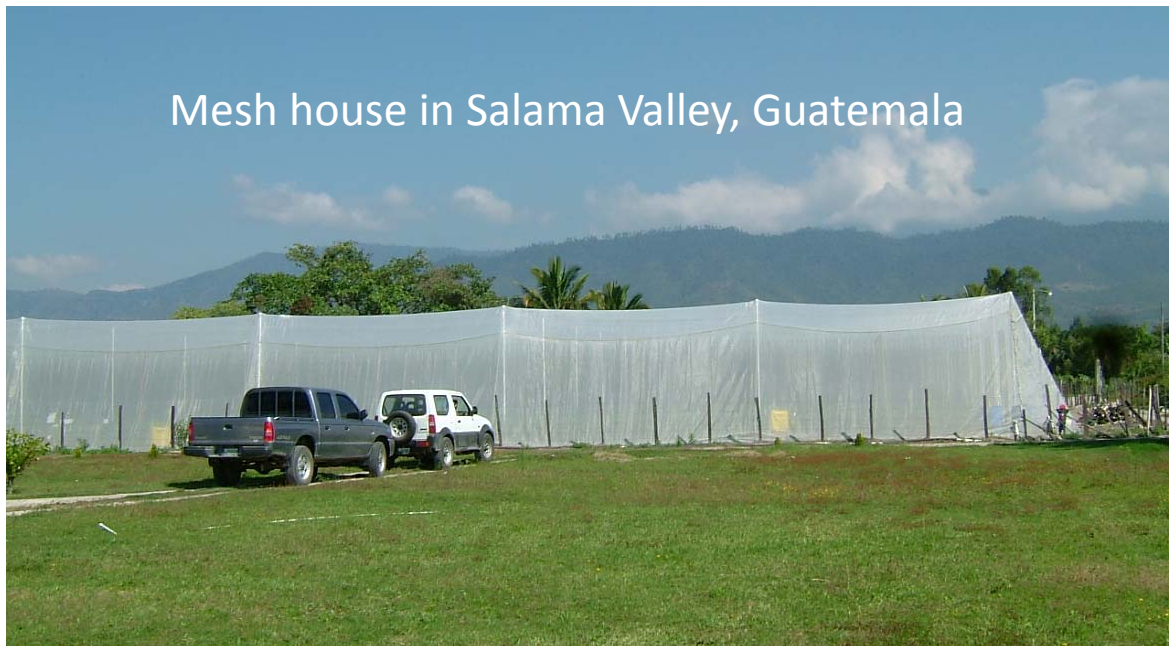
| SAMPLE | Agdia | (19-8) | POTY R0003 |
|--------|-------|------------|-------------|
| SAMPLE | | CMV 00024 | H-9 ♀ Agdia |
| SAMPLE | | CMV 00024 | H-8 ♀ Agdia |
| SAMPLE | | CMV 00024 | S-10 Agdia |
| SAMPLE | | TMV 00001 | Agdia |
| SAMPLE | | TMV 00031 | P-6-H Agdia |
| SAMPLE | | TRVV 00019 | Agdia |
| SAMPLE | | TRVV 00019 | P-1-S Agdia |

Guatemala Salamá Valley

Whitefly vector. Virus may be TYLCV or
another begomovirus



Mesh house in Salama Valley, Guatemala



Guatemala
Salamá Valley

TOMATO

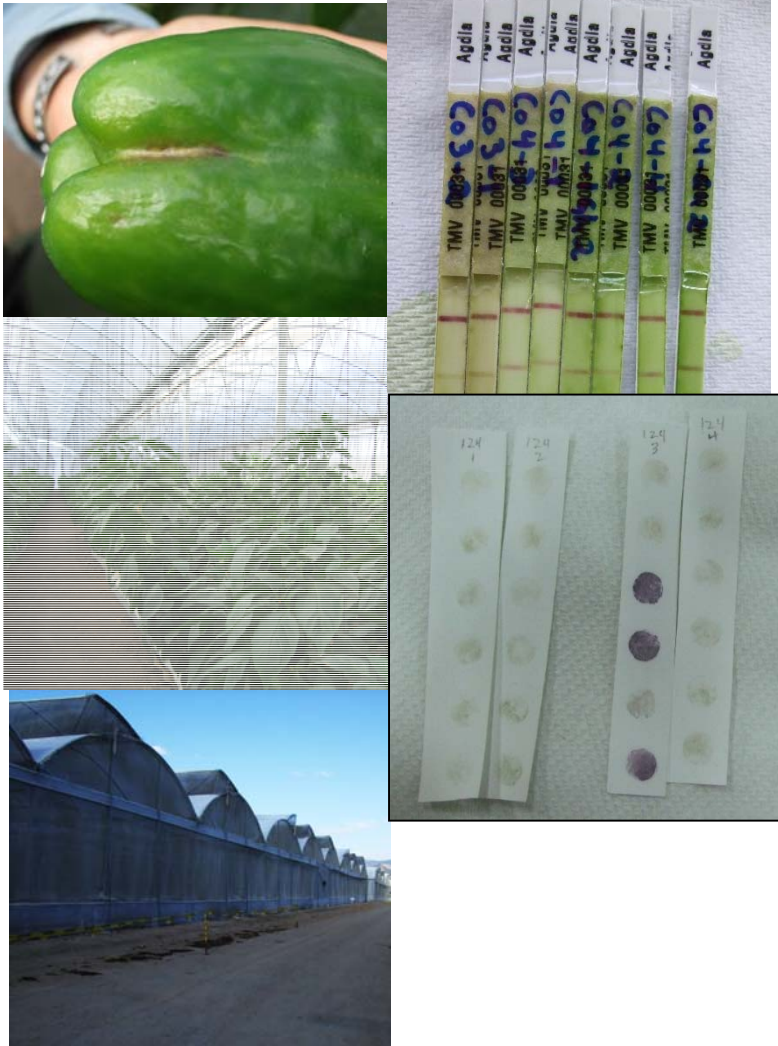


Pepper in Guatemala – protected pepper production

Accepted for pre-clearance export if grown in this way.
Investment paid off in 3-5 years.



Honduras: *Pepper mild mottle virus*



- Seed-transmitted tobamovirus cross-reacted detected by TMV immunostrip
- Spread by contact and in circulating irrigation water
- Manage by clean seed and resistant cultivars. Low tolerance level in pepper seeds

East Africa

Potato virus Y in tomato in Kenya



Necrotic symptoms suggested Tospovirus. RT-PCR from FTA Cards by Naidu detects PVY



Symptoms also suggest begomoviruses here and elsewhere in EA. Current work with J. Brown and P. Sseruwagi.

Southeast Asia

PVY in Indonesia

Pengalengan, West Java



Determined to be Tuber necrosis strain of PVY – a quarantine strain that could impact the production of virus-free potatoes
---Naidu Rayapati

Central Asia

Potato in Tajikistan



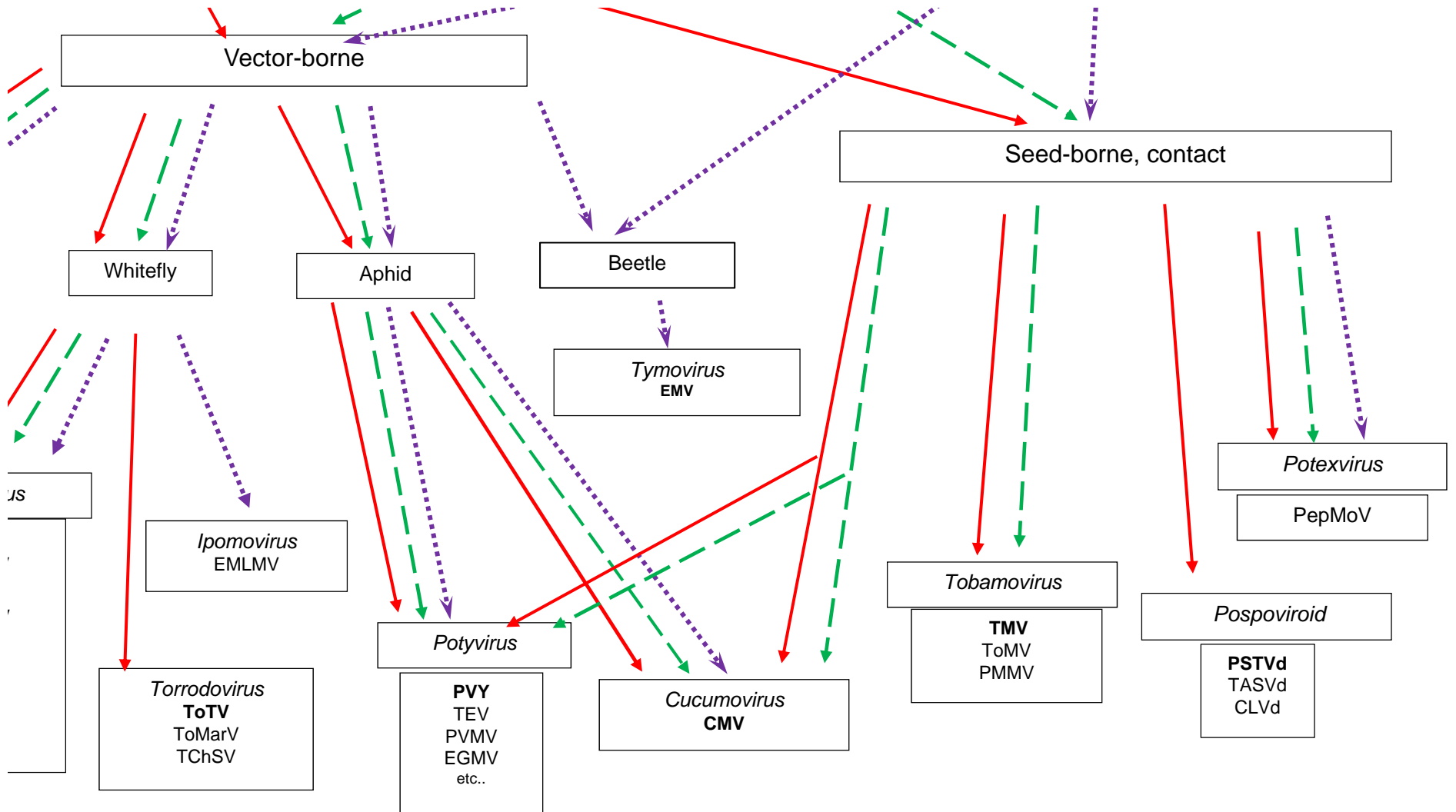
Also determined to be Tuber necrosis strain of PVY – a quarantine strain that could impact potato production -
--Naidu Rayapati

Why do virus diagnosis?

- **Curiosity** to know the cause of a symptom
 - One or more viruses? Phytoplasma? Fungi? Bacteria? Insect?
- Growers want an answer – **What can I spray?**
- To know what virus or viruses are present to develop a management practice – virus IPM is long term plan
 - **Source?** Where did the virus come from?
 - Can the source be reduced? Weeds? Seeds? Vectors?
 - How is the **virus transmitted?**
 - Biological – specific vector taxa transmit certain taxa of viruses
 - Mechanical – by human/physical contact during transplant and harvest is important for certain viruses
 - Seed – only common for certain taxonomic groups of viruses

Facts about Virus Diagnosis

- Virus can rarely be diagnosed by symptoms
 - Strains, host and variety, environment, time of infection all cause variations in symptoms
- Plants may be infected with multiple viruses
- Diagnostic tests are available for only certain known viruses or virus families
- There are no rapid diagnostic tests for unknown viruses
 - New viruses are emerging rapidly
 - Or, viruses are just now being recognized, even though they have been around



Viruses in Solonaceous crops - IPM IL