Commission on Phytosanitary Measures :
Scientific Session

New Inspection Technologies

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Presentation Linkage

IPPC Strategic Framework 2012-2019

"Specifically from a plant protection point of view, new technologies will provide NPPOs with more tools to facilitate inspections and certification of commodities, improve pest diagnosis, enhance traceability of commodities and rapid and effective communication. Regulatory policy should encourage use of these tools". (pg. 13)

Strategic Objective A. Protect sustainable agriculture and enhance global food security through the prevention of pest spread.

> **Organizational Goal A1.** Pests are detected, reported, and eradicated or controlled by means of improved inspection, monitoring, surveillance, diagnosis, pest reporting and pest response systems.

Dilemma of Safer and Freer Trade

Each day in 2013 Customs and Boarder Protection admitted:

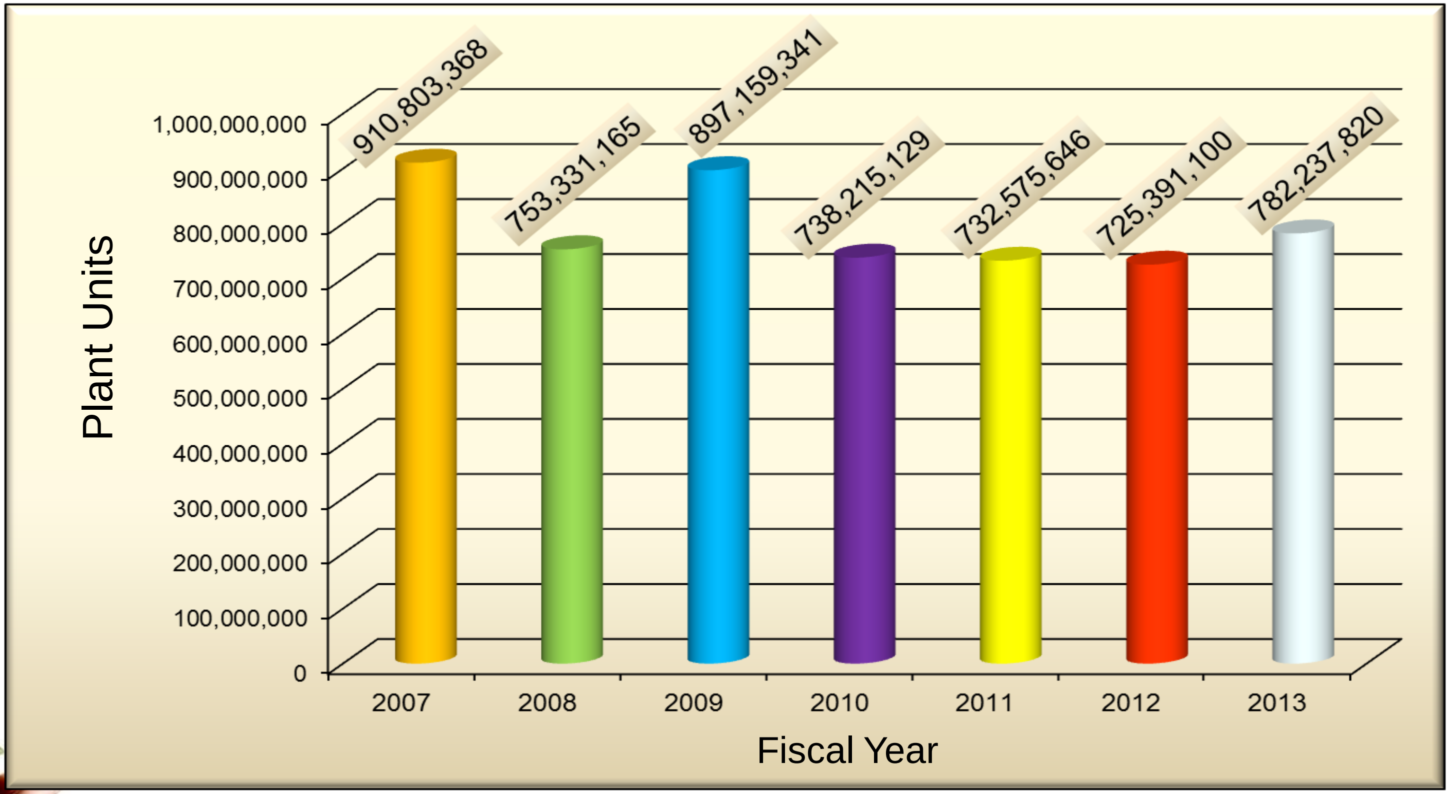
- **992,243** passengers and pedestrians
- **269,753** incoming privately owned vehicles
- **280,059** incoming international air passengers and crews
- **48,994** ship passengers and crew
- **67,337** truck, rail and sea containers

and each day seized:

- **4,379** prohibited plant/meat/animal bi-products
  - **440** pest interceptions forwarded to USDA and nearly 50% of these were reportable pests that are harmful to agriculture.

Current challenges

National Plant Unit Imports FY 2007 -2013



Data source: AQAS Jan 21, 2014 FLenis

Current challenges

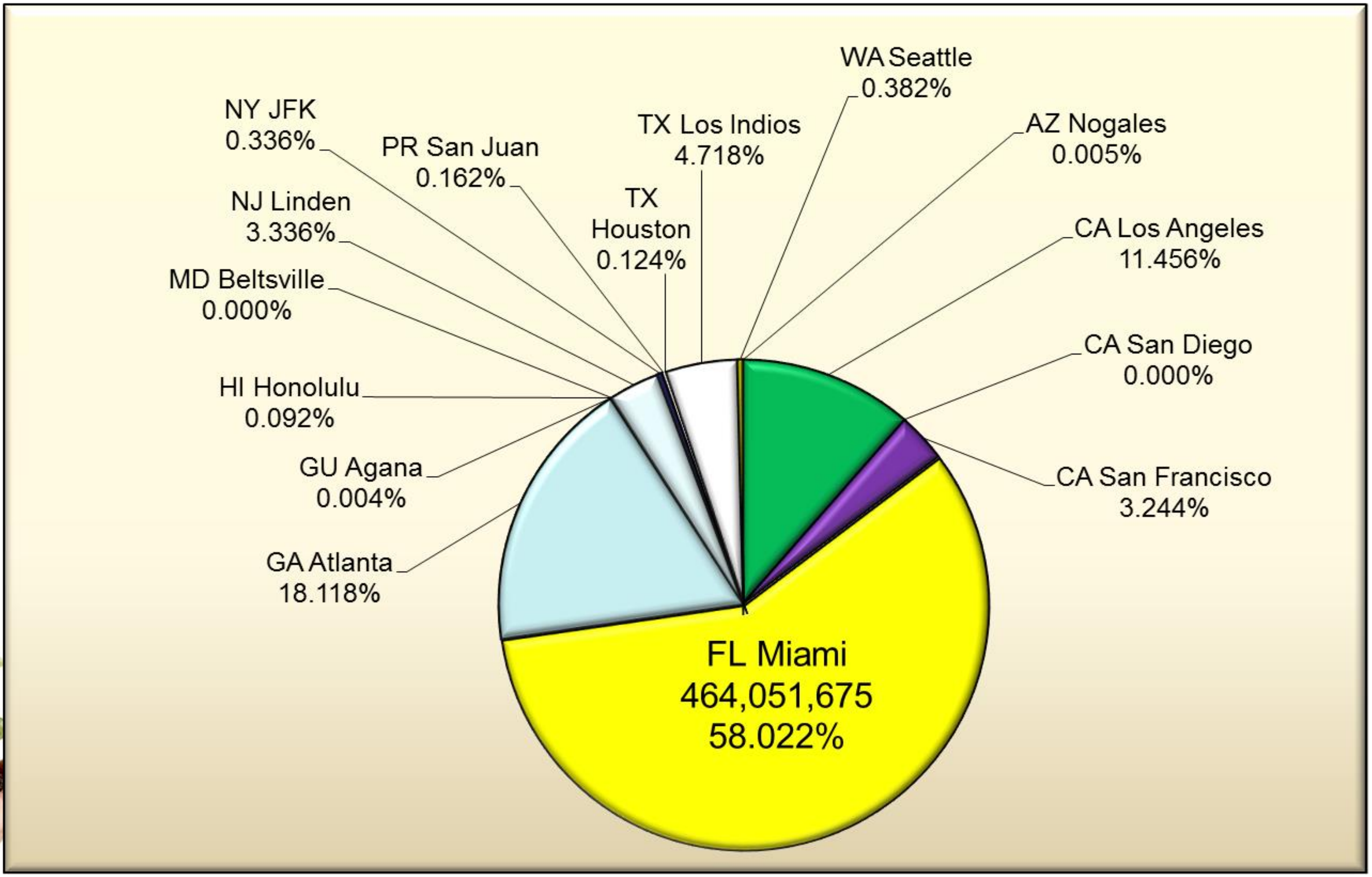
Plant Inspection Stations

National Processed Commodity Totals in FY 2013

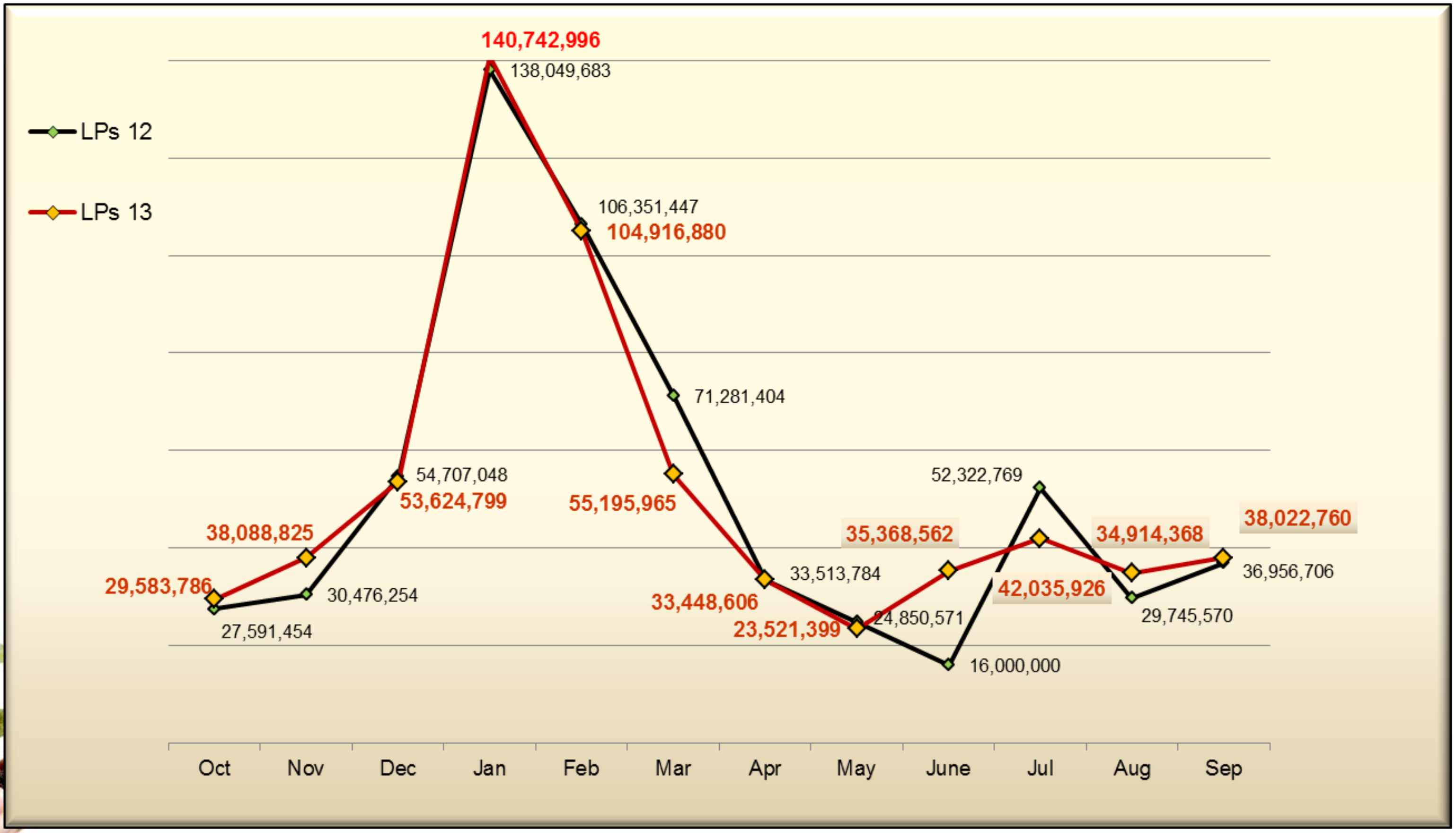
PIS	Each (Botanical specimens, Mail etc.)	Flasks (In vitro plants)	Grams (Soil)	Kilograms (Seed)	Plant Units
AZ Nogales			1,736	15,244	41,763
CA Los Angeles	8	145,269	6,736	5,303	91,404,802
CA San Diego	21		2,315	5,597	2,781
CA San Francisco	11	527,472	77,144	528,440	25,859,195
FL Miami	**106**	**2,603,507**	**7,930**	**1,093,458**	**440,461,733**
FL Orlando		61,992		719	9,779,542
GA Atlanta	46	622,835	10,591	130,349	142,463,668
GU Agana			5,362	89,331	30,612
HI Honolulu	738	64,874	525	11,935	764,584
MD Beltsville		42		130	1,976
NJ Linden		715,557	1,286,154	3,090	25,490,137
NY JFK	304	11,026	7,791	2,072	2,609,456
PR San Juan		80,093		106,785	1,104,335
TX Houston	4	2,555	463	2,733	994,294
TX Los Indios				62,442	37,714,235
WA Seattle		387,380	4,597	3,784	3,479,750

Plant Inspection Stations

National Plant Unit Imports Per PIS in FY 2013



Monthly Plant Units in FY 2012 and 2013 Miami Plant Inspection Station



What do the numbers mean? How can APHIS, how can any country, effectively and efficiently inspect these large numbers of plant materials?

In the future

New Thinking, New Tools, New Ways Forward

- New methods for sampling are needed for large shipments of single taxa and for large shipments of co-mingled taxa
- Sampling methods that focus resources on high risk pests
- New tools to detect plant pests at the shipping container, crates, or box or bag levels (in port or during shipment)
- New tools for detection/identification that are sophisticated yet rapid and simple to use by all levels of inspection staff

  Detection Tool – A pest is present; **Identification Tool**- What pest is present?

- Cooperation/collaboration….with phytosanitary scientists at the regional or international level; with scientists outside the agricultural disciplines (biochemists and analytical chemists, engineers, physicists….)
- Phytosanitary research projects that work jointly between countries on shared high risk pests

Sampling

A Risk-based Sampling Approach Developed and Implemented by APHIS

Previous approach:

- Inspection of a minimum 2% of every consignment of imported plants for planting regardless of known risk.

Risk-based sampling and inspection approach:

- is based on past inspection records for plants for planting
- incorporates a statistically robust approach to sampling imports
- will target high-risk plants for planting for extensive inspection
- will provide a faster inspection process for lower-risk plants
- will focus APHIS resources and provide greater security against the introduction of quarantine pests into the United States

*Taxa known to be extremely low risk, will not be inspected under a **Propagative Monitoring and Release Program** but will be periodically monitored (spot inspected) to verify continued low risk status

Risk-based Sampling

The protocol is based on the hypergeometric probability distribution, which determines the probability of finding a pest within a certain number of independent samples from a shipment. The new protocol calculates the number of sample units (such as bags, boxes, or crates) an APHIS inspector should select from each shipment.

Implemented at these Plant Inspections Stations in the U.S.

2013:

Linden, New Jersey
San Juan, Puerto Rico
Houston, Texas
Honolulu, Hawaii

2014:

Beltsville, Maryland
Orlando, Florida
Nogales, Arizona
San Francisco, California

Risk-based Sampling

How does it work?

Item Description	Code/Codigo	Boxes/Cajas	Piezas/Unidades
Croton Petra URC 8”	213-237	25	10,000

Risk-based Sampling Tool

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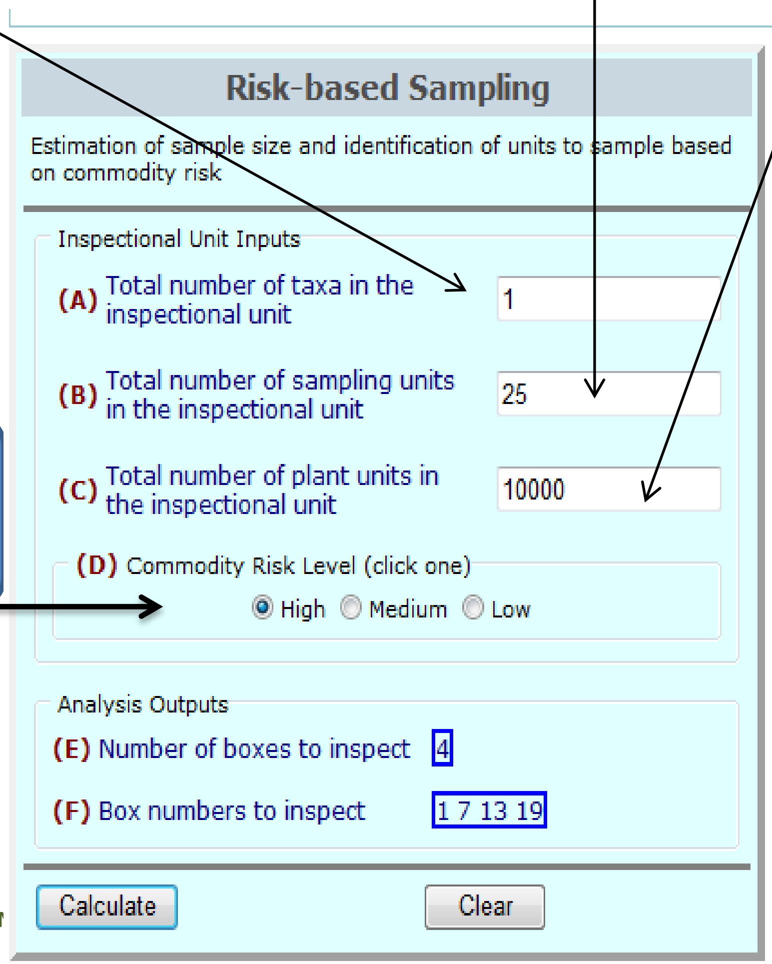
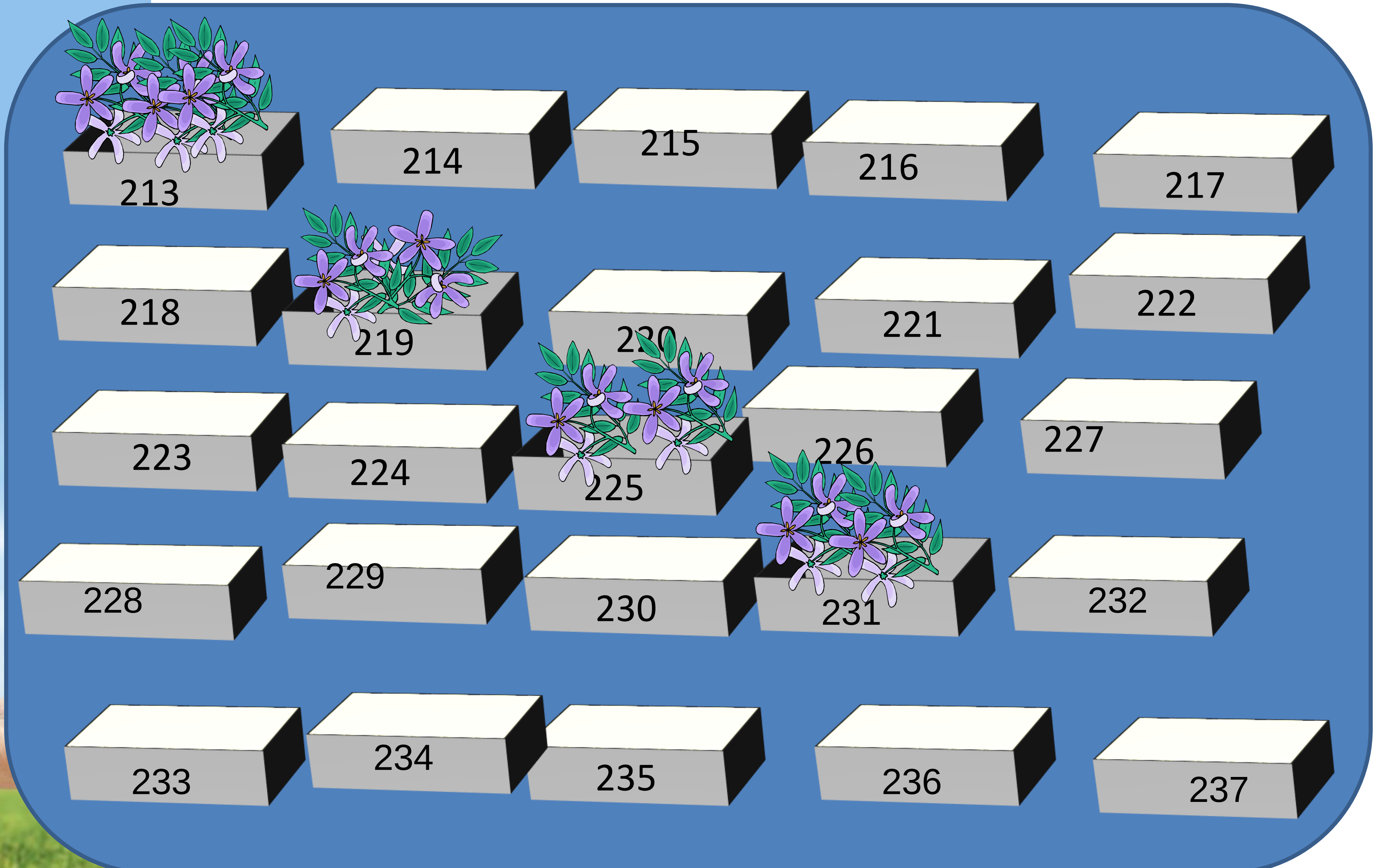
Croton Petra URC 8”	213-237	25	10,000



On-going analysis of interception data will re-assess risk

The four boxes identified undergo 100% inspection

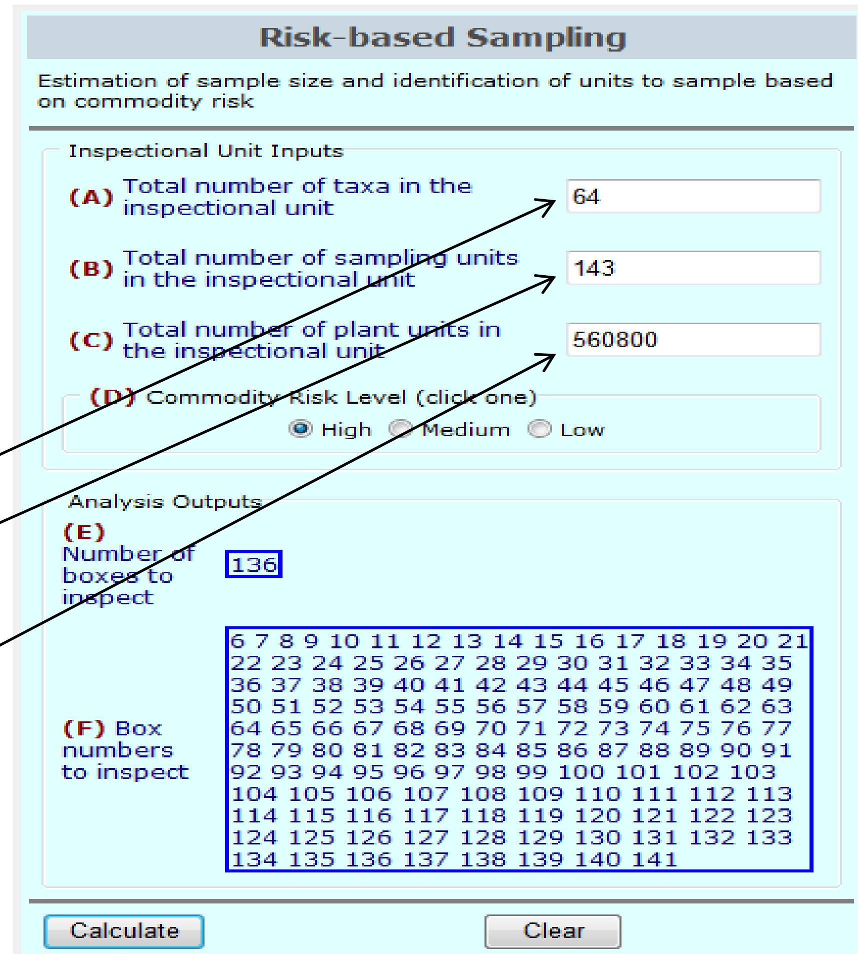


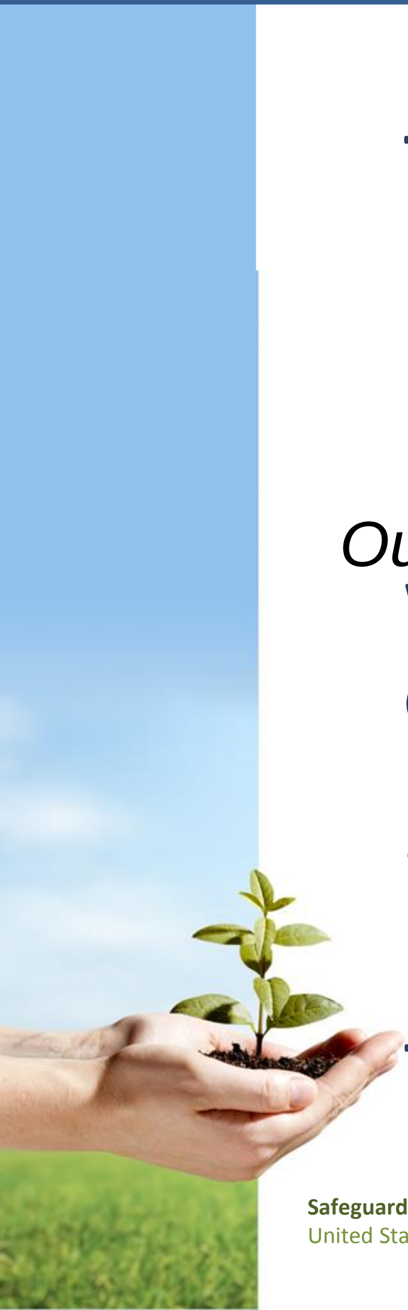
USDA United States Department of Agriculture

The risk-based sampling tool can be used for mixed taxa

Commingled Inspectional Units on an invoice:

- Not operationally feasible to separate taxa
- Invoice becomes the inspectional Unit
  - 64 taxa
  - 143 boxes
  - 560,800 plant units





The Propagative Monitoring and Release Program and Risk-based Sampling are assisting Inspectors to effectively sample the highest risk plant materials and focus APHIS resources.

Our Challenge

What can lab scientists provide Inspectors to detect plant pests in containers, in shipment boxes/crates/bags and also tools to accurately identify plant pests to allow entry of plants materials without actionable pest, to decrease treatments and determine pest pathways?

New Tools Scan

DHS S&T and APHIS PPQ Study
Identifying New Detection Technology

– Goal

Guide investments in R&D of detection systems to meet stakeholder needs

– Interviews, site visit and horizon scanning

Determine stakeholder needs based on interviews with 16 PPQ and

7 CBP Ag Inspectors. Opportunities for technical interventions revealed. Extensive scanning of available tecnologies.

– Findings

Report summarizes requirements, available technologies, gap analysis. Compared hypothetical inspection scenarios using performance characteristics of technology to identify promising technologies to move forward.

Determined technology readiness levels (TRLs) and identified a follow-on project to determine the methods and cost of validation the promising technology.

New Tools Scan

DHS S&T and APHIS PPQ Study Detection Technology *Requirements*

PPQ and CBP Inspector Requirements

- False positive/negative rates : below 5%
- Level of detection : as low as possible, desired - one organism
- Time to results:
  - Passenger luggage – seconds
  - Cargo – less than one hour, preferably 15 min
- Specificity : find plant material in non-plant cargo and for pests at least to the family level
- Instrument Size : portable weighing 3-5 lbs., or on a cart
- Instrument Power : battery operated 8 hr. (a shift), ideal 24 hr. ;
- Instrument Training : less than one week, 2 days preferred
- Instrument Cost : Issued to an inspector ($1,000 to $20,000 USD)
  Issued to a unit ($15,000 to $50,000 USD)

New Tools

DHS S&T and APHIS PPQ Study Detection Technology *Recommendations*

- **Technology with promising characteristics**

  At the tailgate, in de-vanned pallets or in boxes (during shipping?):

  – **Acoustic detection** to "hear" chewing patterns or mating calls of live wood-boring insects.

  – **Volatile organic compound detection** to "smell" specific compounds present that identify plant families; chemicals released by insects or plant pathogens; and compounds released by distressed plants.

  At the point of inspection stations:

  – **Near infrared detection** to "see" insects and some diseases in sorters of seeds, grains, spices or dried goods.

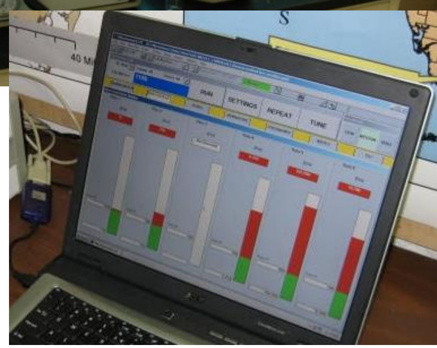
  – **Hyperspectral imaging cameras** to "visualize" insect or pathogen damage; maybe useful for detection of plant pests in cut flowers.

  -Any technology to enhance the vision of inspection specialists.

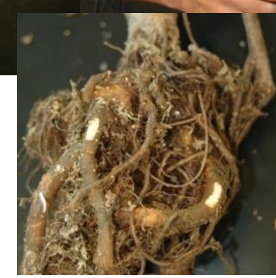
United States Department of Agriculture

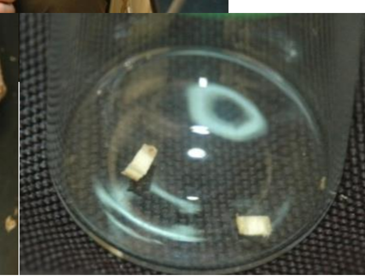
New Tools Volatile Organic Compounds

Volatile Organic Compound detection and pest identification using zNose®



Computer graph indicating detection of five relevant specific VOCs





PPQ inspector, Jose Santos, assists with bonsai tree z-Nose experiments

Based upon ultra-fast gas chromatography

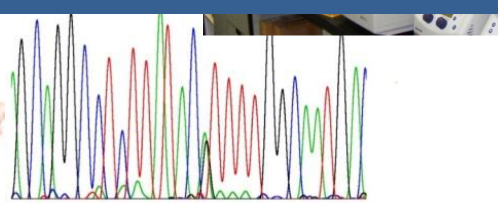
Current Tools

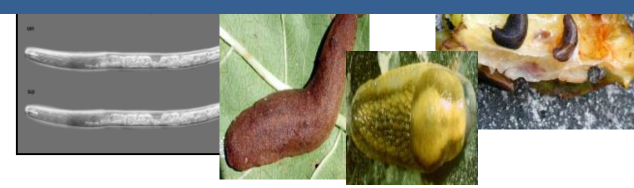
Lab-based technology used by APHIS for pest detection and identification

Conventional and real-time PCR ; DNA sequencing

The Question?

How can we implement this type of technology that is user-friendly with comparable results when used at inspection locations?





New Tools CANARY

Identification technology-plant pest inspections using CANARY - a new serological tool

Application

BioSecurity

Buildings

Mail Screening

Powder ID

Surface wipes

Environmental Field Testing

Agri-Food Testing

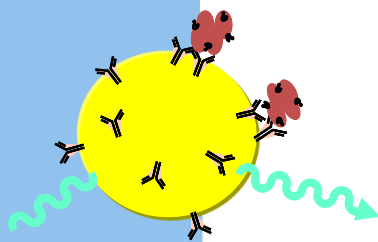
Current technologies : either fast OR sensitive

	Time	Sensitivity
PCR	$\geq$1 hr	100s – 1000
Immuno	<1 hr	10,000s – Millions

CANARY technology is BOTH

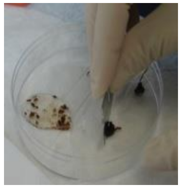
	Time	Sensitivity
CANARY®	10 minutes	100s - 1000

Identification technology
plant pest inspections - CANARY

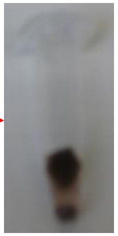


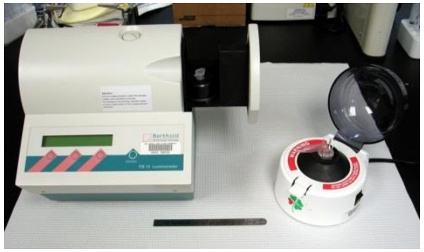
Infected plant

Slice root

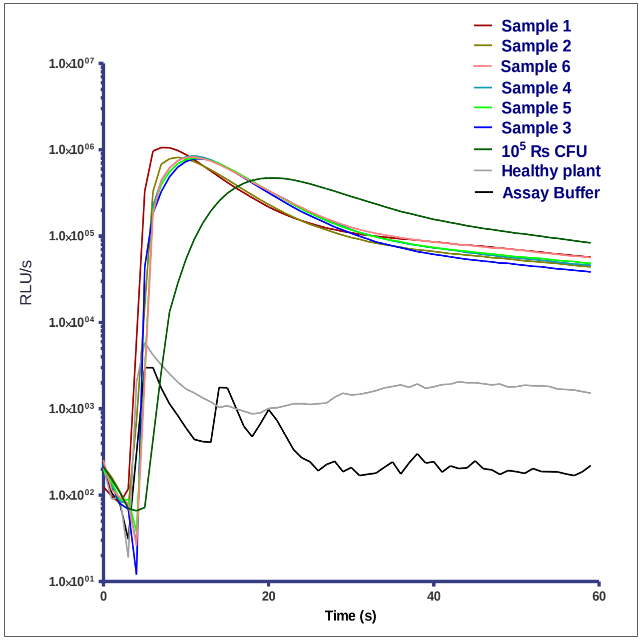


Soak in assay buffer 5 min





CANARY use on diagnostic samples



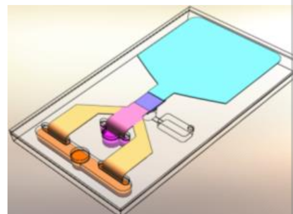
<u>10 minutes or less</u> are required for sample preparation and sample testing for *Ralstonia solanacearum*.

New Tools MTIDx

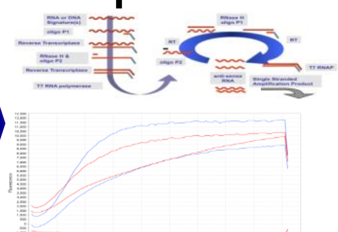
Identification technology plant pest inspections - MTIDx

Sample Input

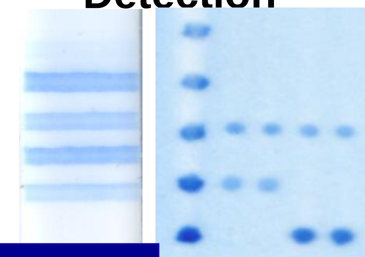
Preparation - Extraction



Amplification



Detection



Preparation

Amplification

Detection

Sample to answer in about 30 min

HLB, next Phytophthora sp. then Fruit Flies

Modified slide courtesy of Dr. R. Bruce Cary, Mesa Tech International, Inc.

Working Together, Working Smarter

Benefits of cooperation/collaboration of scientists within regulatory agencies

- Decrease duplication of parallel efforts
  - Example:

APHIS and DHS looking at new technologies (volatile organic compound detection, portable molecular devices, interest in acoustic detection, spectral analysis or vision enhancement tools) to provide to increase effectiveness and efficiency of inspectors.

Seventh Framework Programme funded EU collaborative project: Q-DETECT evaluating new technologies (acoustic detection, spectral analysis, volatile organic compound detection, pest trapping technology, portable molecular devices) to provide to Inspectors. Q-DETECT is a multi-disciplinary research network focused on developing innovative tools that enhance the capacity of phytosanitary inspectors.

Working Together, Working Smarter

Benefits of cooperation/collaboration of scientists within regulatory agencies

Working together will complement efforts:

Volatile organic signature collection and library development

- Select shared high-risk pests for collecting “smell prints” so libraries will be developed quicker with more populations
- Identified chemicals can be used on VOC devices available in several countries.

Unique detection/identification tools can be evaluated in countries where the pest is not under quarantine, or in labs where large pest collections exist.

- CANARY platform was taken to Fera for evaluation by APHIS and Fera scientists
- Genie II Lamp could be evaluated in the US

Benefits of cooperation/collaboration of scientists within regulatory agencies

Diagnostic method development and validation

- EPPO has 119 methods for plant pest detection, many validated
- QUADs members (US, Can, NZ, AU) have similar plant pest detection methods, many validated
- Strengthen validations by engaging more countries during the validation

Lab accreditation and proficiency testing (PT)

DNA Bar-coding

Pest collections

Pest decontamination and destruction

EUPHRESCO-Net is a network of funders cooperating to commission research projects on plant health across Europe. EUPHRESCO aims to increase cooperation and coordination of national phytosanitary (statutory plant health) research programs. Many projects would benefit non-EU countries by partnering on projects with EUPHRESCO investigators.

Final Thoughts

Detection and Identification Tools Opportunities and Challenges

Opportunities

- Detection of plants in non-plant cargo
- Ability to inspect more cargo and luggage due to increased efficiencies and potentially detect more pests
- Ability to inspect cargo and detect pests in larger commodity quantities - whole container, vans, crates or boxes - leading to decreased inspection time
- Rapid identification of plant pests within 1 hr.; use of multiple rapid ID tools at PIS for final determination.
  - Decrease in the # of treatments
  - Potential entry of more commodities with more knowledge of intercepted pests
- Increased and supported cooperation will save time, money and bring experienced scientist together and result in quicker solutions

Final Thoughts

Detection and Identification Tools Opportunities and Challenges

Challenges
• Technologies need to be applied to inspection settings • Assure minimal, or justifiable, impact on workflows at inspection stations and ports of entry • Funds for development/evaluation needs commitment (4-5 yrs.) but funding needs to realize a cost benefit • Libraries of signatures (acoustic, volatiles, infrared and hyperspectral images) need to be compiled to be useful • Pests need to be prioritized to target highest risk and technology matched to make the greatest impact • Policies may need to change due to findings • Tools must generate unambiguous, scientifically andlegally defensible data

Summary

"IPPC can play a critical role in terms of providing a global venue where networks, partnerships and associations can be developed as they relate to scientific and phytosanitary expertise and resources". (IPPC Strategic Framework 2012-2019)

Scientists within Regional Plant Protection Organizations work cooperatively, linking regional phytosanitary scientists to work in international cooperation on tools for detection pests or evaluation of technology of interest will demonstrate *new thinking, new tools and new ways forward.*

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http://www.aphis.usda.gov/plant_health/
http://www.aphis.usda.gov/plant_health/cphst/index.shtml