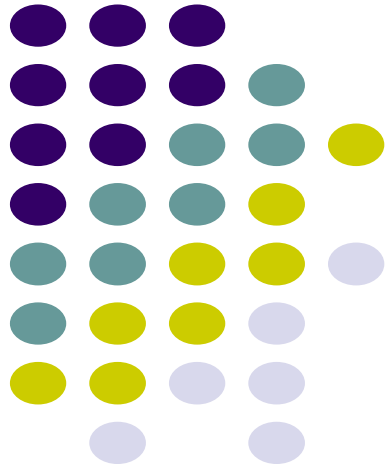
Plant Disease Diagnostic Capabilities and Networks in the diagnosis of plant diseases - The path to effective control measures

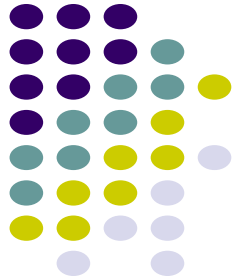


- Plant disease diagnostic networks have developed worldwide to address the problems of efficient and effective disease diagnosis and pathogen detection, engendering cooperation of institutions and experts within countries and across national borders.
- Networking maximizes impact in the face of shrinking government investments in agriculture and diminishing human resource capacity in diagnostics and applied pathology.
- New technologies promise to improve the speed and accuracy of disease diagnostics and pathogen detection.
- Widespread adoption of standard operating procedures and diagnostic laboratory accreditation serve to build trust and confidence among institutions.

Why Diagnostics Matter?

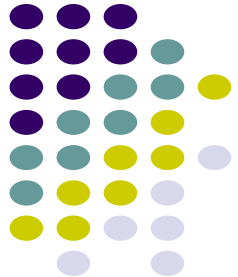
- It is well recognized that threats by invasive pathogens to plants, whether crops, horticultural commodities, or members of natural communities such as forests and grasslands, are increasing as a result of globalization, increased human mobility, climate change, and pathogen and vector evolution
- Taken in total with damage caused by emerging, re-emerging (e.g., new races, pathotypes, forms resistant to pesticides or antibiotics), and chronic/endemic pathogens, the potential for economic loss is significant in plant systems
- Food security is threatened in resource-poor countries during disease epidemics in staple crops and income generation from opportunities to exploit new and emerging markets is curtailed
- Disease diagnosis and pathogen detection are central to our ability to protect crops and natural plant systems, and are the crucial prelude to undertaking prevention and management measures

Plant Safeguarding and Biosecurity



- The responsibility for safeguarding plants against invasive pathogens is held officially by national plant protection organizations (NPPOs).
- In addition to their regulatory functions, NPPOs conduct pathogen surveillance and pest risk analyses, inspect, treat, and certify export products, inspect and, if necessary, mitigate risks on imports and share information on pathogens and regulations

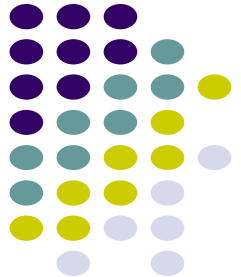
Disease Management Decision Making



- Diagnostic networks are crucial in conducting large-scale monitoring programs; surveillance may be done by established networks or by networks organized for monitoring a specific pathogen and disbanded after completion of the program.
- The example of soybean rust illustrates the role of diagnostic networks in pathogen detection, diagnosis, and surveillance. *Phakopsora pachyrhizi,* causal agent of soybean rust, was initially listed as a select agent (indicative of a potential bioterrorist threat) before its recent entry into the United States. It is an economically devastating disease.

- Diagnostic tests including a real-time PCR assay, an immunofluorescence spore assay, and a field-usable lateral flow immunoassay were developed and tested.
- Surveillance and monitoring were accomplished utilizing a network of sentinel plots and spore traps**,** tied into Web-based reporting and communications. Thousands of farmers and agronomic professionals were trained as first detectors.

DIAGNOSTIC CAPACITY

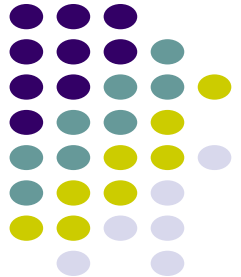


- **Human Resources**
- Common and easily recognized diseases are often diagnosed by an astute individual, who may be a trained diagnostician, experienced farmer, extension educator, or consultant familiar with the crop.
- However, unlike human and veterinary medicine, trained practitioners in plant pathology are a relatively rare commodity, and clinicians with appropriate training and access to necessary infrastructure and technology to diagnose the broad range of pathogens afflicting plants are particularly scarce.
- Human resource development in plant diagnostics in the developing world has generally lagged behind that of developed countries

- **Technology**
- Capacity for traditional pathogen identification is generally insufficient to meet needs in both developed and developing countries, and therefore the creation of high-tech tools for plant pathogen diagnostics has expanded at a rapid rate
- Field-ready serological tests such as lateral flow devices (LFDs) are commonly used as diagnostic tools to aid disease management decision making, to back up diagnoses based on symptoms, and as a triage tool to pre-screen plants for specified target diseases.
- For example, an LFD for *Phytophthora* spp. detection has proven to be of significant value in the United Kingdom for pre-screening woody plants for the absence of *P. ramorum/P. kernoviae* at the time of inspection. Samples testing positive are sent to a laboratory for follow-up testing with more specific lab tests such as PCR and pathogen culture.

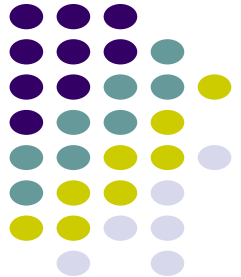
- **Infrastructure**
- Visual examination, microscopy, culturing, a few simple biochemical tests, and ELISA are the mainstays for most routine diagnoses.
- When coupled with diagnostic references such as disease compendia, pathogen-specific manuals, and image databases, these techniques in the hands of trained diagnosticians or specialists are sufficient to provide answers in a reasonable amount of time at a manageable cost.
- Many diagnostic networks build and maintain expertise databases within their communications systems to facilitate knowledge sharing. For example, EPPO supports a searchable database on its Web site containing a list of laboratories by country and an expertise list by pathogen. Experts can be contacted via email by network members upon entry of an access code.

PLANT DISEASE DIAGNOSTIC NETWORKS



- The United States has National Plant Diagnostic Network [NPDN]
- The Mediterranean and European Plant Protection Organization (EPPO) has expanded from 15 to 50 member countries.
- **Global Plant Clinic**
- The Global Plant Clinic (GPC) is a consortium of CABI Bioscience, Rothamsted Research, and Central Science Laboratory, United Kingdom. The GPC provides a cost-free diagnostic and advisory service for NPPOs in developing countries that provide diseased plant samples. The GPC initiated the establishment of mobile plant health clinics in several developing countries.
- Plant health clinics fulfill an advisory role in a cost-efficient and locally operated manner. They occur in public places such as markets on a regular basis where growers routinely arrive with diseased plant samples. The clinics offer reliable advice on routine plant health problems affecting any crop and differentiate symptoms due to abiotic and biotic stresses.

The International Plant Diagnostic Network



- The International Plant Diagnostic Network [IPDN(http://www.intpdn.org)] was initiated in 2005 with the goal of fostering development of local capacity for diagnostics through establishment of communication and data sharing networks, training in classical and modern diagnostics and research into new diagnostic methods
- The IPDN is modeled after the United States NPDN, and as with that network, is comprised of regional hub and local satellite diagnostic laboratories. Three regional programs have been established to date; in Central America (hub lab in Guatemala coordinated by a private company; Agroexpertos), East Africa (hub lab in Kenya coordinated by Kenya Agriculutural Research Institute), and West Africa (hub lab in Benin coordinated by IITA).
- An important objective of the IPDN is training diagnosticians in basic and advanced diagnostic methodologies. Reporting new diseases through international outlets is highly encouraged. For example, the West Africa regional program recently reported for the first time the occurrence of *Ralstonia solanaceraum,* the cause of a devastating wilt disease of tomato, throughout Benin.