Principles of plant disease control to ensure food security

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World Vegetable Center

How to Increase Food Security

- Agricultural intensification through more efficient land use

- Improved management of critical diseases

- Sustainable disease management through understanding dynamic interactions between crops, beneficial and antagonistic organisms

    - Physical environment

    - Human interventions

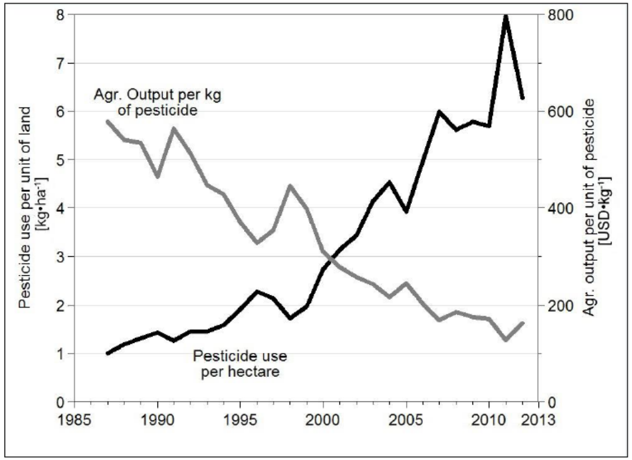
The Association of Southeast Asian Nations

"UNIDO Regional Trade Standards Compliance Report, 2013"

"ASEAN potential to gain from macro trends of increasing population and purchasing powers not met in all countries by increased vegetable production"

- Food safety and quality issues cause import rejections:
  - MRLs exceeded of pesticides (approved and prohibited) and mycotoxins
  - presence of quarantine plant pathogens and pests

Inappropriate pesticide use accepted practice



Loss of producer profit

Loss of trade and value chains

Loss of country and retailer credibility

Loss of biodiversity

Loss of yield

Increased pest resistance

Health hazard to growers

Health hazard to consumers

Solutions to inappropriate pesticide use

- Precise pest and disease diagnostics
- Host resistance
- Agronomic practices
- Judicious pesticide use
- Biological control

- What do I do?


Clinique des Plantes

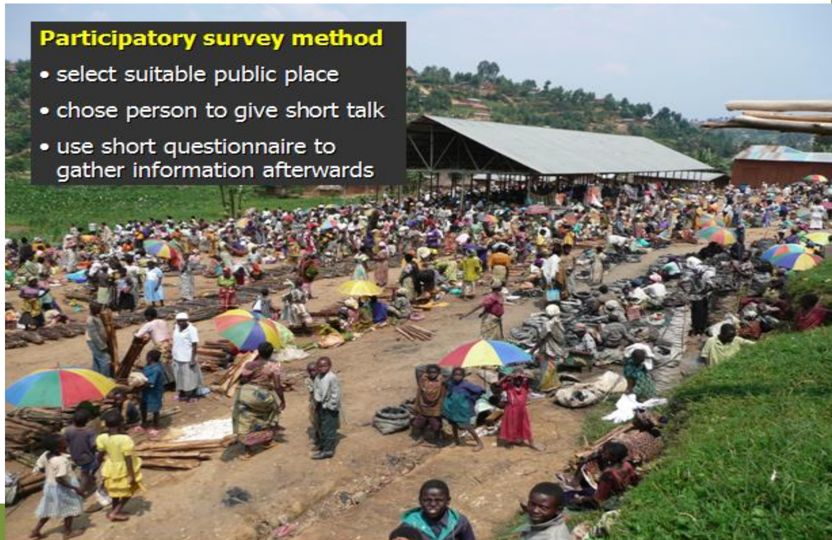

1. Le BXW
2. Comment le BXW se transmet-il?
Les insectes transmettent le BXW
Les outils transmettent le BXW

Systems required

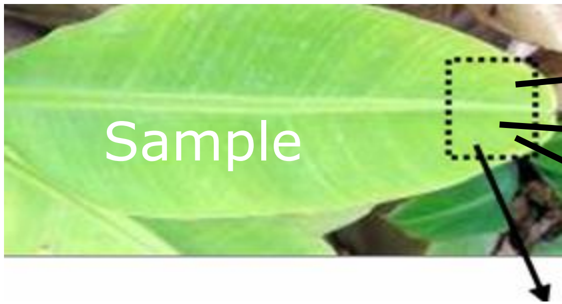
- risk assessment
- disease **surveillance**
- disease diagnosis
- control recommendations
- extension / input suppliers
- farmer adoption
- impact on value chain
- advocacy

Mobile plant clinics and going public

Monitoring of common and emerging diseases and efficacy of control methods

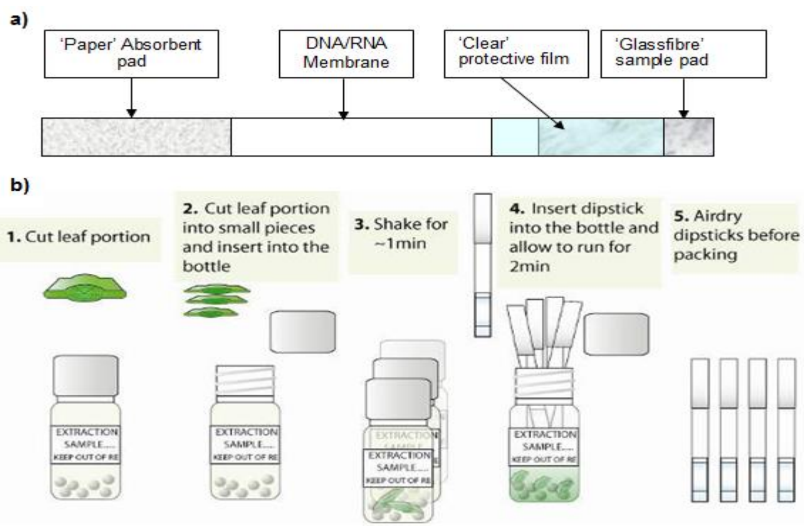


Diagnostics to encompass pathogen type and variation - farmers require information on all key biotic constraints

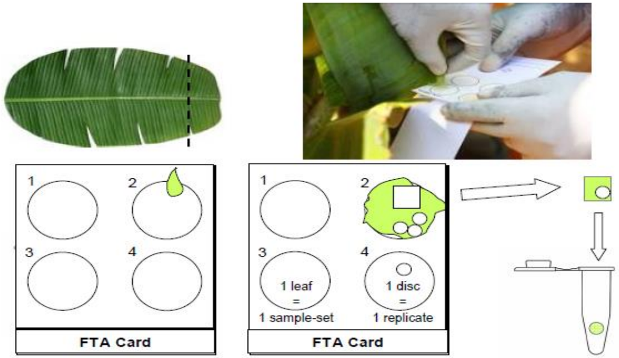


Silica gel

PhytoPASS sticks



2 min. extraction dipsticks



FTA cards

Comparability of survey data - systematic surveillance towards PRA

Standardized protocols:

Shared objectives

Strategic partners

Sampling strategy

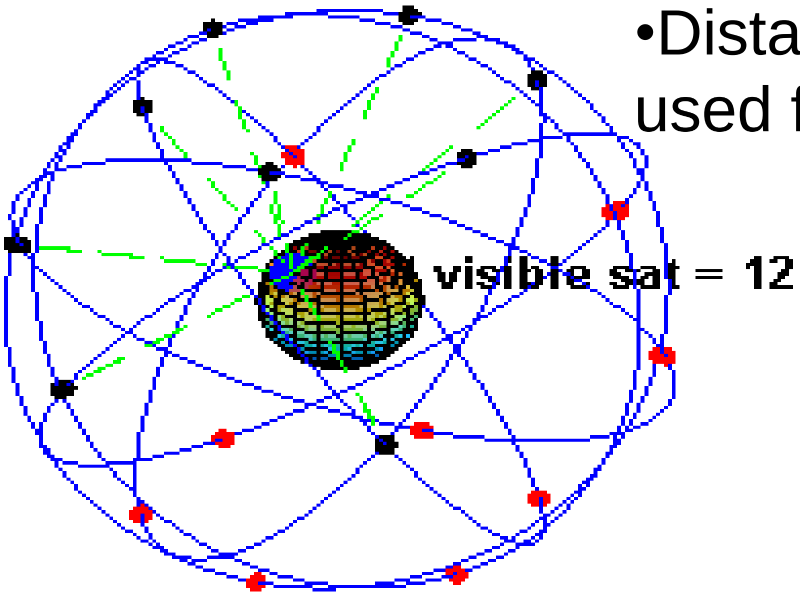
Optimal field and lab diagnostics - centralised?

Greater linkages to existing information / projects / networks?

Data accessibility

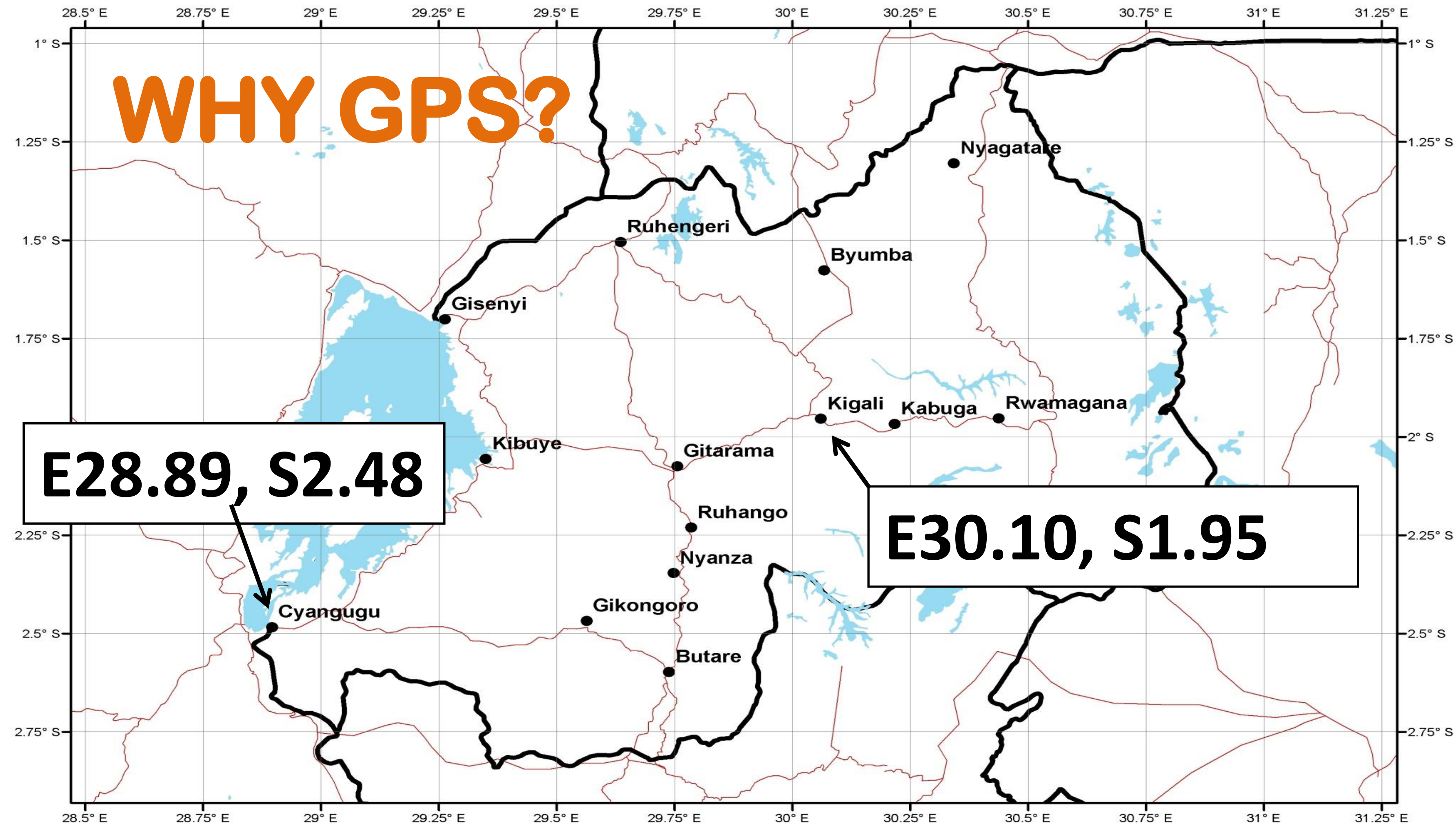
Spatially designed surveys GPS - GIS

Global Positioning System (GPS)



- 24-32 (US) satellites
- Minimum of 3 satellites for signal
- Distance from GPS unit to satellites used for positioning

WHY GPS?



Unique address

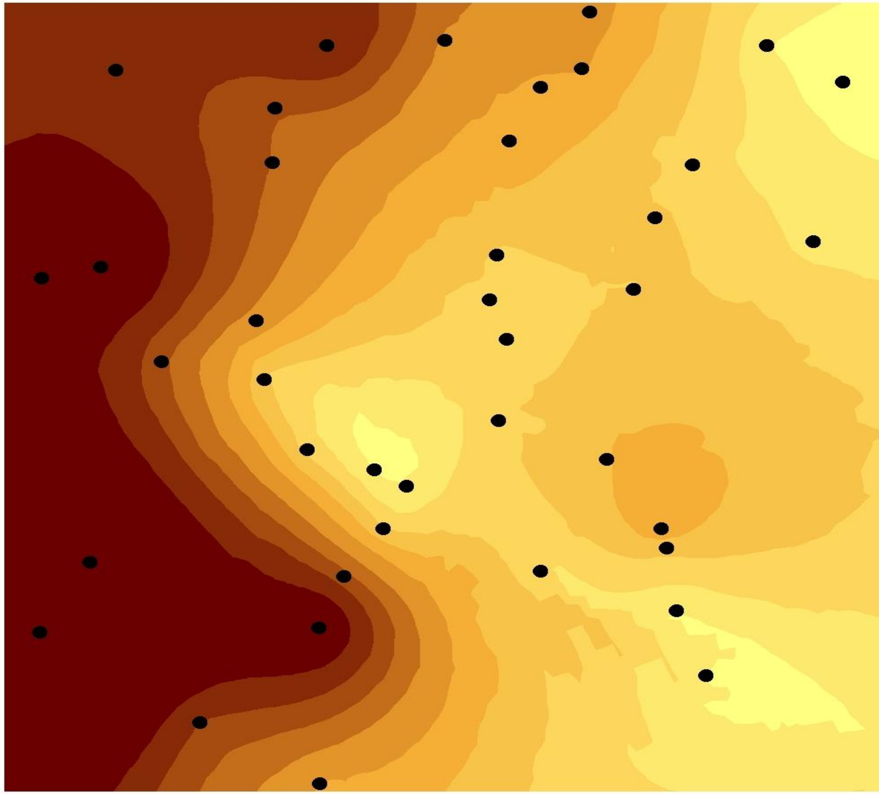
Why (spatial) sampling?

To estimate statistics across a region without bias

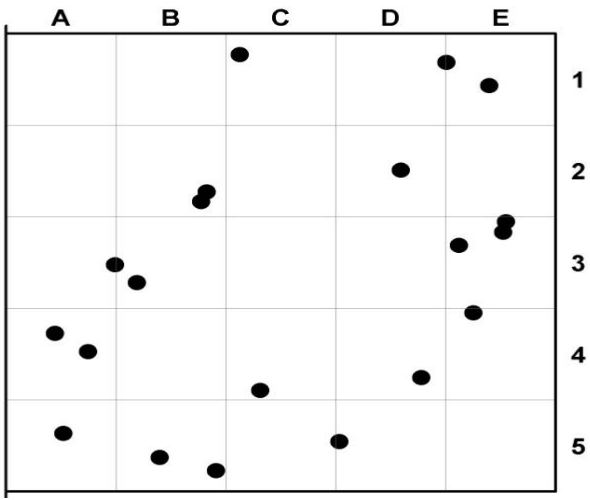
Real status is unknown
so we sample to estimate

Questions:
How many samples do you need?
Where do you sample?

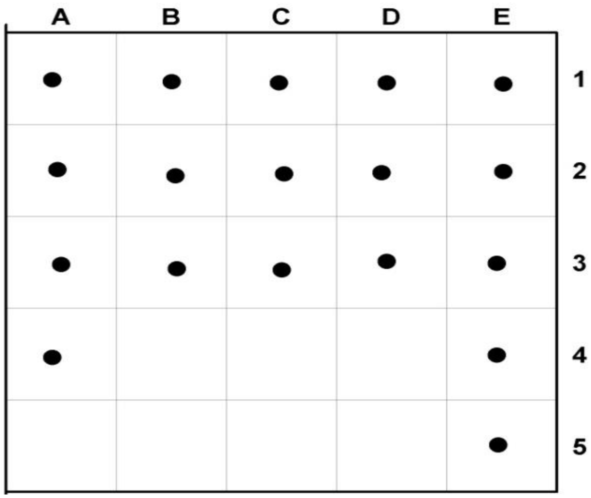
Answers:
What is the parameter you want to know?
What are the statistics of the parameter?
What resources are available?



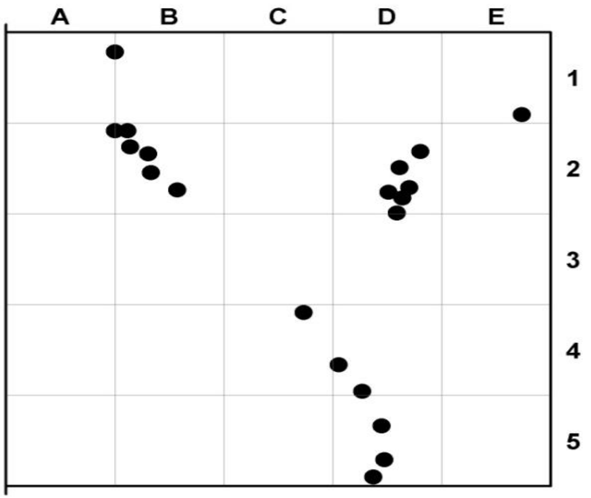
Sample Site Selection



Random sampling

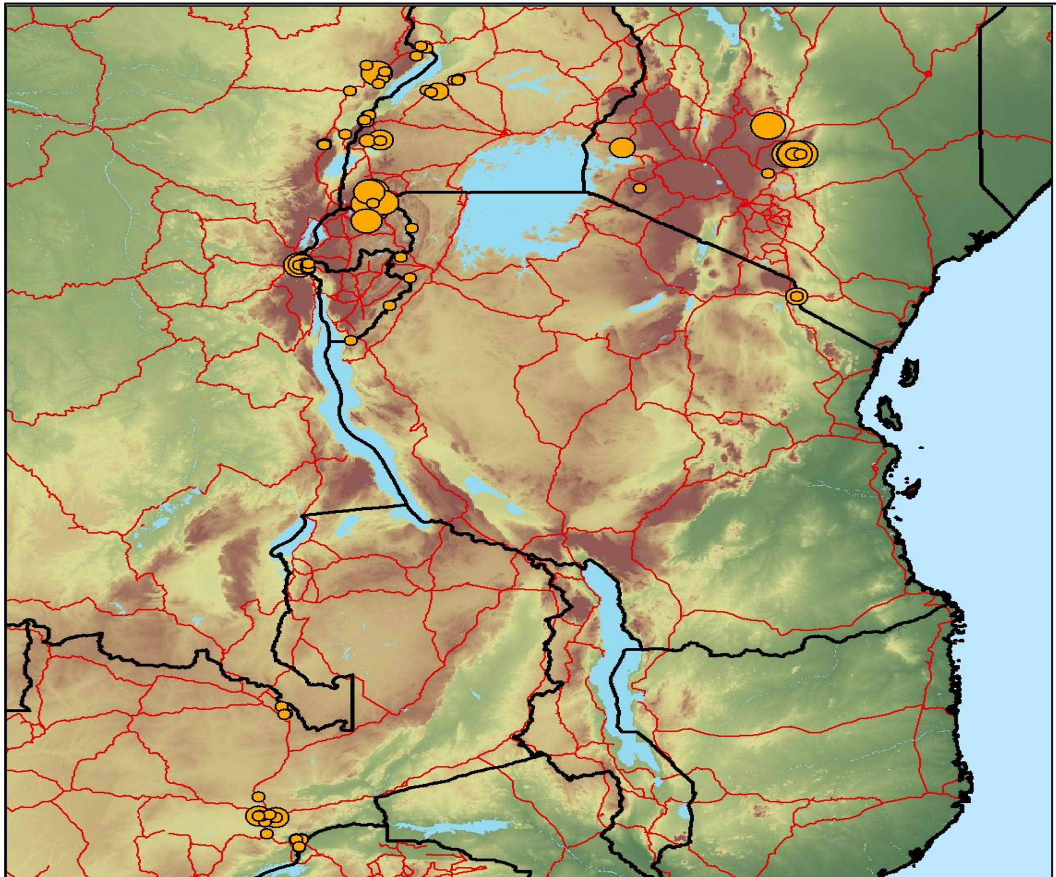


Stratified sampling



Convenience sampling

Are the locations correct?

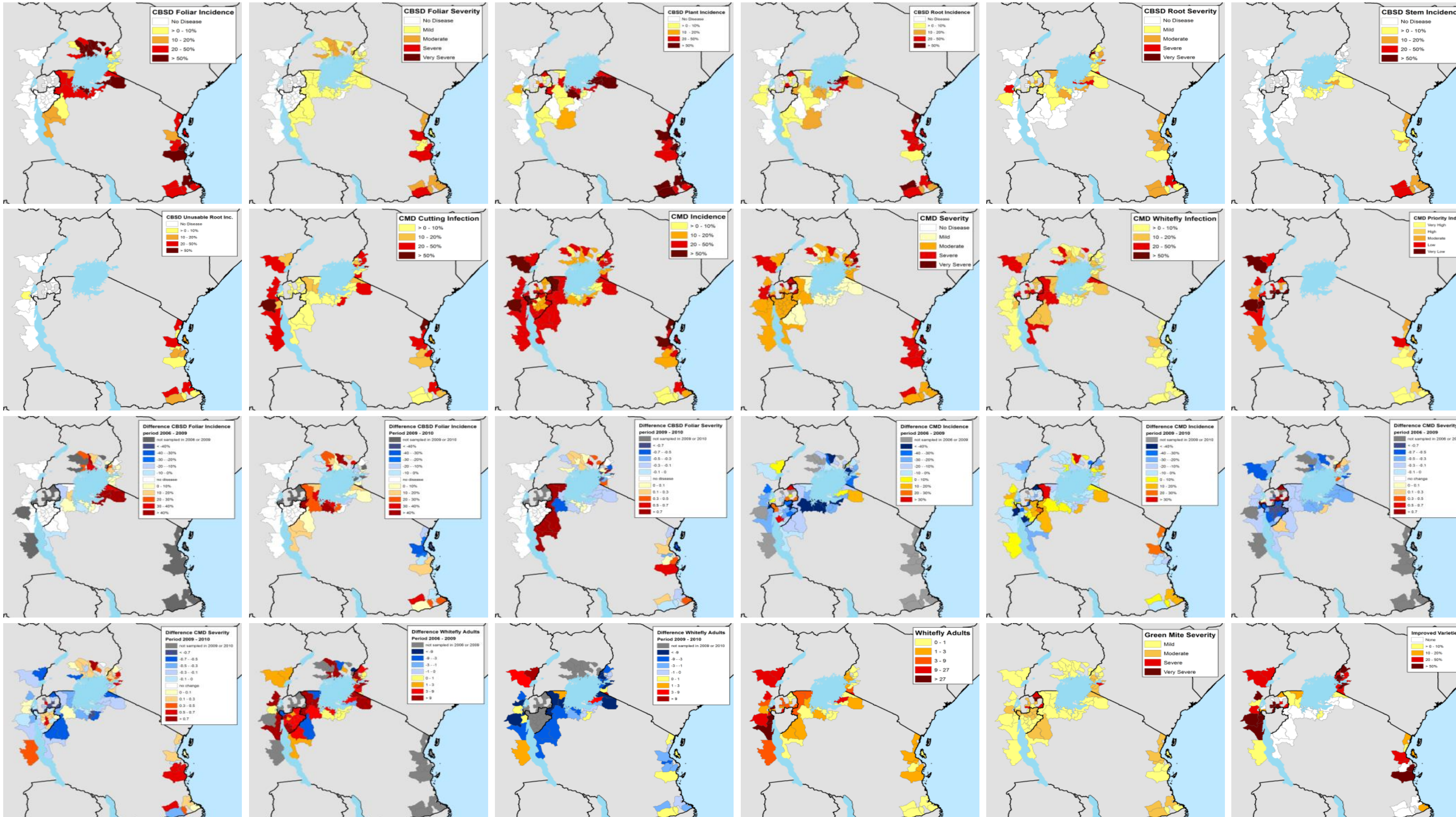


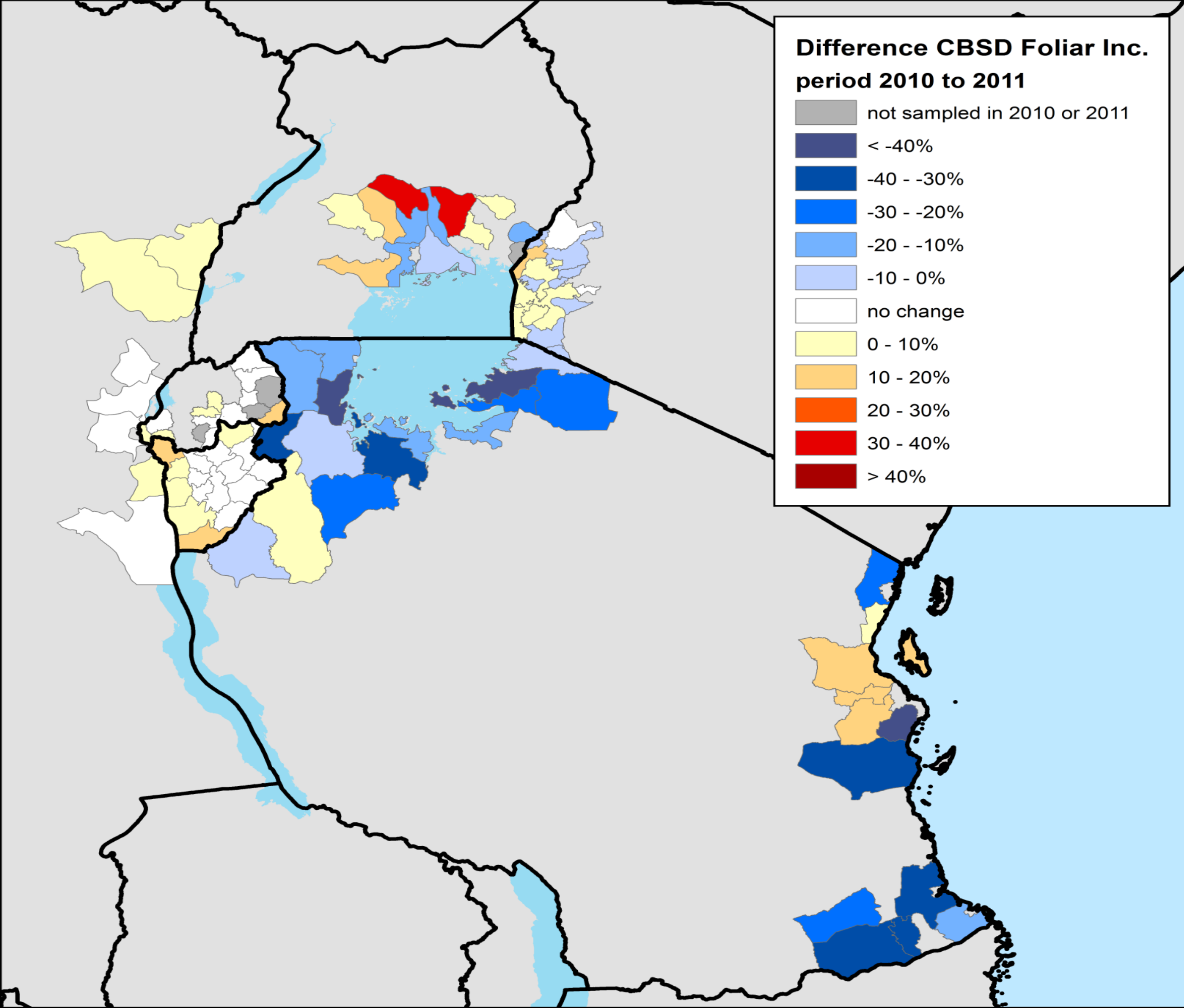
Alt. (m)	Frequency
0 -15	238
15 - 30	6
30 - 50	4
50 - 100	12
100 -200	13
>200	10
all	**283**

Extensive Surveys

- **Frequency**. Conducted annually, same time of year, by NARS teams
- **Methods**. Standard protocol agreed beforehand. Training provided
- **Data Handling**. Results entered into standardized spreadsheet template
- **Outputs**. GIS maps developed to illustrate data at country and regional level

GIS Maps – Extensive Surveys 2010 (> 150 all years)

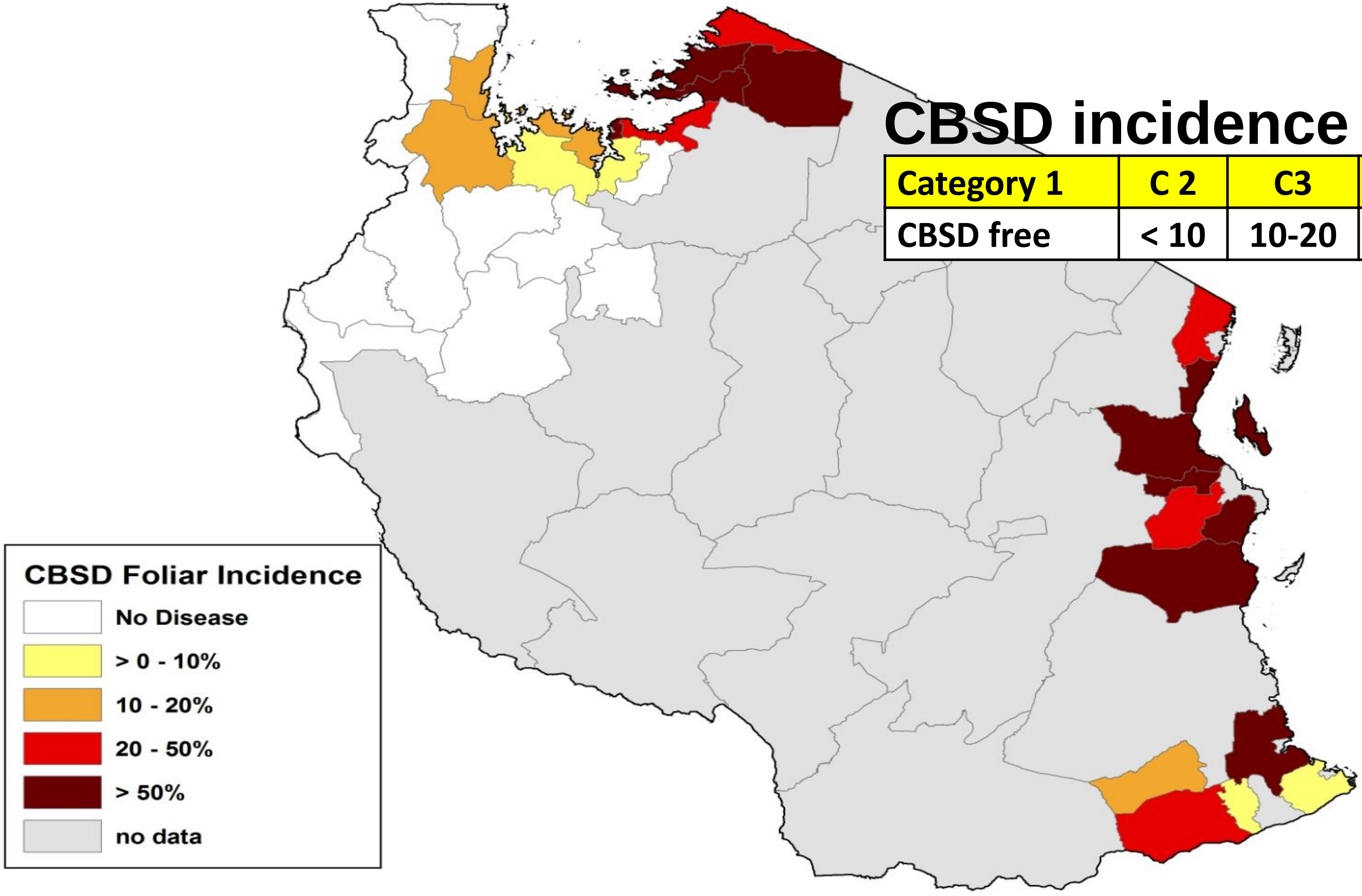




Quantifying Impact

CBSD Change: 2010-11

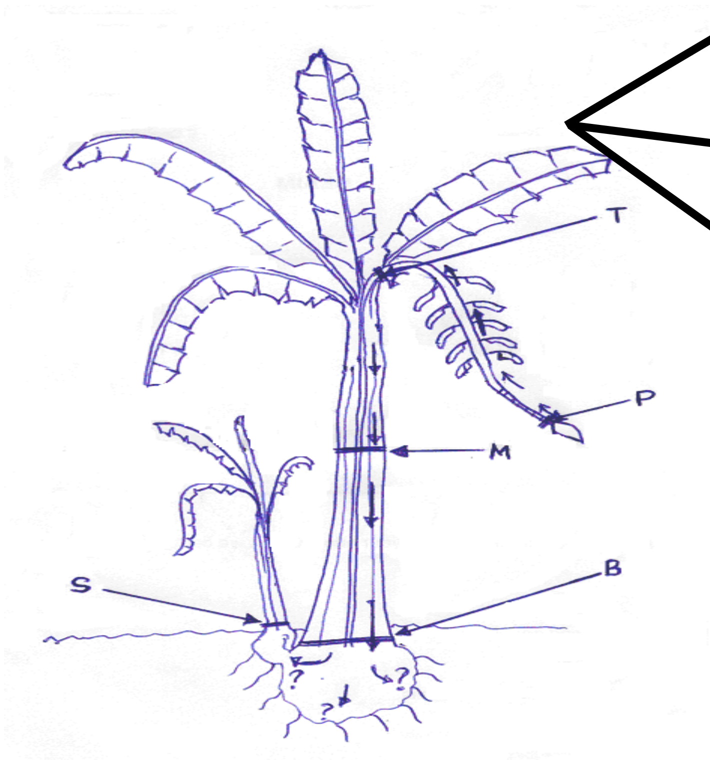
Ensuring quality of multiplied seed

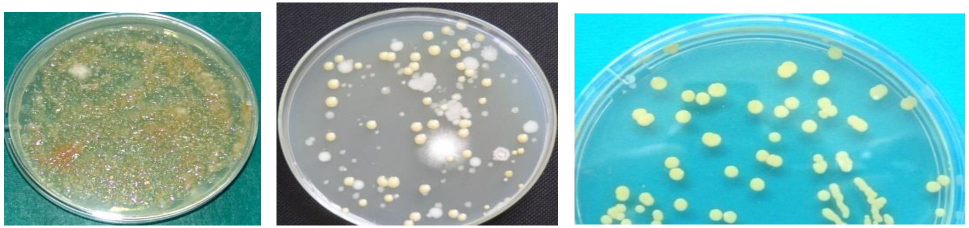


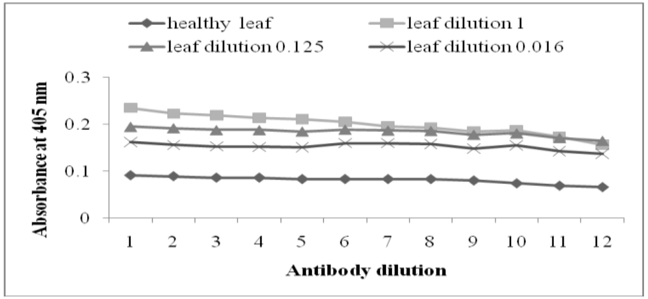
CBSD incidence categories

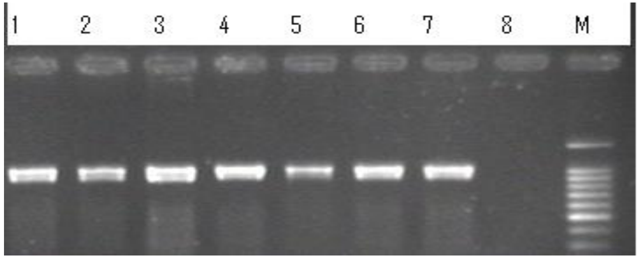
Category 1	C 2	C3	C4	C5
CBSD free	< 10	10-20	20-50	50-100

BXW Diagnostics

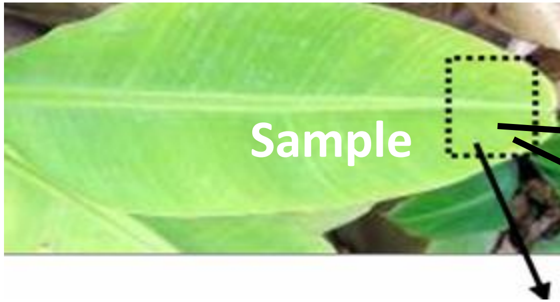




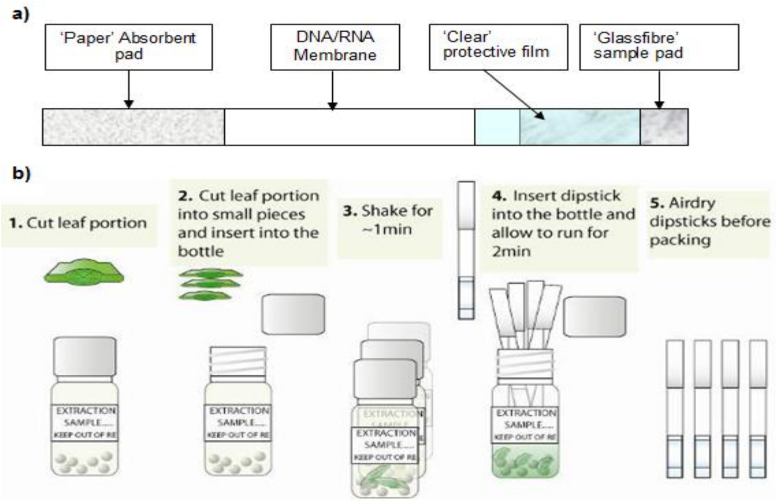




Field to laboratory for confirmatory diagnostics (Xcm and BBTV)



PhytoPASS sticks



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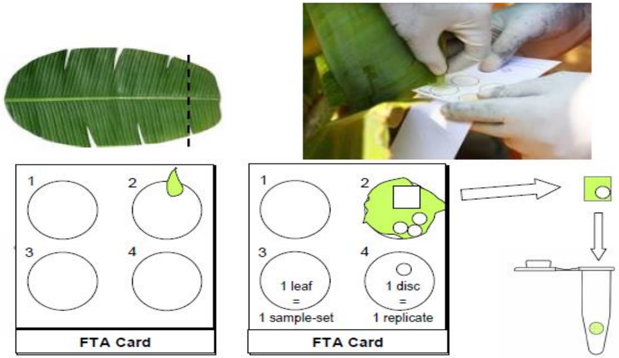
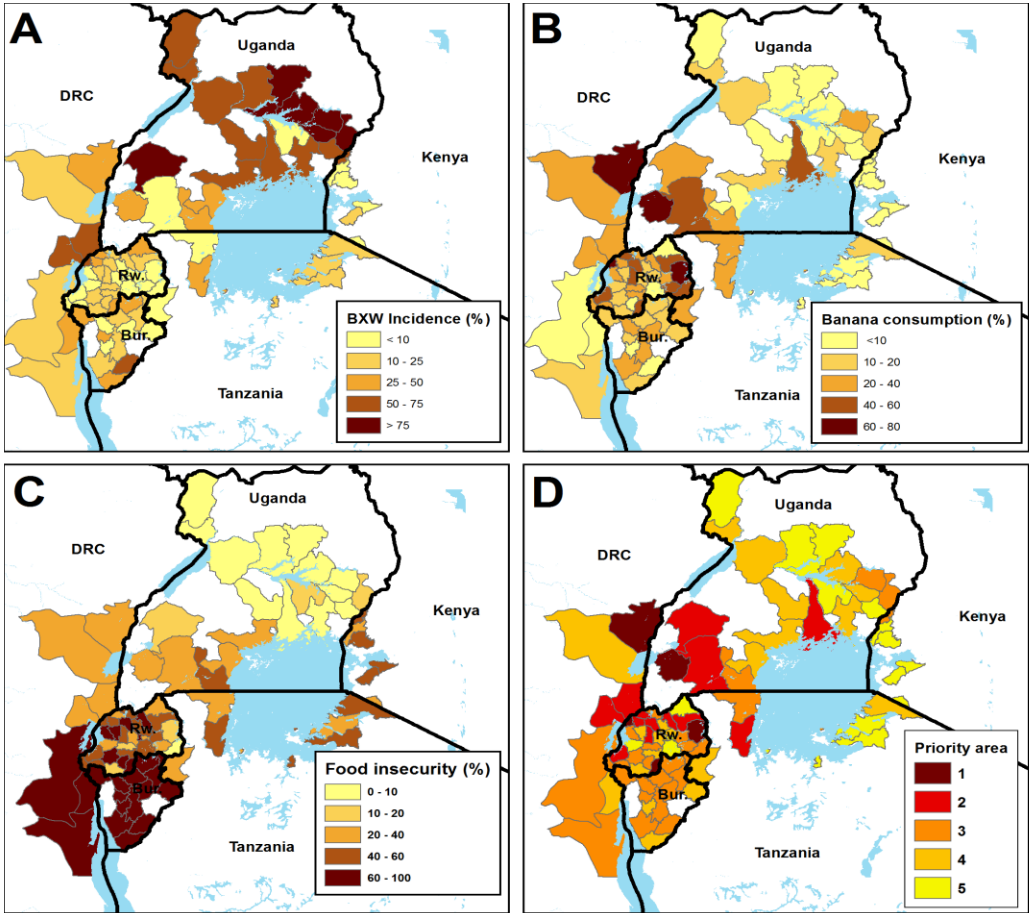


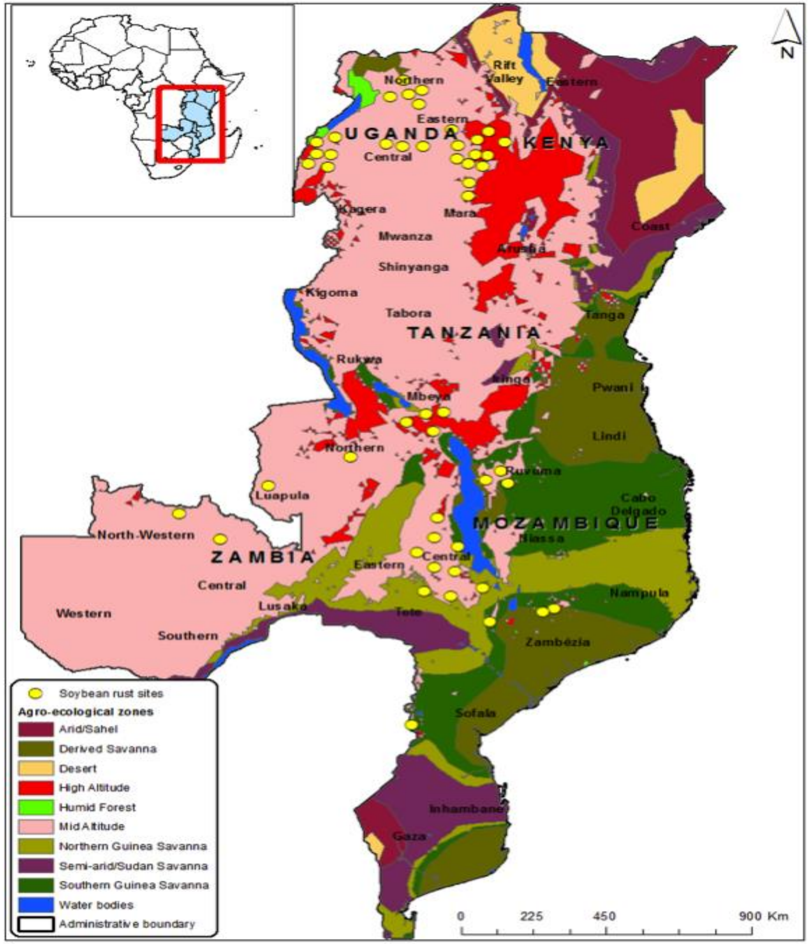
FTA cards

Priority areas for interventions to manage BXW

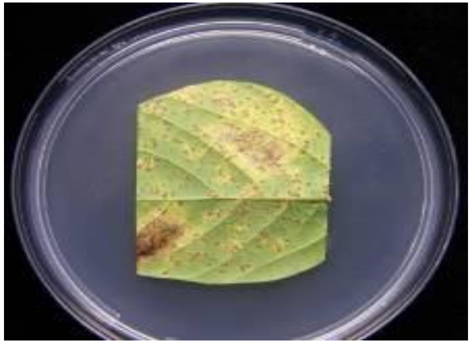


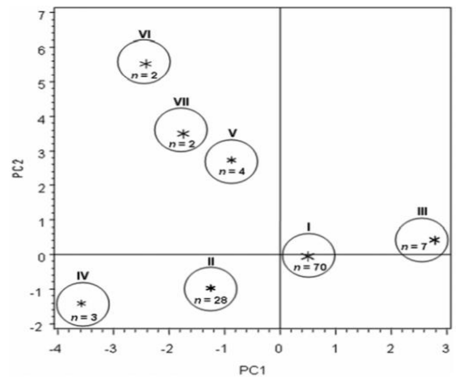
Priority areas based on weighted importance of factors e.g.

1/5*A + 3/5*B + 1/5*C.



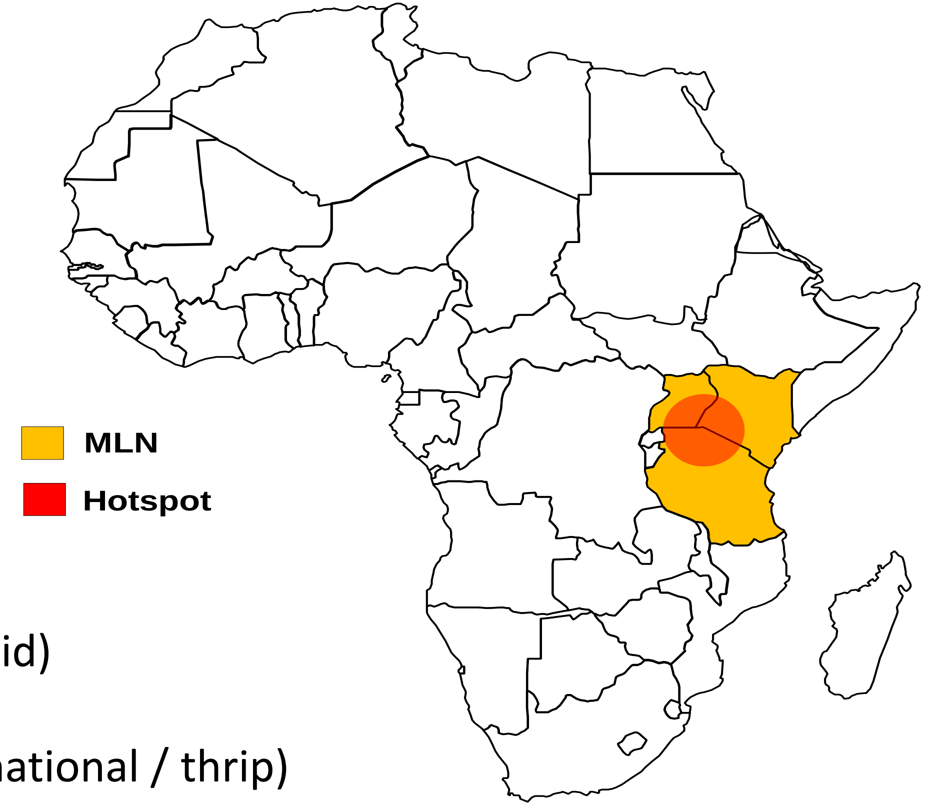
Soybean rust mitigation





Rapid and precise diagnostics
Map variability of rust populations and risk of spread through prevailing winds
Develop and deploy resistant cultivars, sentinel plots

Maize lethal necrosis



Sugarcane mosaic virus (local / aphid)

+

Maize chlorotic mottle virus (international / thrip)

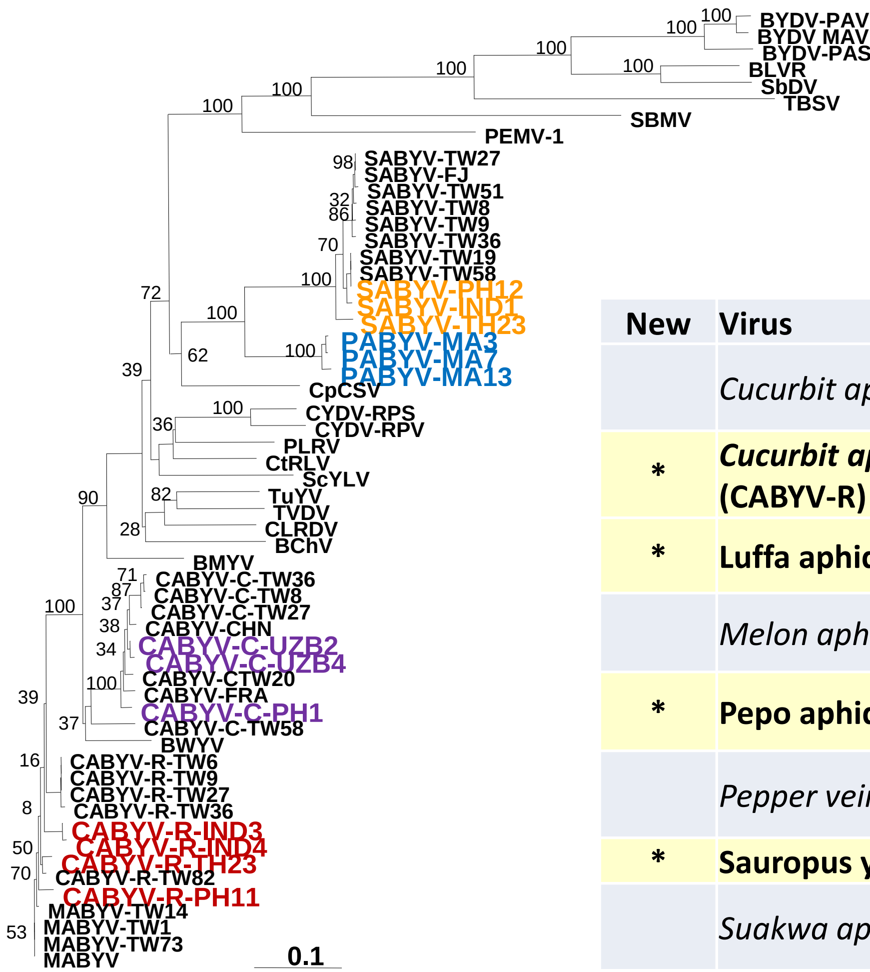
Monitoring known, emerging and new viruses

Crop	Total	BV	CMV	ToMV	CVMV	PMMV	TSWV
Tomato	36	32	1	0	0	0	7
Pepper	38	33	7	7	23	3	0
Eggplant	16	15	0	0	0	0	0

Crop	Total	BV	CMV	ToMV	CVMV	PMMV	TSWV
Tomato	10	9	0	0	0	0	0
Pepper	46	24	7	0	17	0	0
Eggplant	4	1	0	0	0	0	0

Chili infected with PepYLCVs

Aphid-borne Poleroviruses (*Luteoviridae*)



partial RdRp (aa)

New	Virus	Countries
	Cucurbit aphid-borne yellows virus [Common] (CABYV-C)	PHL, TWN, UZB
*	***Cucurbit aphid-borne yellows virus*** **[Recombinant] (CABYV-R)**	**IND, PHL, THA, TWN**
*	**Luffa aphid-borne yellows virus (LABYV)**	**THA**
	Melon aphid-borne yellows virus (MABYV)	TWN
*	**Pepo aphid-borne yellows virus (PABYV)**	**MLI, CIV**
	Pepper vein yellows virus (PeVYV)	IND, IDN, MLI, PHL, THA, TWN
*	**Sauropus yellowing virus (SaYV)**	**THA**
	Suakwa aphid-borne yellows virus (SABYV)	IND, PHL, THA, TWN

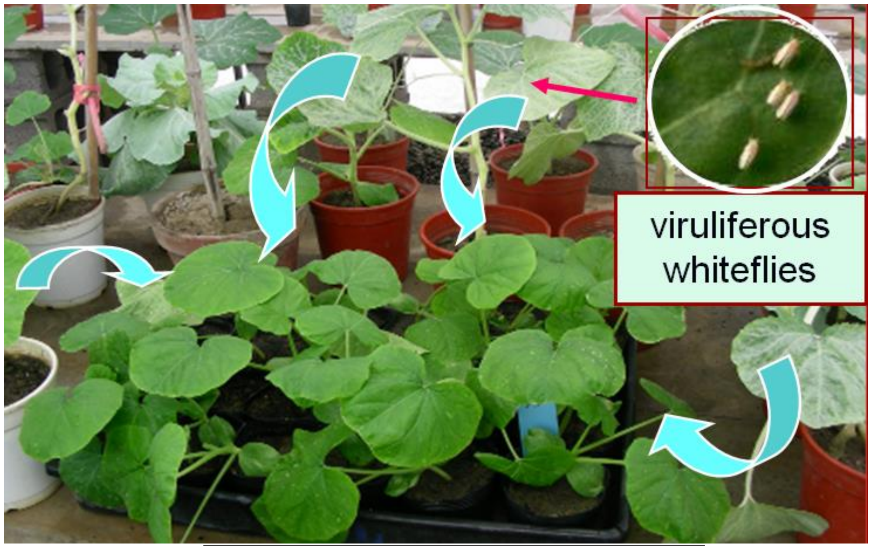
Host resistance

World Vegetable Center

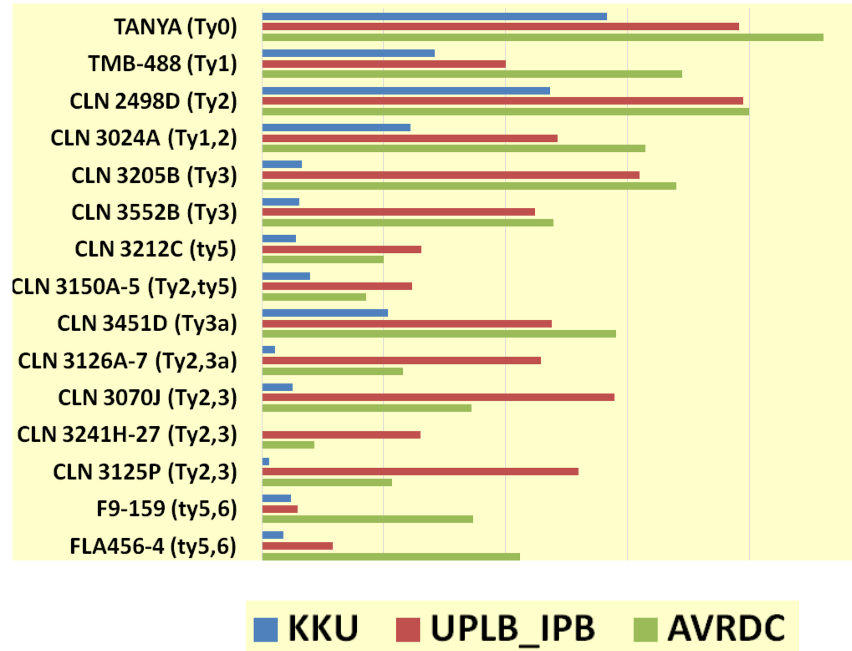
No. of accessions	62,000
No. of species	442
No. of countries of origin	156
No. of new varieties	520

The world's largest public sector collection of vegetable germplasm

Screening for new resistance (Squash leaf curl Philippines virus)



Pyramiding genes (Tomato yellow leaf curl viruses)



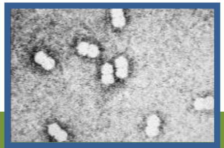
Agronomic practices

Tomato bacterial wilt caused by *Ralstonia solanacearum* (soil-borne, vascular bacterial disease)		
Control principle	Specific measures	Efficacy
Pathogen exclusion	Use a plot without disease history Use clean seedlings No contact with contaminated water	***
Pathogen reduction	Practice rotation Remove diseased plants Apply chemical or organic amendments	**
Host resistance	Use locally effective resistant cultivars	***
Direct protection	Use sterilized pruning tools	*

Agronomic practices

Tomato leaf curl virus caused by begomoviruses (insect-transmitted viral disease)		
Control principle	Specific measures	Efficacy
Pathogen exclusion	Raise healthy seedlings by protection with 60-mesh net	***
Pathogen reduction	Control whitefly, with pesticide, trap crops, pheromone traps Remove and destroy infected plants	*
Host resistance	Use locally effective resistant cultivars	***
Direct protection	Apply summer oil on leaves	*





Agronomic practices

Graft preferred vegetable variety onto rootstock with resistance to prevalent diseases (or flooding)

Grafting

2007:
Lam Dong Province 4000 ha cultivated with grafted seedlings

2012:
Full adoption in Lam Dong and increasing in Red River Delta

Yield increased by 18 t ha^{-1}

Increased profit in Lam Dong of US$ 9million p.a.

Judicious Pesticide Use

Enforce GAP

Increase awareness:

- MRLs and health impacts
- Appropriate use of approved products at correct dose for specific crops
- Appropriate timings of applications (respecting Pre-Harvest Interval)
- Use of correct safety and application equipment
- Store and dispose responsibly

Biological control

Senegalese grasshopper

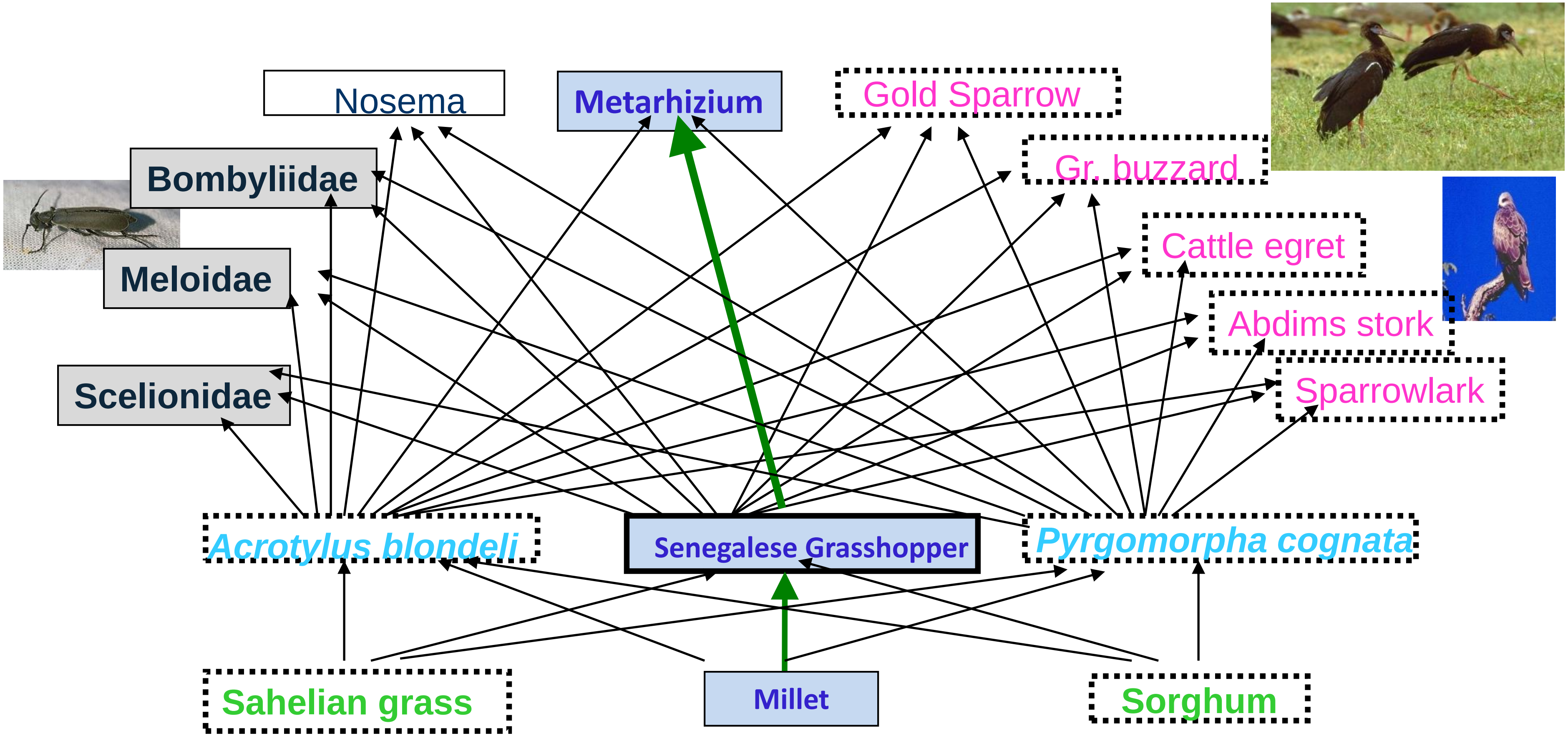
(*Oedaleus senegalensis*)

Metarhizium anisopliae var. *acridum*

Green muscle™ Africa
Green guard ™ Australia

Millet
(*Pennisetum glaucum*)

Biocontrol – ecological equilibrium



Food quality and safety - Aflatoxin

- Highly toxic metabolite produced by ubiquitous *Aspergillus flavus*
- Fungus infects crops and produces toxin in field and store
- Contamination possible without visible signs of the fungus

Biocontrol of aflatoxin - Aflasafe™

- In nature, some strains produce aflatoxin (toxigenic) and others do not (atoxigenic)
- Increase frequency of atoxigenic strains that cannot mate with toxic relatives but that are ecologically competitive against them
- Aflatoxin reduced in field and stores
- Native strains selected and marketed as Aflasafe™