UK perspective of using new technologies & factors which may restrict further implementation

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EPPO Inspectors' technical workshop
The Hauge 18 -20th November 25

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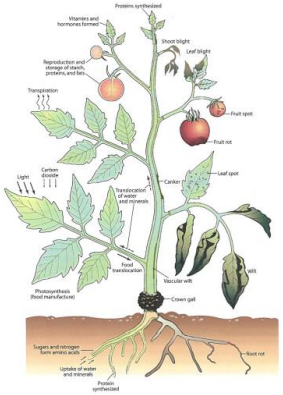
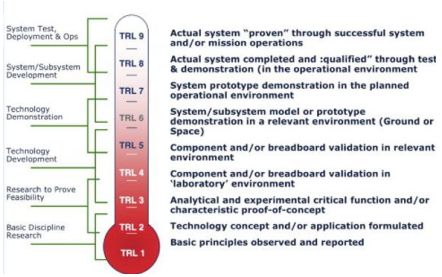
Outline of presentation

- Introduction
  - My background
  - Inspection focus
  - Methods available



- Technology Readiness & Deployment Levels level



- UK examples

My background

Civil Servant since 1995

MAFF

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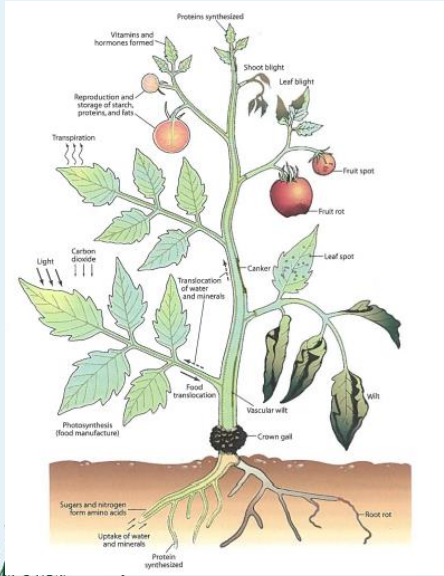
Plant pathologist - Specialising in fungal diseases (mycologist)



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Also involved with

- Producing laboratory methods (DNA & antibody)


- Point of sampling testing


- Production of standards & protocols

- Overseeing inspection for England & Wales



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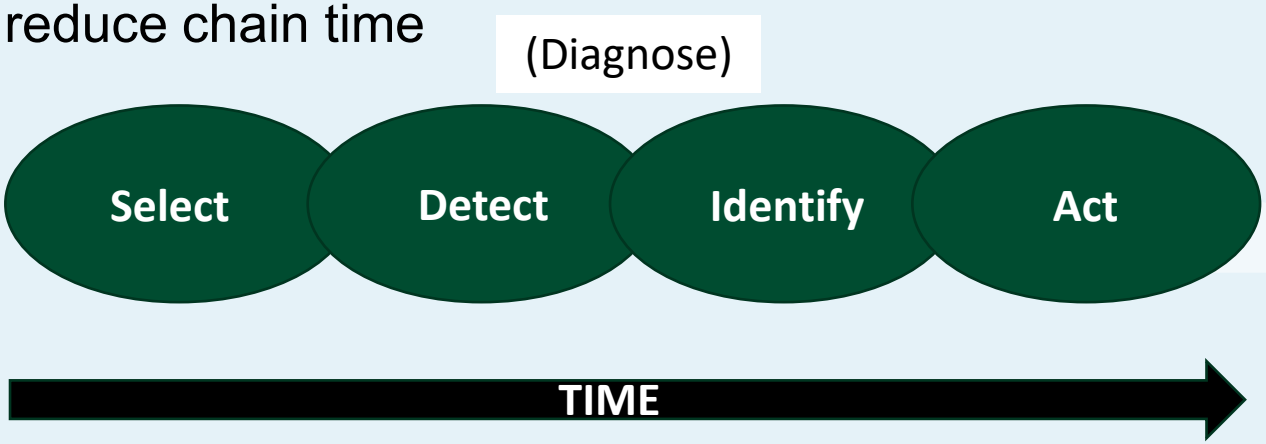
Inspection need

- “Inspection to action
- Often time critical
  - – fresh produce, just in time delivery, port costs, reduce pest spread
- Activities focus on:
  - Select, Detect & Identify (Diagnose), Act.
- Try to reduce chain time



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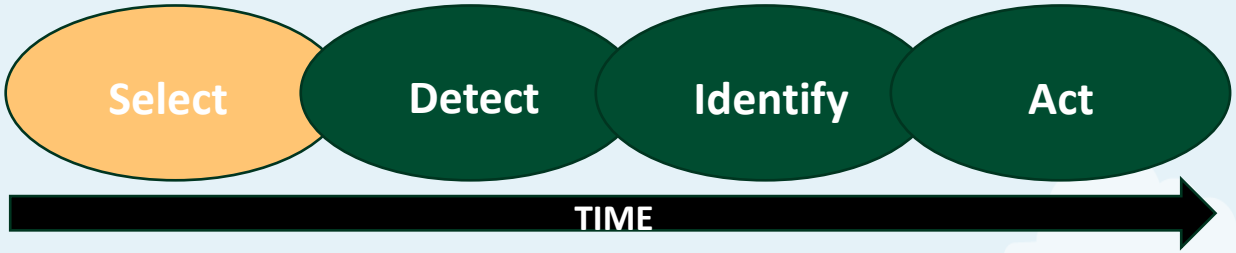
Sampling problems



Which sample do I take ?

What facilities available ?

How much time do we have ?

How do we cover the ground ?

When do we sample ?

What will we do with results ?

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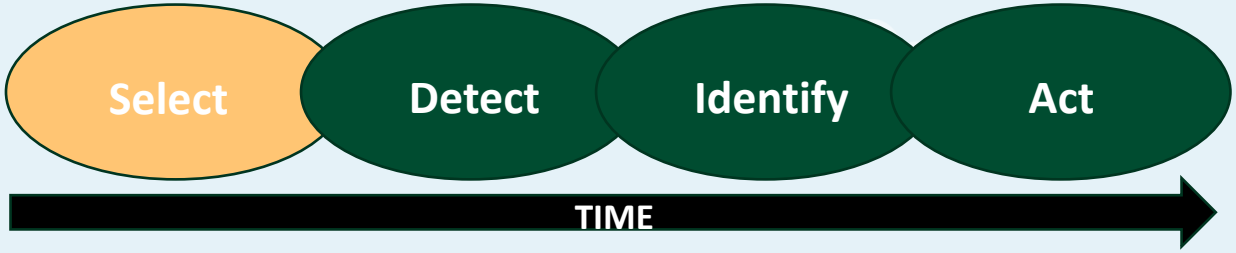
Pest signs

- Know what good looks like
- Dealing with hidden (cryptic) infection



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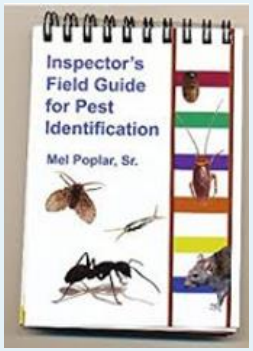
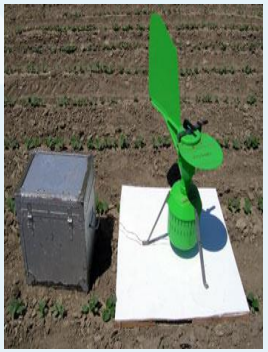
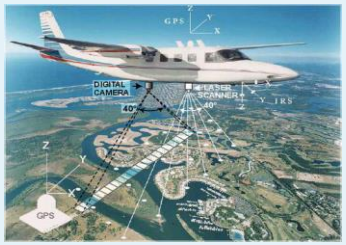
Field methods & aids available

Detect | Identify

- Guides & knowledge
- Trapping (autonomous or not)
  - sticky, light, air, pheromone *etc*
- Magnifiers
- Remote Sensing (UAV & traps)
- Lateral Flow Devices, LAMP platforms
- Sequencing







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Field technologies applied by UK

Detect Identify

- Science partner with Fera since 1980's
- In crops & at the border
- Many new adaptations

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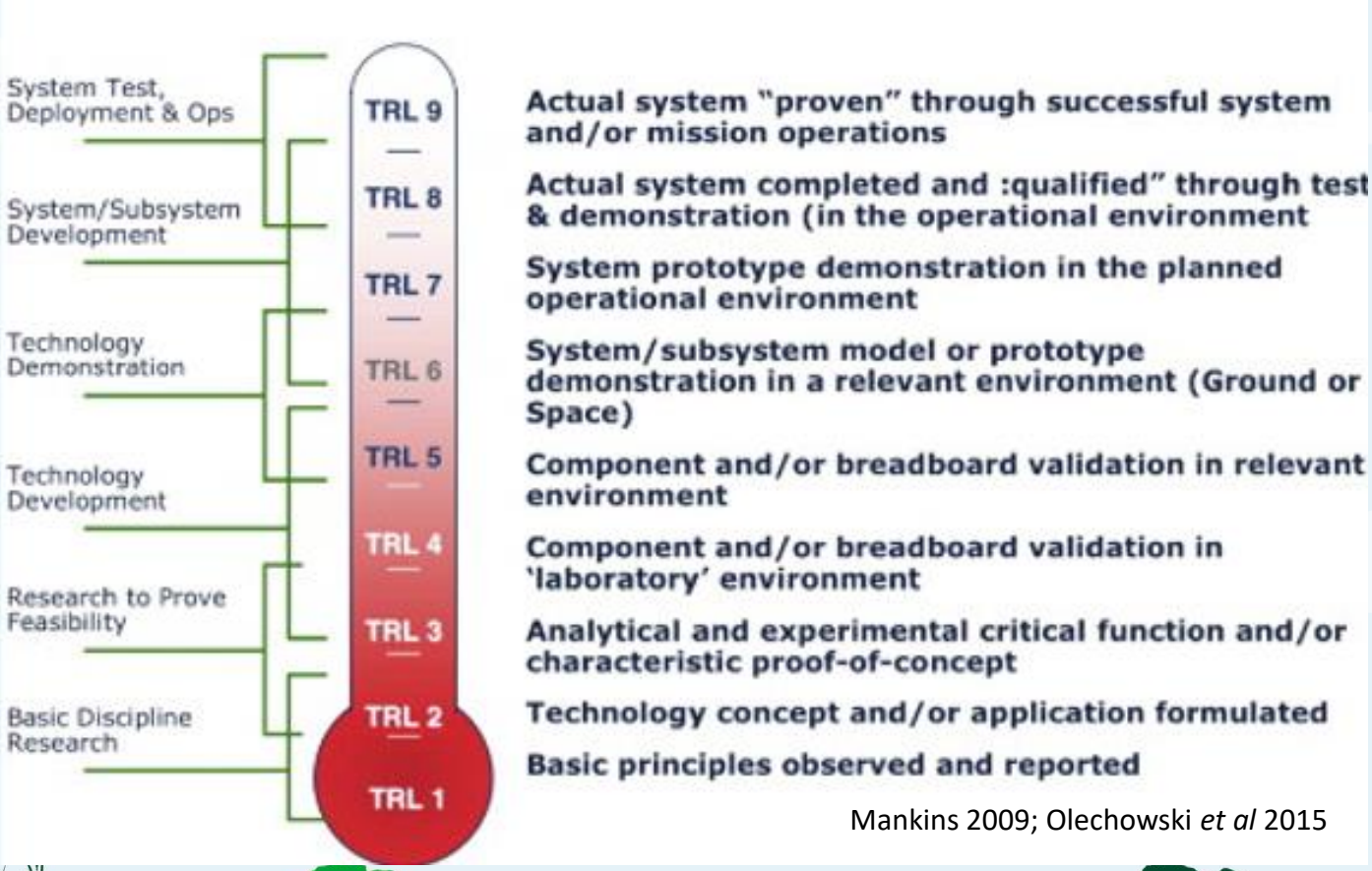
Technology maturity

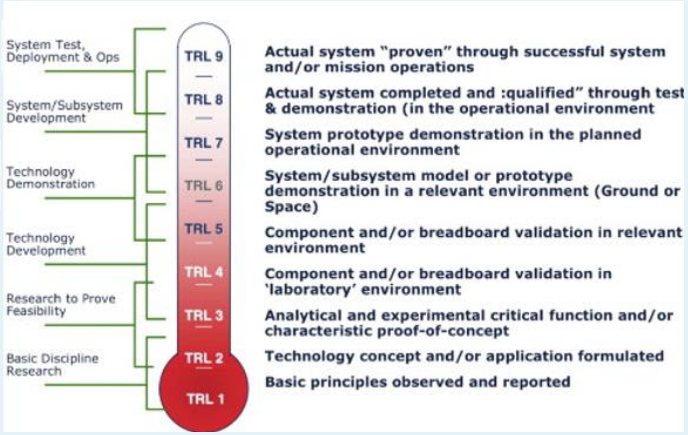
- Often described as a Technology Readiness Level (TRL), scale 1-9



Mankins 2009; Olechowski *et al* 2015

Field test not a lab assay

Technology maturity



Verses

Deployment readiness

- Wider operational considerations required
  - Where, why & how
  - Simple, robust, quick
- May be compromises

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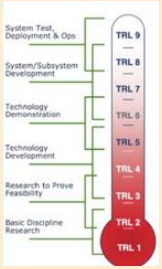
Potential barriers

Technical barriers

- Test performance & robustness
- Specific demands
  - Challenging & diverse test matrices
  - Diversity of targets & small business markets
  - Pest biology
- Lack of technical developments



Policy decisions

- How results will be used
- Legal basis for tests
- Uncertainty about approval processes

Operational & logistical barriers

- Costs
- Physical setting & complexity of workflows
- End user skills, training and support
- Staffing (capacity, shift patterns, staff turnover)

Cultural barriers

- Risk aversion
  - Tests performance different to lab
  - Limited validation
  - Interpretation & relaying of information
- Other real-time priorities
- Shift patterns / need for support

- Fera, UK developing idea of Deployment Readiness Levels (DRL)
- Used own experience questionnaires & practical application

Readiness framework TRL with DRL

Fundamental research – studentships, private academic research

Deployment partnership with stakeholder / business

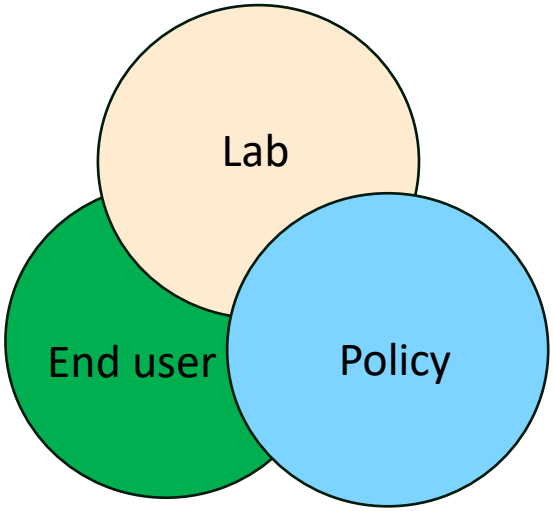
Technology

TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9
Basic principle observed	Technology concept formulated	Concept feasibility	Applied to model target	Applied to target pathogen(s)	Complete test protocol	Tested by end users	On-site performance measured	Deployable/ deployed technology

Assay design

Assay refinement

Deployment against
Bemisia tabaci



DRL 5 Fix target

What life stage, host

Ease of sampling

DRL 6 Protocols

New legislation

Ease of use

DRL 7 User evaluation

Limit of detection

Can user see the need ?

DRL 8 Parallel field/lab tests

Results don't match

Results at sampling pt.

Always use ?

DRL 9 Deployment

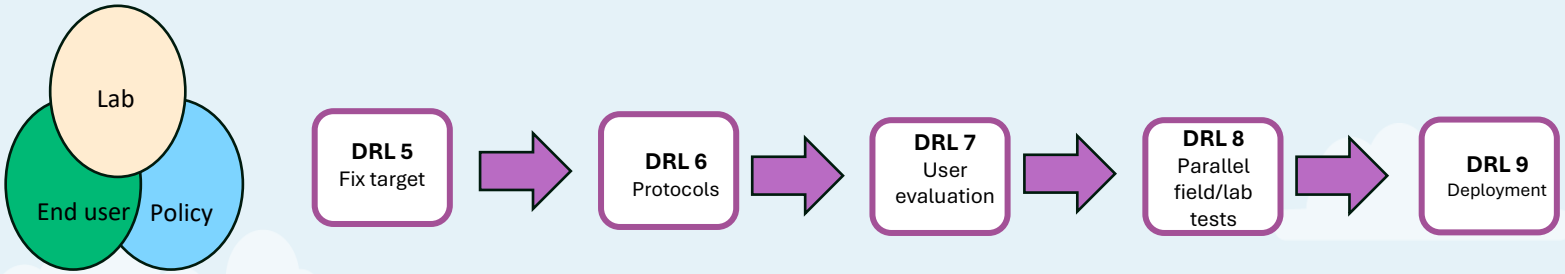
Time availability

Policy support, application of results, legislation, funding

End user: Inspectors, BCP operators, importers, etc

On-site training, quality assurance, support & learning

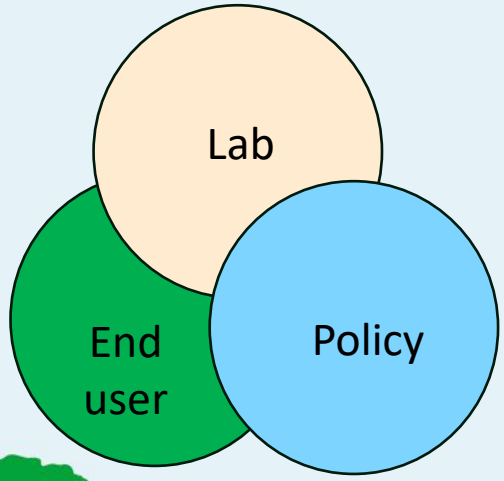
Benefits of DRL framework



- Co-design - clear pathway towards deployment for tests
- Helps set deployment expectations (time, effort, costs)
- Encourages pre-emptive approach to potential barriers:
  - DRL 5: What do end users want & why
  - DRL 6: Assay considered in entirety – e.g. robustness & reliability, costs & policy
  - DRL 7: Refine user requirements before application
  - DRL 8: Evaluate systems in “real world”
  - DRL 9: Deploy in “real world” & regular review

Recent deployment activities

- Serological, molecular & drone
- Involving lab, policy & inspectors
- Applying DRL framework



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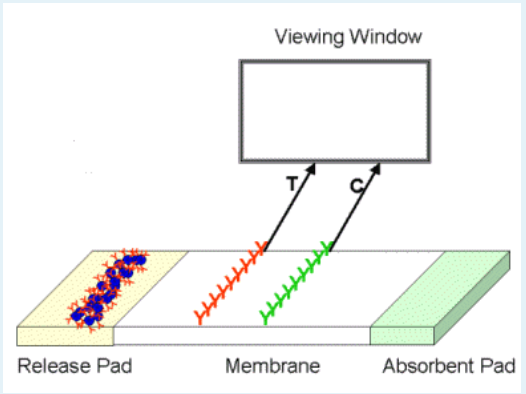
Lateral flow devices

- Inspectors preferred tool
  - Quick, robust, high accuracy, relatively cheep
  - *Phytophthora* spp *device* routinely being used DRL9)
  - *Xanthomonas* spp assay being rolled out (DRL 8)

- Looking to produce new devices from:
  - Historic cell lines (DRL 5)
  - New synthetic & classic antibodies (TRL 5)
  - Use of LAMP amplicons on LFDs (TRL5)



Drone use

- Multispectral & thermal cameras
- Imagining used for:
  - *Narcissus* inspections (DRL 8)
  - Colorado beetle surveillance (DRL 9)
  - Seed potato crops for PVY detection (DRL 7)
  - Yellow-Legged Hornet nests (DRL 9)
  - Avian Influenza (DRL 6)

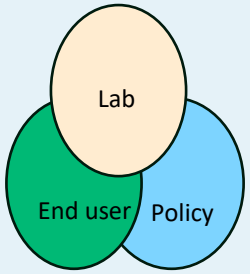
- Advanced image processing under consideration (TRL 3)




Molecular tools – LAMP / Genie

- Talk by Ben Walpole
  - *Bemisia tabaci* & Liriomyza species (DRL 8-9)

- TRL & DRL process being applied for other targets



- Targets under discussion:
  - *Xylella*, *Phytophthora* & *Xanthomonas* spp, various potato & tomato viruses

Molecular tools – Barcoding at the border

- Method development for sequencing at border points (TRL 3)

or

Quick DNA prep → Nucleic acid enrichment → Sequence

Bioinformatics

Interrogate database of species of concern

Species of concern found

No species of concern found

MinION sequencer

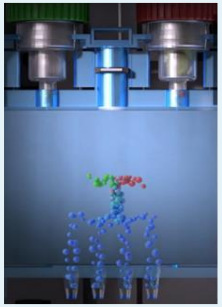
OptiGene LAMP cartridge system - MDX4A

- User centric design
- One step cartridge system, results < 30 min
- No to low interpretation of results
- On journey to deployment (DRL 6-7)

Add sample into vial & shake

Place vial into test cartridge

Place test cartridge into device. Press start



Fully automated liquid handling and measured dispensing

Fully automated isothermal DNA/RNA amplification and pathogen identification by fluorescence measurement

Results displayed on wireless connected smart device

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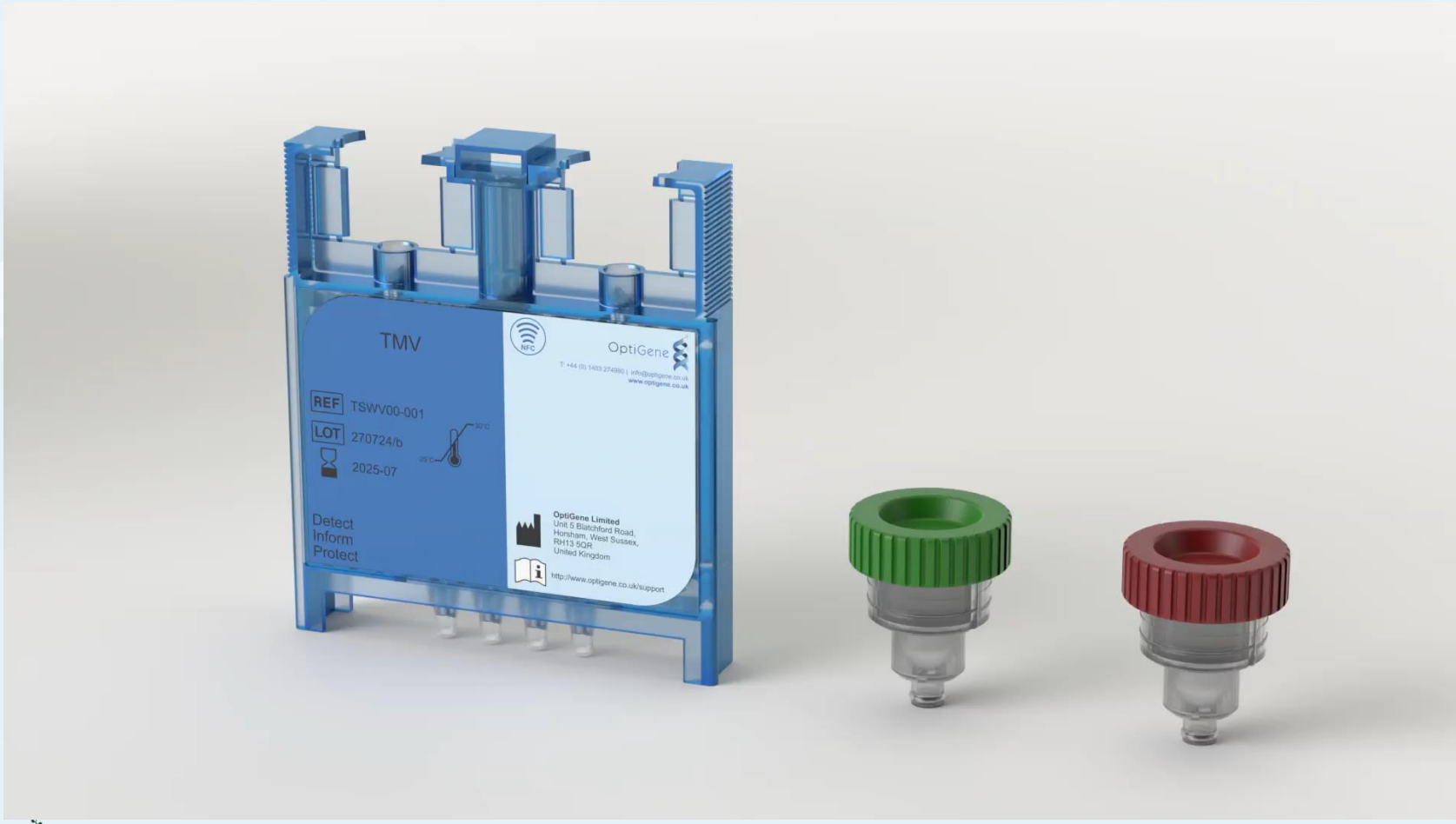
LAMP cartridge system - MDX4A



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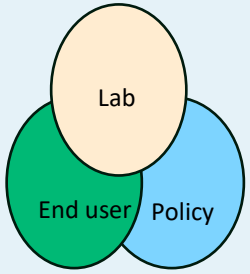
Conclusions



- Often clear need for in-field diagnostic tools
- Many potential barriers to deployment:
  - Technical, Policy, Operational, Cultural
- Vital to co-design deployment between Lab, Policy teams & End users
- For field use:
  - Try to get TRL & DR levels to evolve together
  - Fera developing a system to help the systems co-evolve.
- DRL approach being put into new tools under development
- Potential for development of EPPO guideline for others to follow
- Looking for partners to develop & evaluate new tools for inspectors

Thank you

- Jenny Tomlinson & Lynn Laurenson
  (Defra Future Proofing Plant Health; Pathsafe Programme; GAP DC; Barcoding for Biosecurity)
- Danni Marrison, Ben Walpole, Paul Beales, APHA
- Ross Haffenden & Michael Andreou, OptiGene
- Defra for funding work & attending this workshop

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Department for Environment Food & Rural Affairs

Questions ?