

# Development of Rapid Field-Based Diagnostics to Improve the Control of Exotic Livestock Diseases

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# Foot-and-Mouth Disease

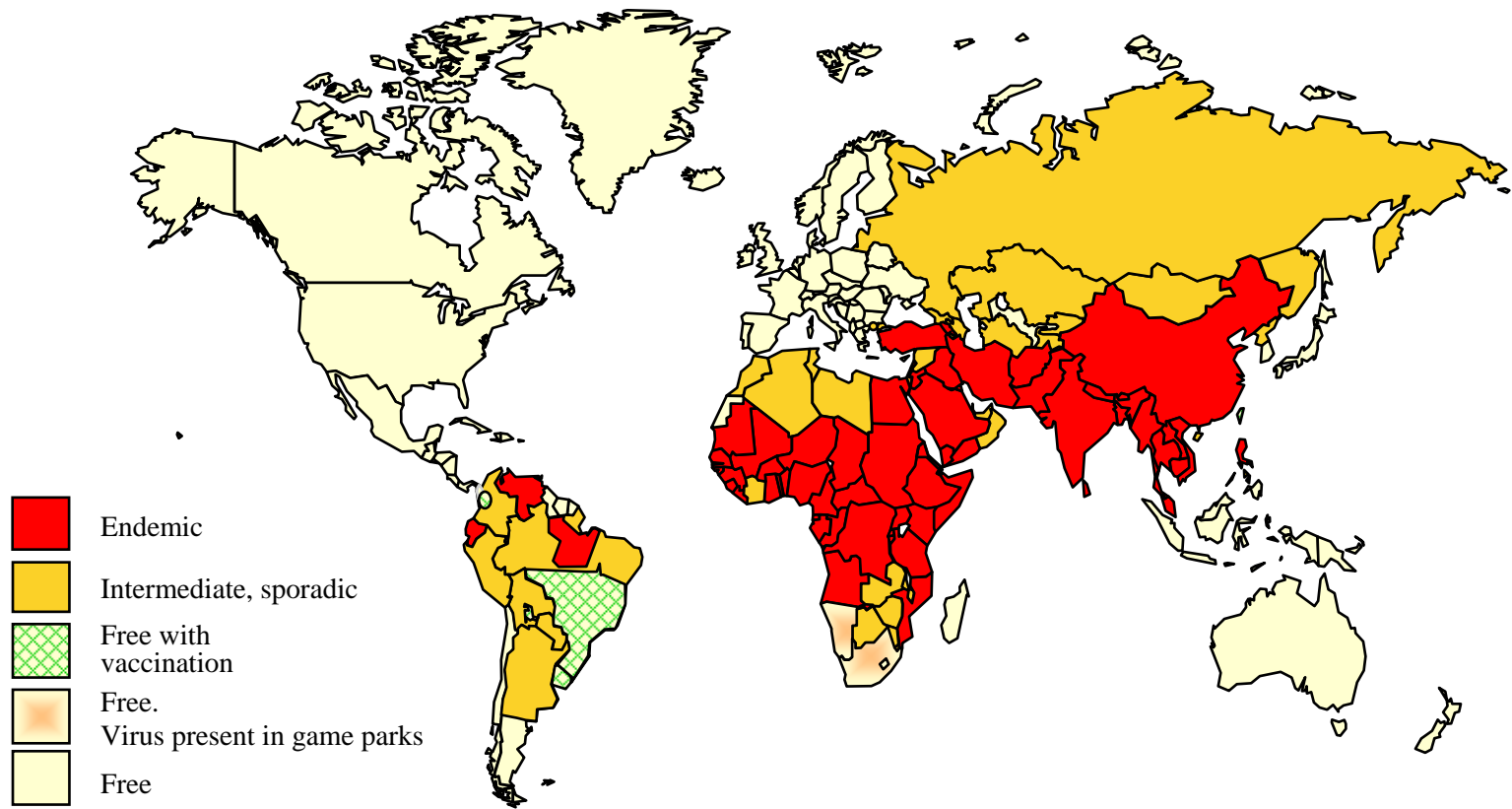
- Causes disease that affects all the major large animal livestock species and various wildlife (cloven-hoofed: cattle sheep, pigs)
- Highly contagious
  - Rapid replication and short incubation
  - Massive virus release
  - High susceptibility of hosts
- Difficult to control and a major international trade issue

## Classification of FMDV:

- Family: *Picornaviridae*
- 7 Serotypes – each including numerous subtypes  
O, A, C, Asia1, SAT1, SAT2, SAT3
- + sense ss RNA genome ~8300nt



# Conjectured Status of FMD:



13 JANUARY 2005

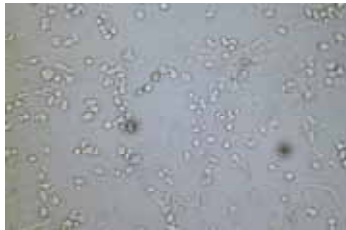
Global FMD control/eradication still a distant prospect !

# UK 2001 Epidemic

- February – September 2001
- Slaughter of ~6 million animals
- Estimated to have cost £8 billion to the national economy
- 2030 infected premises
- Major role of sheep
- Vaccination not used
- Controlled by stamping out
- Diagnostic laboratory tests
  - Virus detection tests
    - 15,000 tests done
  - Serology
    - >million ELISA tests
    - 18,000 VNTs

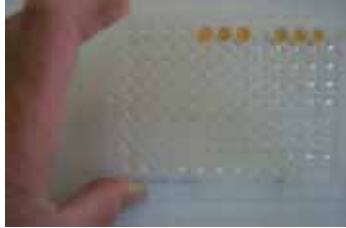


# Laboratory-based assays for FMDV



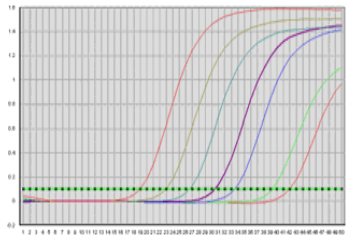
Virus  
isolation  
(CTY or IBRS2)

1-4 days



Ag ELISA

~4 hours



TaqMan®  
RT-PCR

~5 hours

1

10

100

Time to report result (hrs)

# FMDV Diagnostics: what are our priorities?

## Lessons from the 2001 outbreak:

Average time to receipt of samples was >24 hours

- Faster (more rapid detection)
- Ability to support diagnosis based on clinical signs

- Mobile/portable molecular assays
- Pen-side lateral-flow devices

## Desired assay characteristics:

Rapid → Sensitive → Simple to use → Robust  
(use in field) → Disposable ?

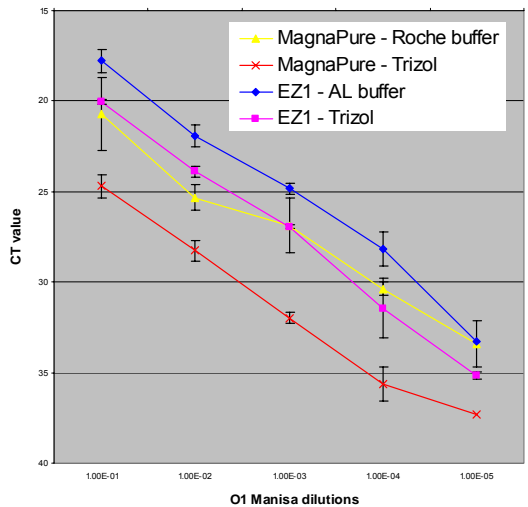


## 2: Use of regional laboratories

Strategy: technical capability to run "IAH" molecular assays



3: "mobile" laboratories for FM



Regional Lab

Advantages

• Farm

• Rapid diagnosis

• Uses existing infrastructure

• Farm

• Limitations

• Probably not "trained" lab

• Cost

• Ineffective for outbreak sources



- Efficiency/quality control
- Compatibility of lab services
- Shelf-life of consumables

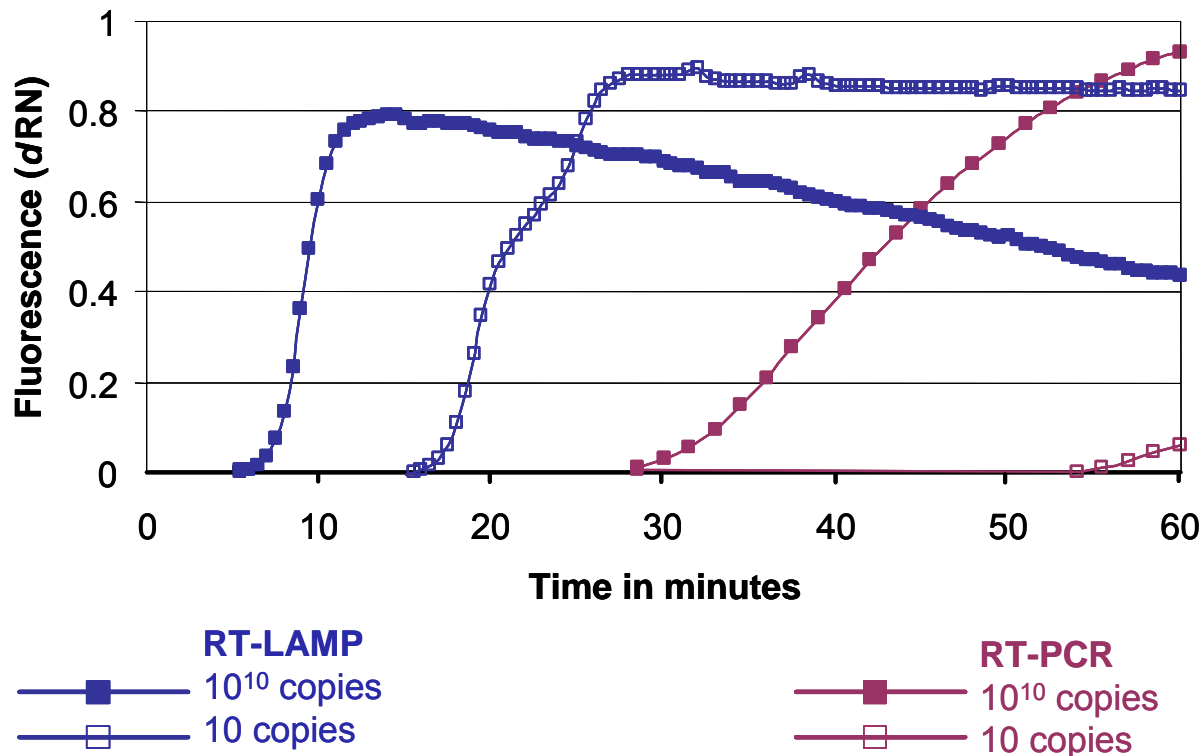
# Potential turn-around times

'Lab' location	Transport time	Assay time
<b>1:</b> Centralised	Up to 24 hours	5 hours approx
<b>2:</b> Regional	1-2 hours	5 hours approx
<b>3:</b> Mobile	Less than 1 hour	Less than 2 hours
<b>4:</b> On-farm	-	Less than 1 hour

# Alternative molecular assay formats:

## 1: Isothermal Amplification Methods

- Single temperature – not so reliant upon sophisticated equipment
  - (i) NASBA (nucleic acid sequence-based amplification)
  - (ii) LAMP (loop-mediated isothermal amplification)



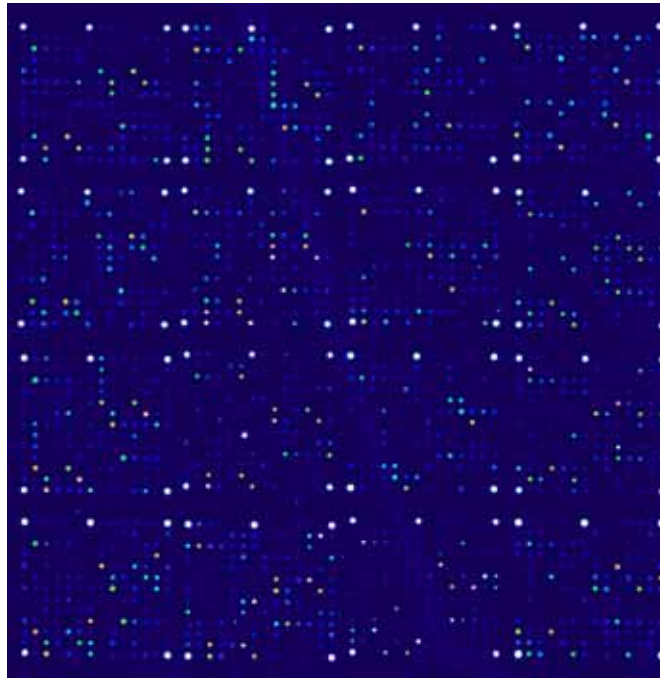
Dukes et al. (2006) *Archives of Virology*



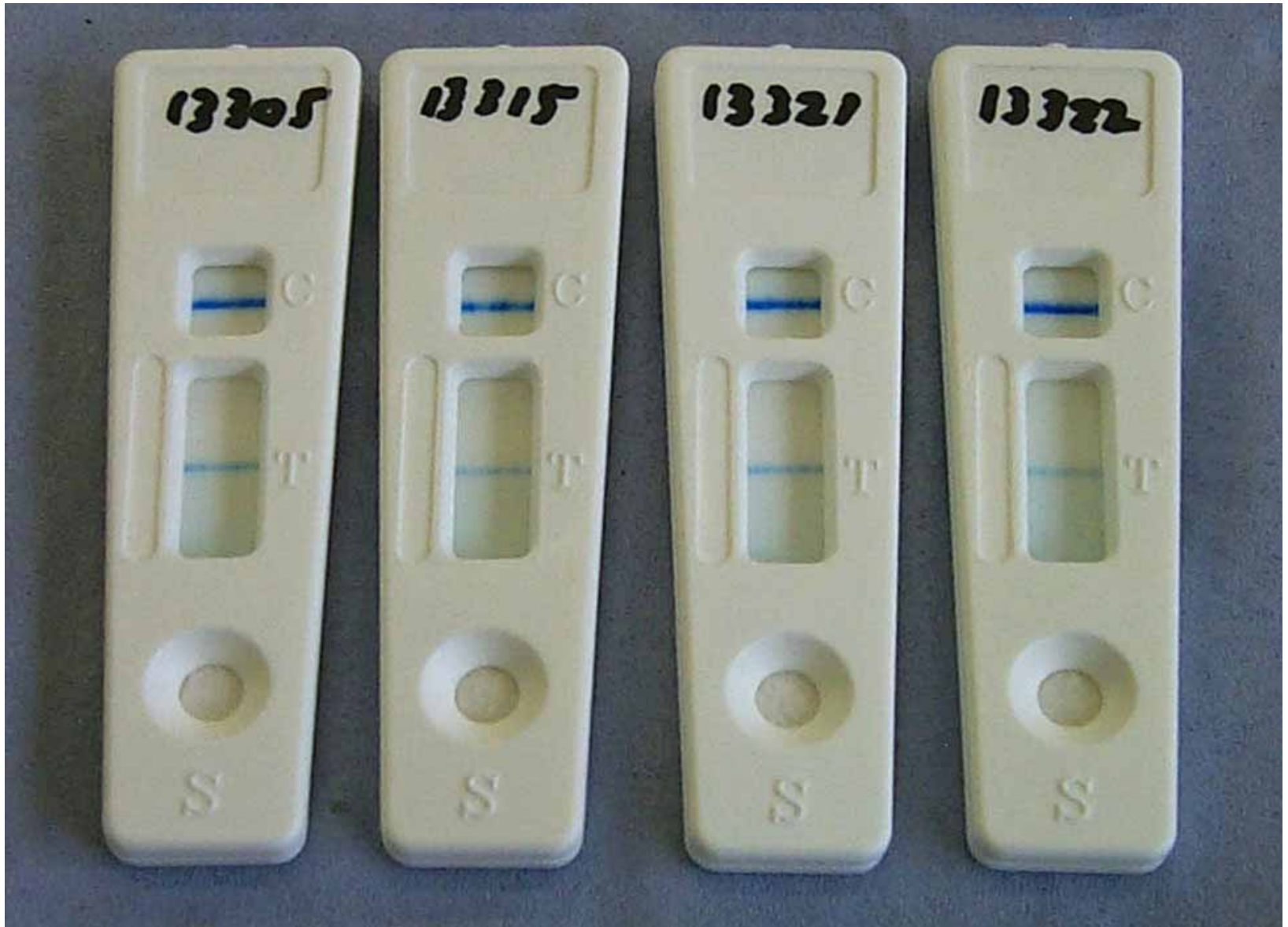
# Alternative molecular assay formats:

## 2: Viral MicroArray

- Potential for differential diagnosis and strain characterisation
- “Portable” formats are being evaluated



# Lateral-flow devices for FMDV



# Scenario for field diagnosis of FMD

**Veterinary visit**



**Clinical  
diagnosis**

Lateral-flow devices (LFDs)  
Sensitivity ~80%



- Rapid confirmation of positives?

“Rapid” Molecular assays  
Sensitivity >95%



- Ability to confirm negatives
- Additional surveillance use

# Challenges:

1. Technology is moving very rapidly
  - Many potential formats and chemistries
  - IP issues – access to most appropriate technologies
2. We are not instrumentation specialists
  - New assay formats are usually target/pathogen-specific
  - Need to establish collaboration with commercial partner(s)
3. Can we convince commercial companies to do this work?
  - Livestock diseases - Limited commercial market
4. Important to involve stakeholders
  - (government, farming organisations, field veterinarians) to ensure assays are fit for purpose
5. Assay validation



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