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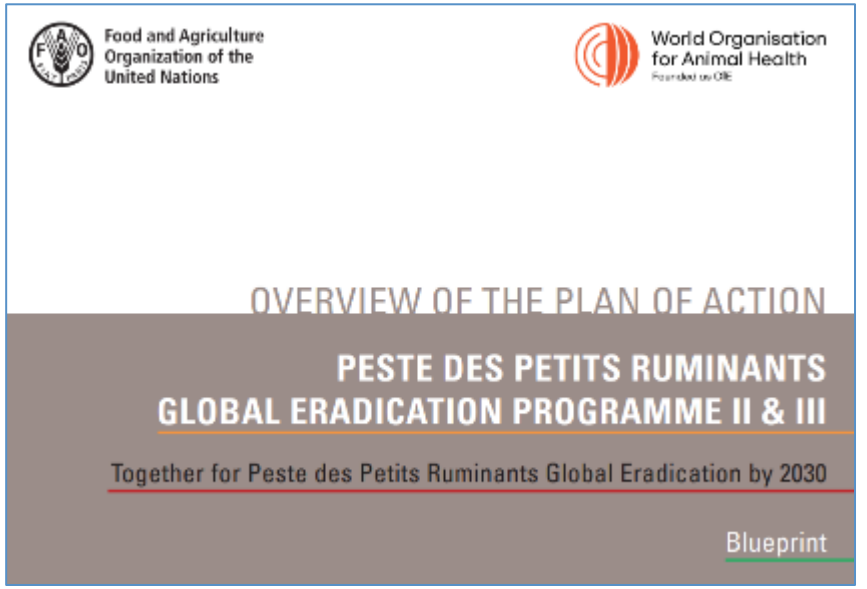
Middle East/GCC-Africa Inter-Regional Workshop to Improve Cross-Regional Trade

Episystem-based PPR eradication

Satya Parida
FAO PPR Secretariat

Why episystems matter

- PPR GEP II aims to stop virus circulation following episystem-based eradication.
- Success requires targeting populations that sustain transmission
- Episystems help to guide:
  - Vaccination
  - Surveillance
  - Cross-border coordination



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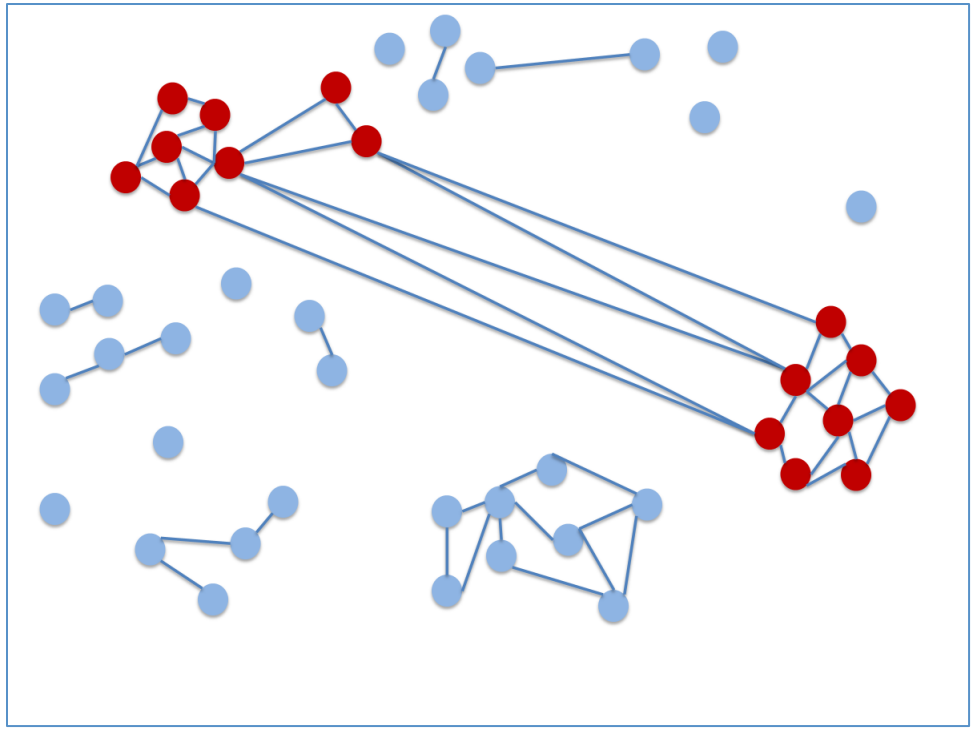
What do we mean by episystems

Episystems are interconnected populations capable of maintaining PPRV transmission.

- They are operational representations of epidemiological connectivity within dynamic livestock systems
- Their characterisation should be continuously refined as additional information becomes available

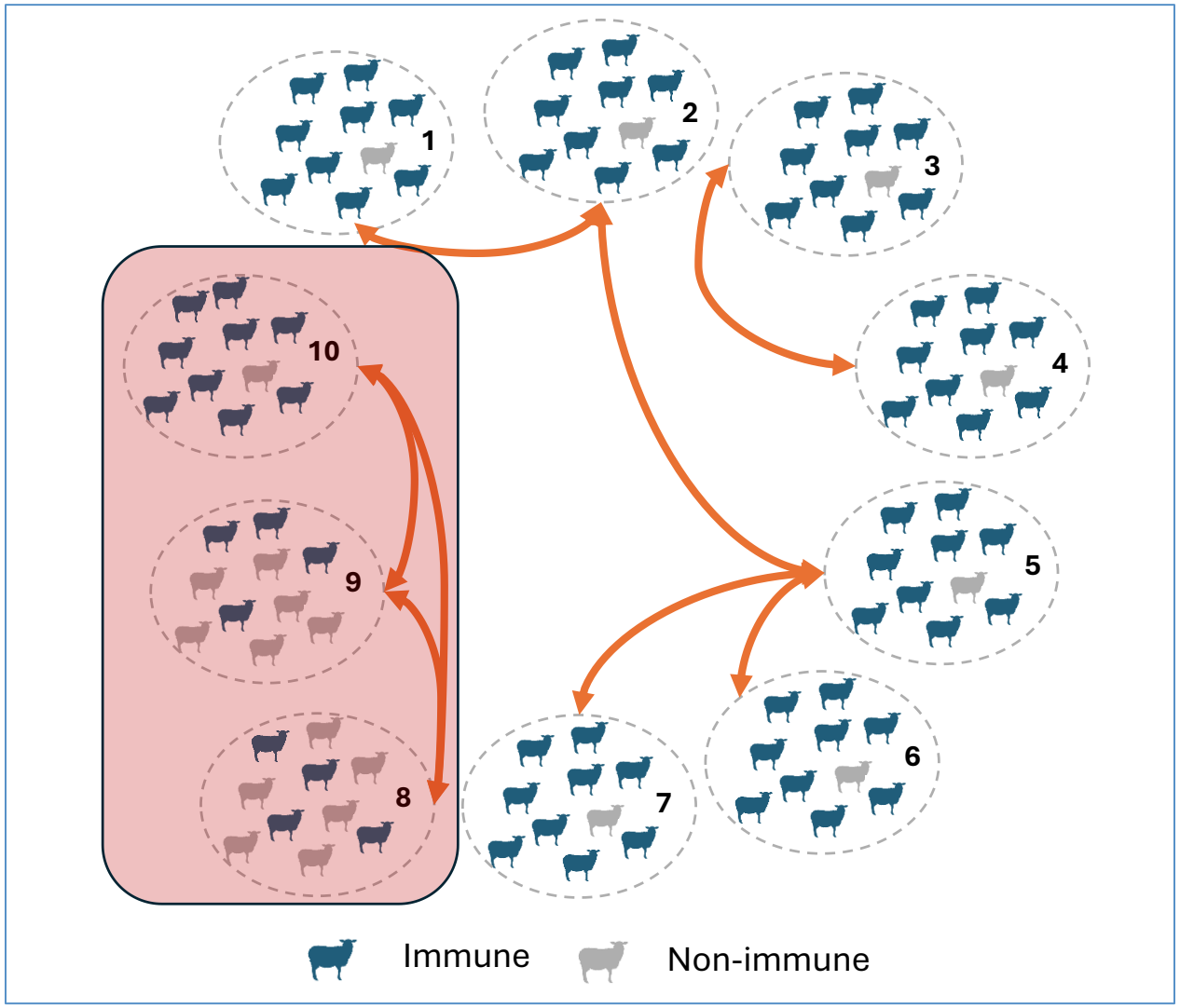


Connectivity: why it matters operationally



Connectivity can link geographically distant populations into a single epidemiological system.

Funded by the European Union



Connectivity can sustain infection even when overall immunity looks high.

- Overall immunity: **80%**
- Low-immunity nodes: **8 & 9 = 40%**
- Connected nodes **(8+9+10)** → **~57%** immune
- **Below threshold** → transmission may **persist** at episystem level

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How can countries start characterising episystems?

Epidemiological factors underpinning episystems:

- Population size and structure
- Population turnover / replacement
- Connectivity and animal movements
- Population immunity

Sources of information:

- Population and vaccination data
- Movement data / expert knowledge
- Surveillance and outbreak investigations
- Participatory search

Episystems are dynamic epidemiological systems, and their operational characterisation should be progressively refined as new information becomes available.

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How to identify episystems

How to identify and characterize PPR episystems:

- Connectivity
- Population dynamics
- Transmission patterns

Data sources:

1. Population and movement data
2. Epidemiological data
3. Phylogenetic data



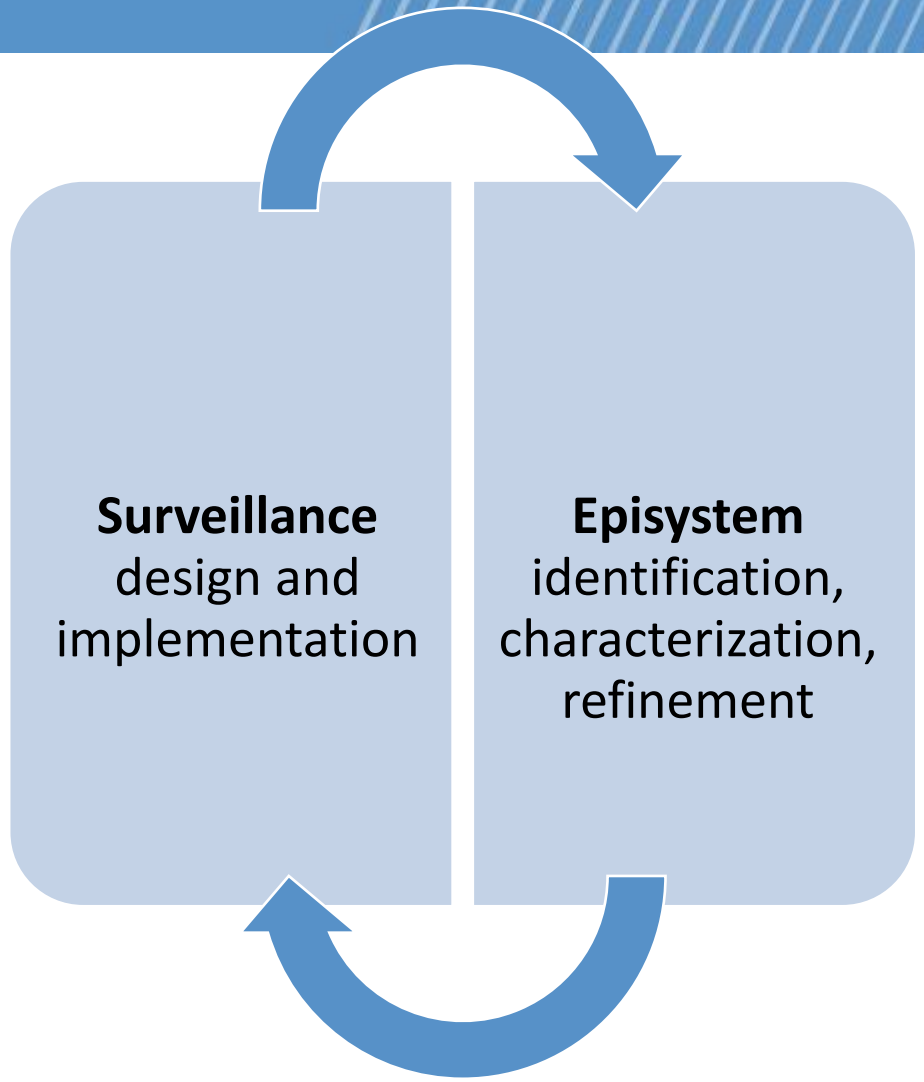
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From Episystems to Surveillance:

- Identifying/characterize episystems to target surveillance.
- Knowledge of connectivity to guide where & how to monitor.

From Surveillance to Episystems:

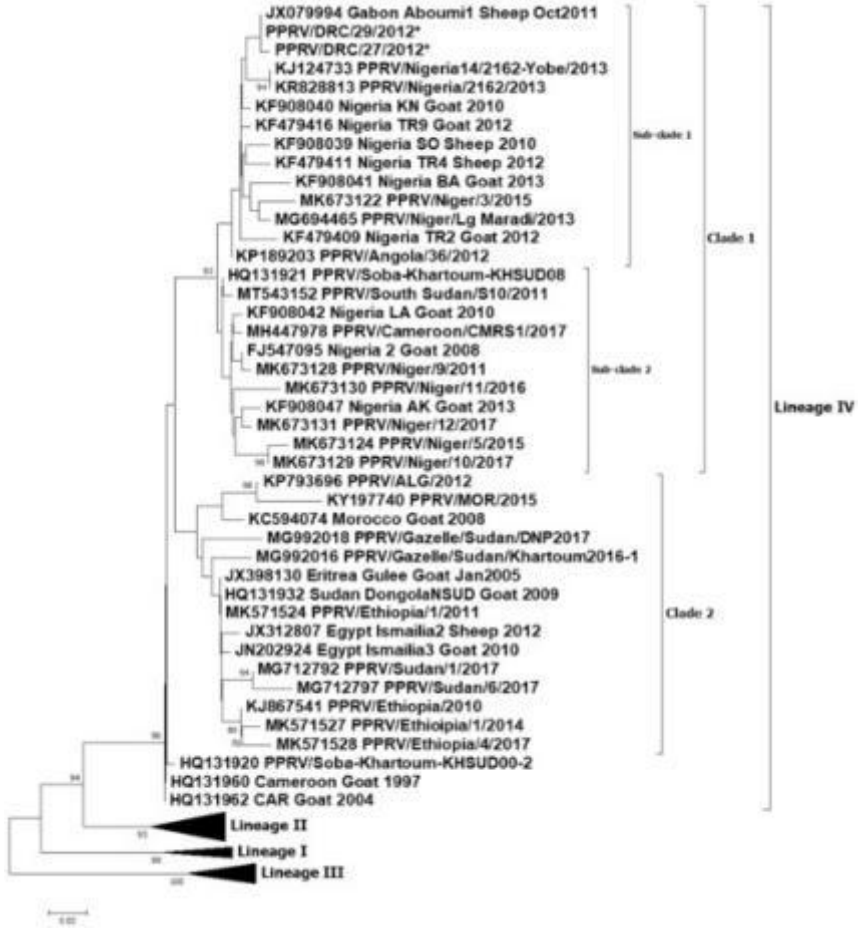
- Surveillance data:
  - continuously refines episystem characterization.
  - validates assumptions about connectivity & transmission.
  - Example: Identifying unexpected linkages between outbreaks using molecular data.



How to identify episystems: phylogenetic data

To identify circulating strains and their transmission pathways:

- Identification of circulating lineages/strains
- Molecular clustering and mapping distribution.
- Refine / validate episystems: link to epidemiological data and verify whether outbreaks within an episystem involve related lineages/strains, confirming interconnectedness.



Neighbor-joining tree constructed using partial N gene sequences of peste des petits ruminants virus (PPRV), showing relationships among the PPRV lineage IV isolates circulating in Africa. Source: Mulumba-Mfumu, et al (2021). https://doi.org/10.3390/v13122373

PPR in North Africa, Morocco-2008

• **Morocco** experienced the first incursion of the disease in the little Maghreb in 2008 and the disease spread rapidly in the country mainly through animal trade

•Across outbreaks 2 833 sick animals were identified

•**257** outbreaks in **36** provinces were reported from 18 July 2008 to 5 November 2008

• Case fatality rates approached 50%

• Of the infected animals, 96% were sheep.



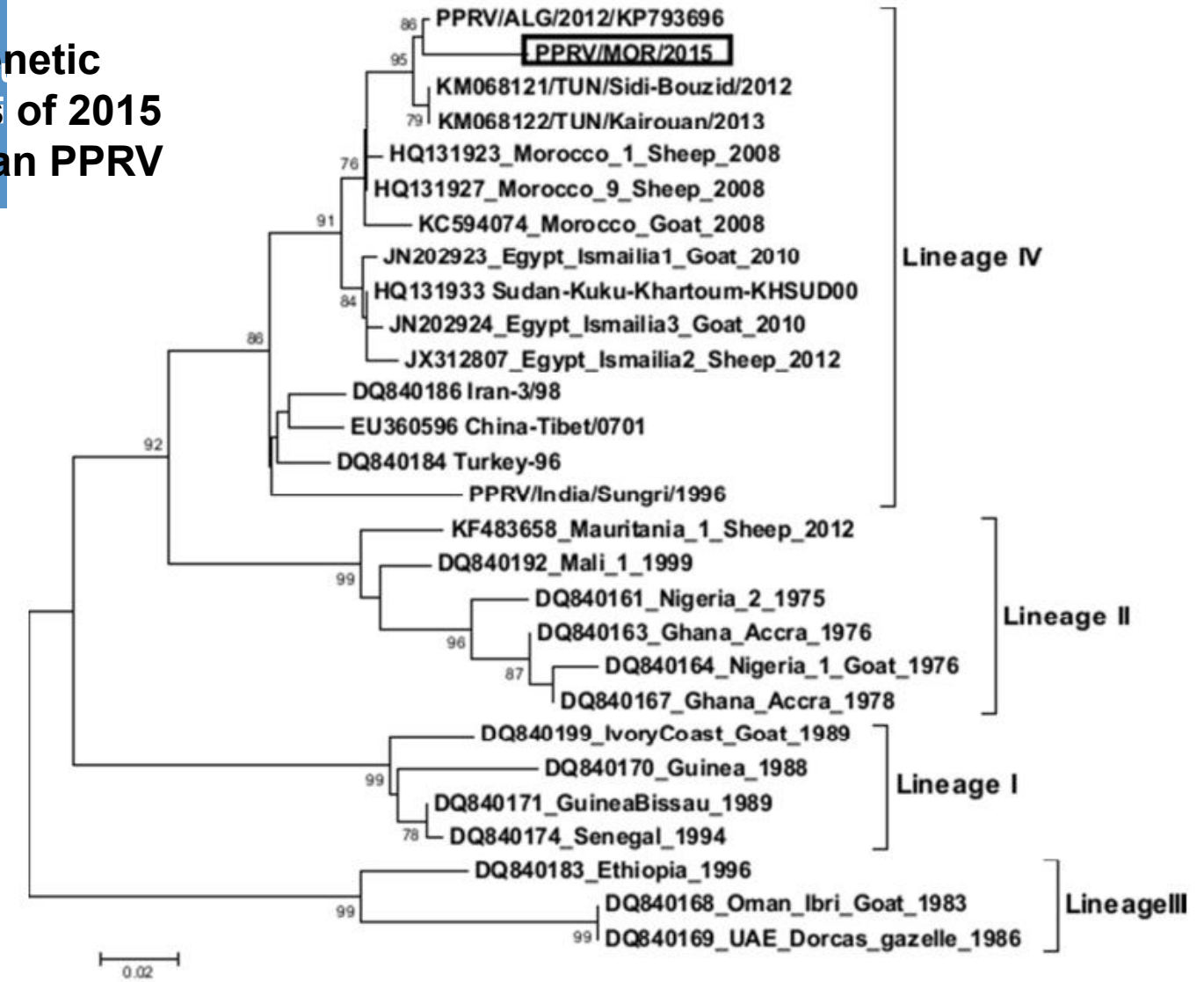
PPR in Morocco-2015



Figure 1: 2015 Outbreak locations of PPRV in Northern Morocco. (Source: OIE, 2016)
104x54mm (100 x 100 DPI)

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Phylogenetic analysis of 2015 Moroccan PPRV

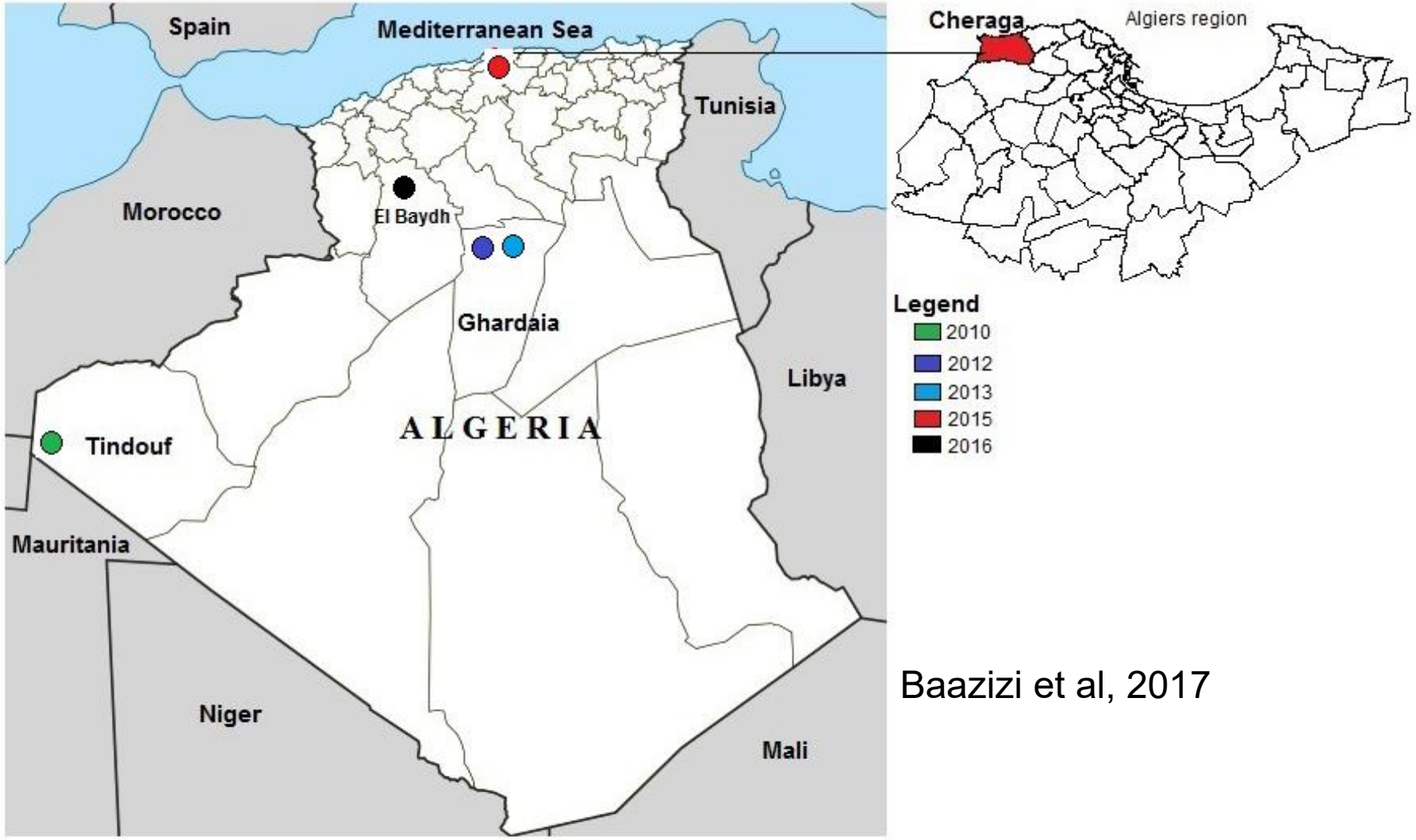


4: Phylogenetic tree based on the nucleoprotein gene of peste des petits ruminants virus is
2015 Morocco outbreak (black rectangle) and selected comparison sequences from GenBank
-joining method was used for phylogenetic analysis; evolutionary distances were computed
Tamura 3-parameter using MEGA 6.0. The GenBank accession numbers are given against e
sequence. Scale bar indicates nucleotide substitutions per site.

Fakir et al., 2016

PPR in Algeria-2010-2016

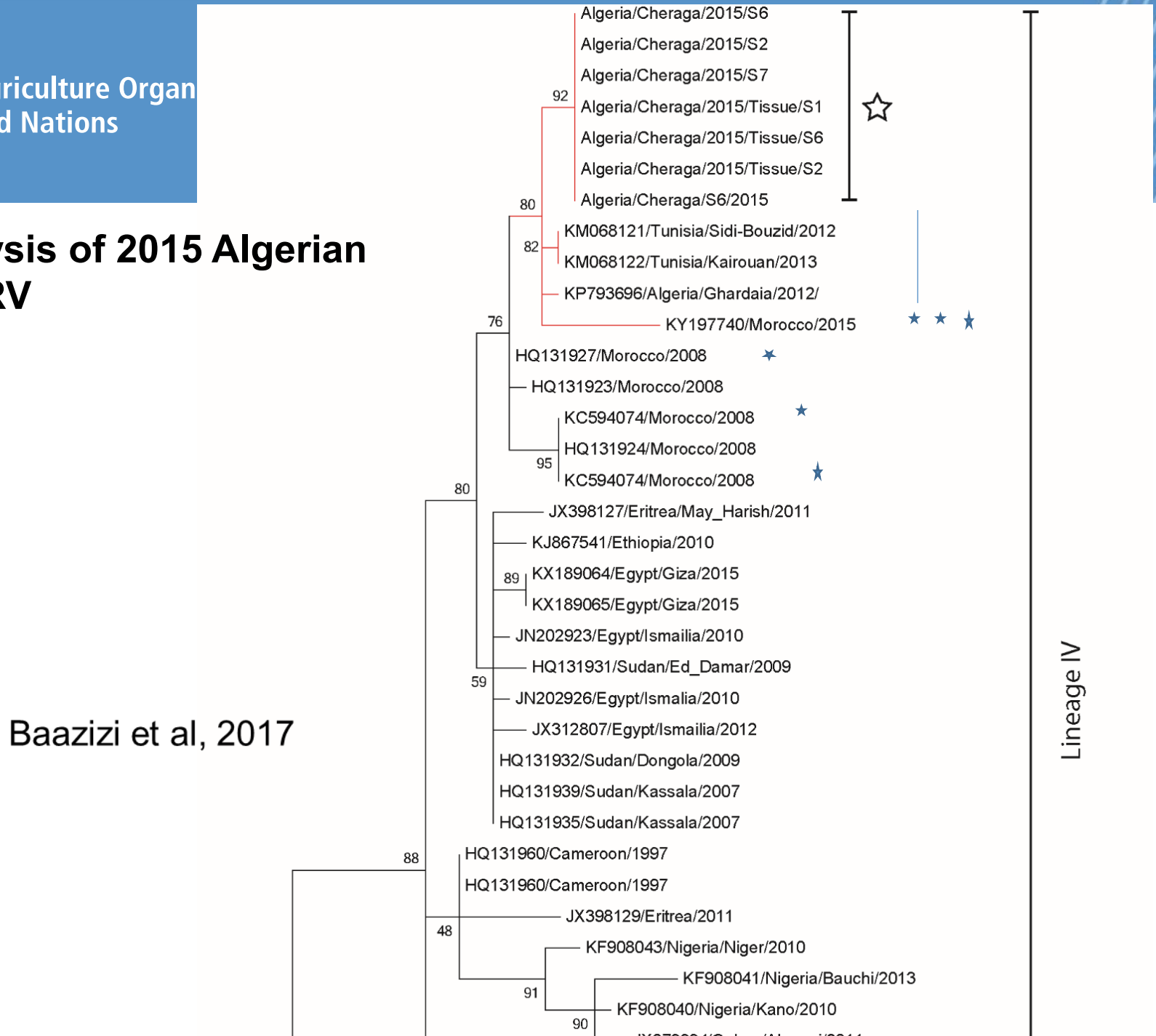
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Baazizi et al, 2017

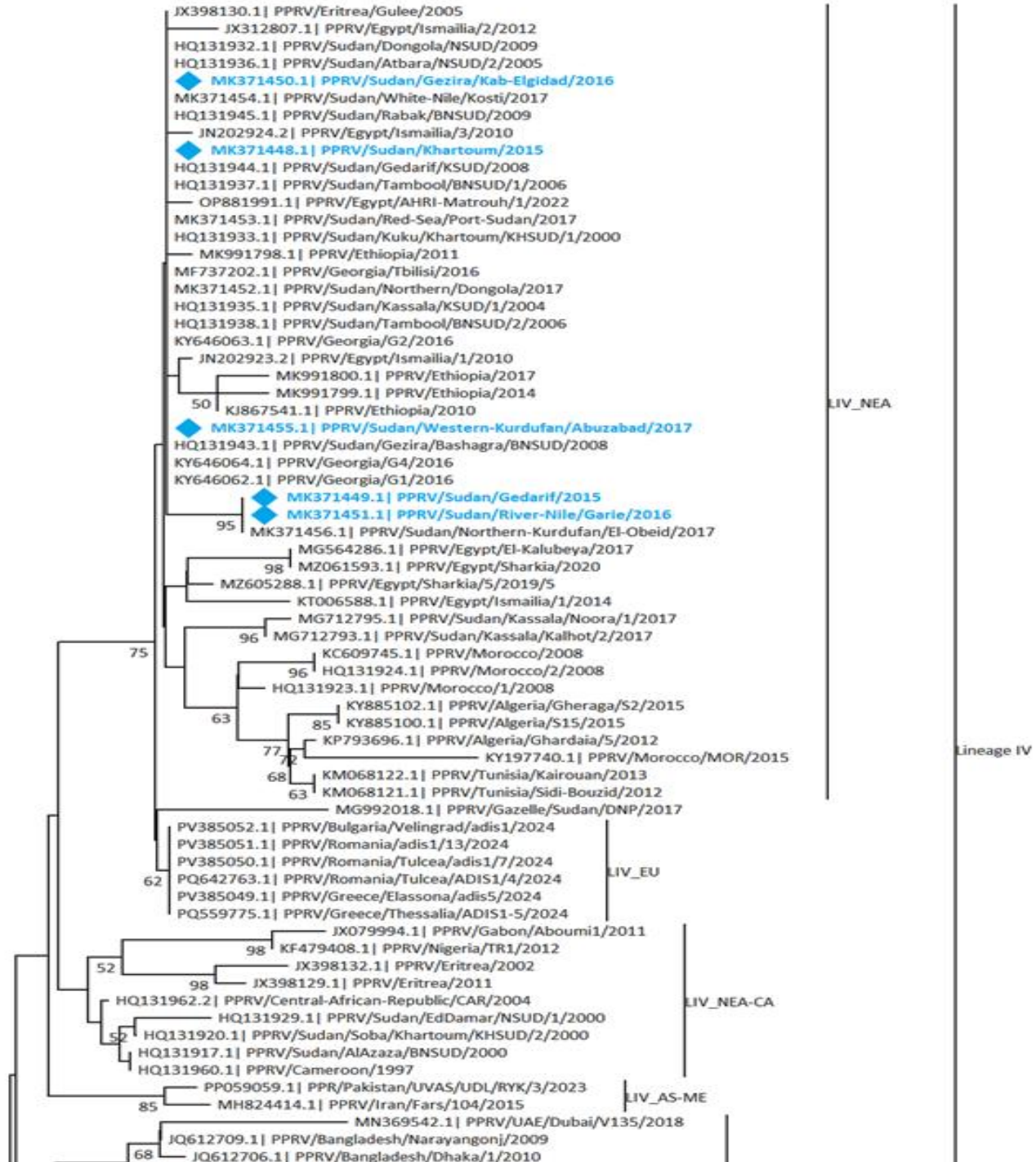
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Phylogenetic analysis of 2015 Algerian and Moroccan PPRV



Baazizi et al, 2017

Asil et al., 2026. Viruses: https://doi.org/10.3390/v18070765



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Animal movement correlates with PPRV lineage circulation



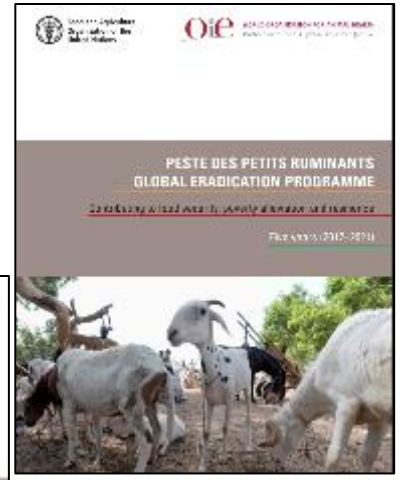
Baazizi et al, 2017

Modified figure from FAO web

Both Epidemiological (Animal movement data)
and
Molecular epidemiological (Phylogenetic analysis)
Data are needed to understand the Episystem
that may help to eradicate the disease

Shifting focus of PPR surveillance: from detection of cases to verifying absence

- **Surveillance objectives evolve:**
  Countries progress: control → elimination → freedom.
  Focus shifts: outbreak detection → demonstration of absence.
- **Risk-based surveillance:**
  Encouraged to ensure resources target subpopulations most likely to maintain or re-introduce infection.
- **Evidence for freedom:**
  must combine post-vaccination evaluation and ongoing passive and active surveillance.
- **Surveillance must include:**
  high-risk groups and zones, particularly along borders and in transboundary episystems.





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How the episystem approach can guide surveillance at different stages of the eradication pathway

Epidemiological setting	Main purpose of surveillance	Recommended approach	Role of the episystem
Infected areas	Guide control through timely detection and confirmation of outbreaks.	Emphasise clinical and participatory surveillance; **investigate suspected outbreaks quickly**.	Identify **maintenance episystems** where virus is likely to persist and target control and investigation there.
Vaccinated areas	Verify that vaccination has interrupted virus circulation and detect any residual infection	Combine **post-vaccination evaluation** with syndromic surveillance in non-vaccinated subpopulations.	Focus on episystems with **low immunity or high connectivity** to ensure effective coverage and detect possible residual foci.
Unvaccinated free areas	Provide assurance of freedom and early warning of reintroduction.	Rely on **passive surveillance and zero-reporting** by frontline actors; periodic checks in risk zones.	Monitor **border episystems** and cross-border movement links for early warning and evidence of vigilance.

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Vaccination in episystem

- Vaccination should be targeted to the interlinked reservoir communities
- Vaccination should be implemented simultaneously across all reservoir populations in the episystem
- Vaccination methods (targeted/Mass) should be appropriate to the community
- Goal of 100% coverage within one vaccination campaign to achieve 70% immunity
- Suboptimal vaccination coverage can favour persistent endemism
- Episystems, action plans and monitoring plans updated annually

- **Global Goal: Eradicate PPR by 2040 (FAO/WOAH Global Strategy) and African Continental Strategy.**
- **Eradication needs: surveillance and vaccination**
- **Episystem would have identified high-risk areas for vaccination**
- **The Challenge: As clinical incidence drops, the virus becomes harder to detect.**
- **The Solution: detection of antibodies becomes the critical tool to:**
  - Prove absence of virus circulation.
  - Measure population immunity (from vaccination or natural infection).
  - Guide vaccination campaign strategies.

Thank you for your attention