PENAPH

Participatory Epidemiology and the Use of Models to Design Control Strategies

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Participatory **Epidemiology**

The use of participatory rural appraisal techniques to collect epidemiological knowledge and intelligence

Participatory Rural Appraisal (PRA)

- Qualitative intelligence gathering process
- Key informants
- Problem solving
  - Multiple methods
  - Multiple perspectives
  - Triangulation
- Best-bet scenarios

Existing Veterinary Knowledge

- Traditional terms and case definitions
- Clinical presentation
- Pathology
- Vectors
- Reservoirs
- Epidemiologic features

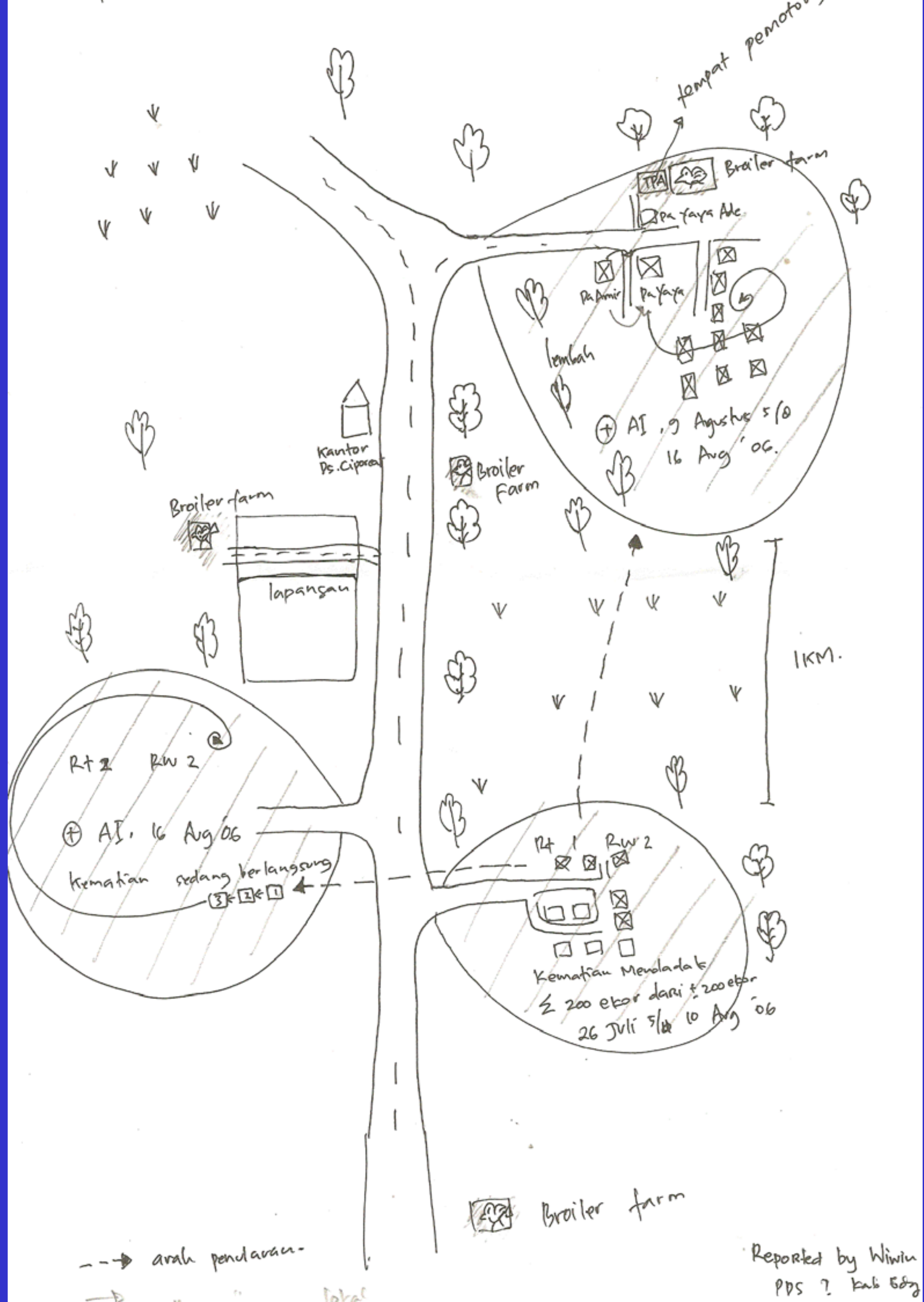
Photo: T. Leyland

Applications

- Basic Research
- Active Surveillance
  - Participatory Disease Surveillance (PDS)
- Holistic Needs Assessment
  - Stakeholders, livelihoods and risk
- Impact Assessment
  - Participatory Impact Assessment (PIA)
  - Qualitative and Quantitative
- Institutional change

Participatory Disease Surveillance PDS

- Active surveillance done by professionals
- Risk-targeted
- High detection rate
  - Information networks
  - Extended time frame
- Sensitive and Specific
  - Validation processes
  - Laboratory support
- Timely



tempat pemoto
TPA
Broiler farm
Pa Yaya Ade
Pa Amir
Pa Yaya
lembah
AI, 9 Agustus s/d 16 Aug '06.
Kantor
Broiler Farm
Broiler farm
lapangan
1KM.
Rt 2 RW 2
AI, 16 Aug 06
Kematian sedang berlangsung
3 2 1
Rt 1 RW 2
Kematian Mendadak
Σ 200 ekor dari ± 200 ekor
26 Juli s/d 10 Aug '06
Broiler farm
arah pendaran.
Reported by Wiwin

Attributes of PE/PDS Programs

- Flexible approach that allows for discovery
- Practitioners are problem-solvers and not enumerators
- Strength of the approach lies in its flexible and qualitative nature
- Orients and complements, but does not replace structured and quantitative methods
- Information from diverse sources and methods
- Analyzed in an iterative process referred to as triangulation
- Integrates biological testing and quantitative methods when appropriate to objectives

PENAPH

Participatory Epidemiology Network for Animal and Public Health

- **Nine core partners**
- **Building Surveillance Capacity**
- **Good Practice Guidelines**
- **Certification of Training**
- **Research, Policy and Advocacy**
- **Pro-Poor and One Health Focus**
- **Knowledge Exchange**

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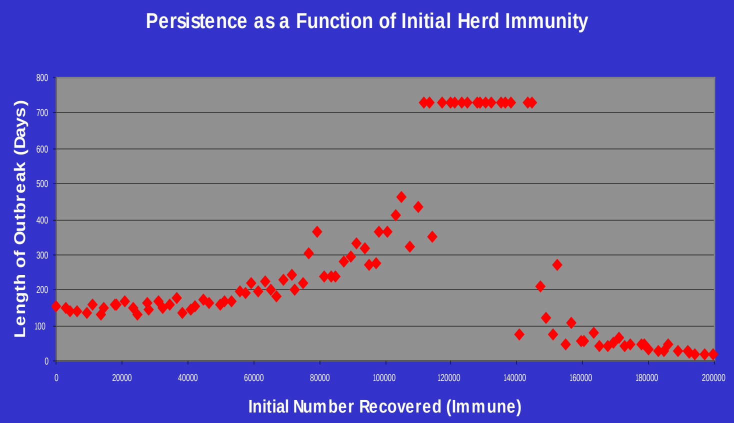
Appropriate Combinations of Complimentary Techniques

- Participatory methods
- Biological testing
- Analytical methods



Participatory Approaches to the Mathematical Modelling of Rinderpest and CBPP

PARC, PACE and CAPE

Modelling Objective

- Model agents and lineages as they occurred in pastoral areas of East Africa
- Involve stakeholders at all levels in design and address principal questions of pastoralists and policy-makers
  - More useful and creates a sense of ownership
- Inform policy dialogue leading to more effective strategies
  - Targeting interventions and surveillance

Data Collection

- Evidence-based literature review
- Participatory epidemiology – expert opinion
  - Mortality, prevalence, clinical course, spatial and temporal patterns and contact structure, estimation of R_0
  - SSI, proportional piling, matrix scoring, relative prevalence scoring, mapping and event trees
- Serology - Estimation of R_0

“Some of us believe we have rinderpest, but we are not really sure. The disease looks like rinderpest, but it doesn’t kill the animals. It is rinderpest-like or mild rinderpest.”

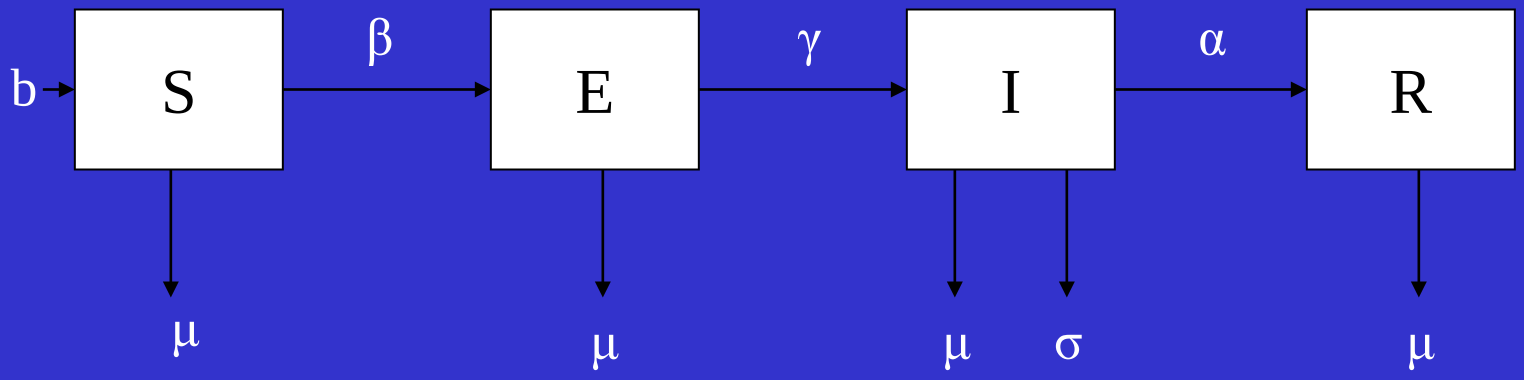
Somali elder on lineage 2 rinderpest

El Wak, Somalia 1996

Modelling Approach

- State-Transition
- Stochastic
  - Critical Community Size
  - Fade - Out
- Open Population
- @ Risk Software
- Input Parameters – Beta Pert Distributions
- Single population and multipopulation
- Outputs – Probability Distributions

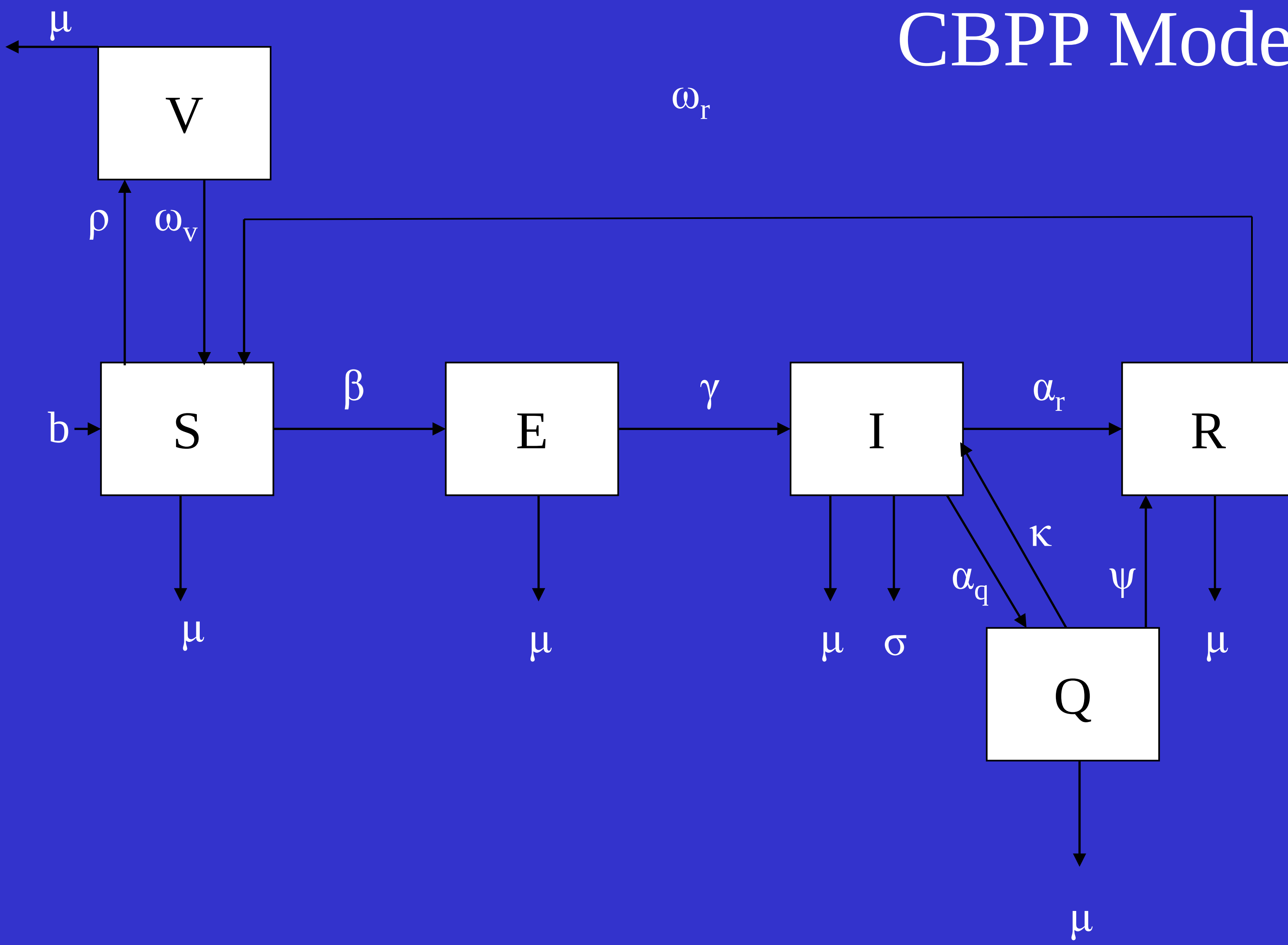
RP Model Structure



S = Susceptible
E = Exposed
I = Infectious
R = Resistant

α = recovery rate
b = birth rate
β = effective contact rate
γ = latency to infectious rate
μ = non-specific mortality rate
σ = RP mortality rate

CBPP Model



The Basic Reproductive Number R_o

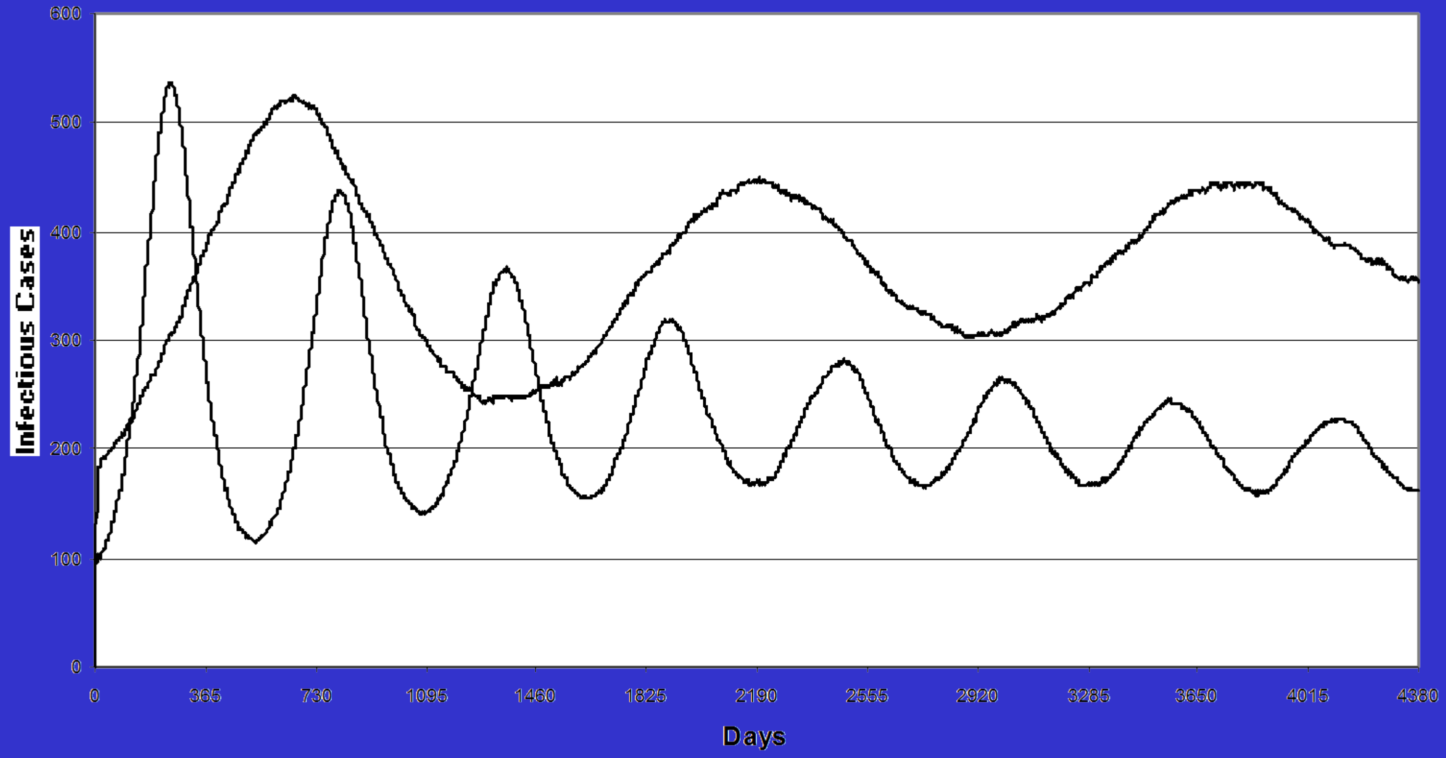
- Number of secondary cases resulting from one infected animal in susceptible population
- R_o is a feature of both the *strain* of infectious agent and the host population

The Importance of R_0

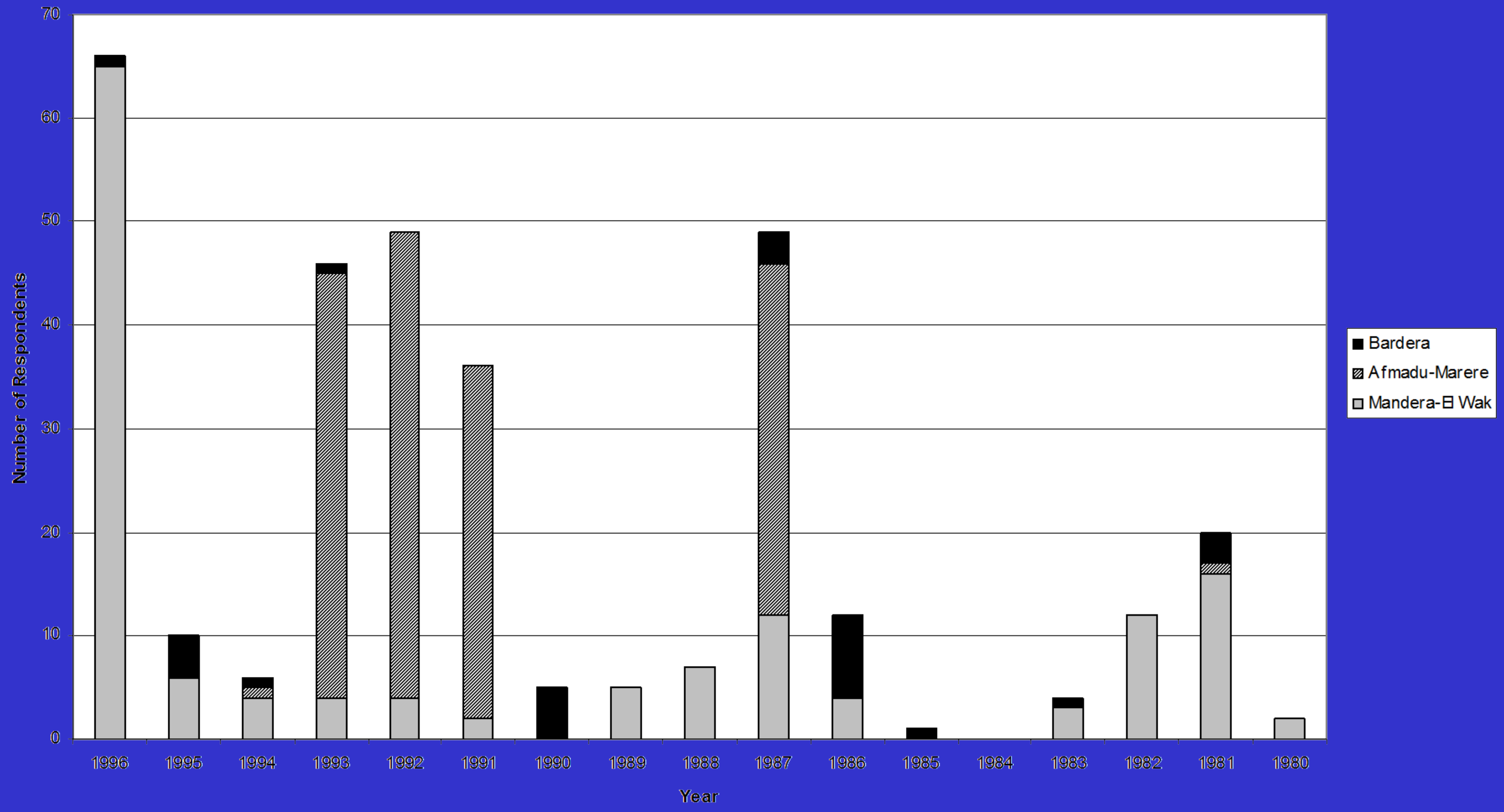
- A measure of the transmission rate
- Can be easily estimated from field data
  - RP - Herd immunity threshold ($1-1/R_0$)
  - CBPP - Average of first infection
  - HPAI – Final fraction size
- Effective contact rate, β, can be calculated from R nought.
- Herd immunity targets

Inter-Epidemic Period

Rinderpest in Sudan and Somalia



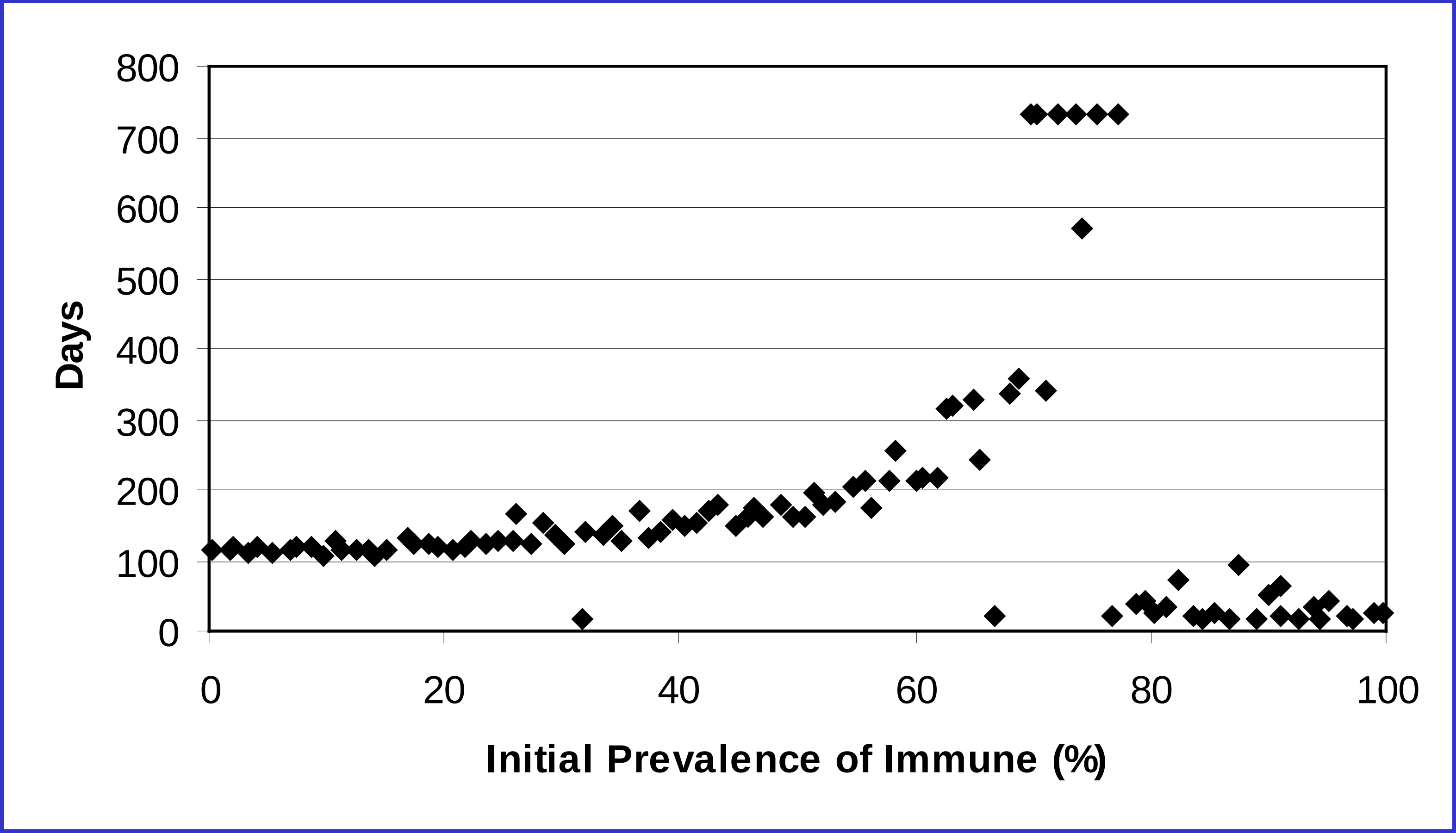
Temporal distribution of reports on rinderpest compatible events by year and interview area



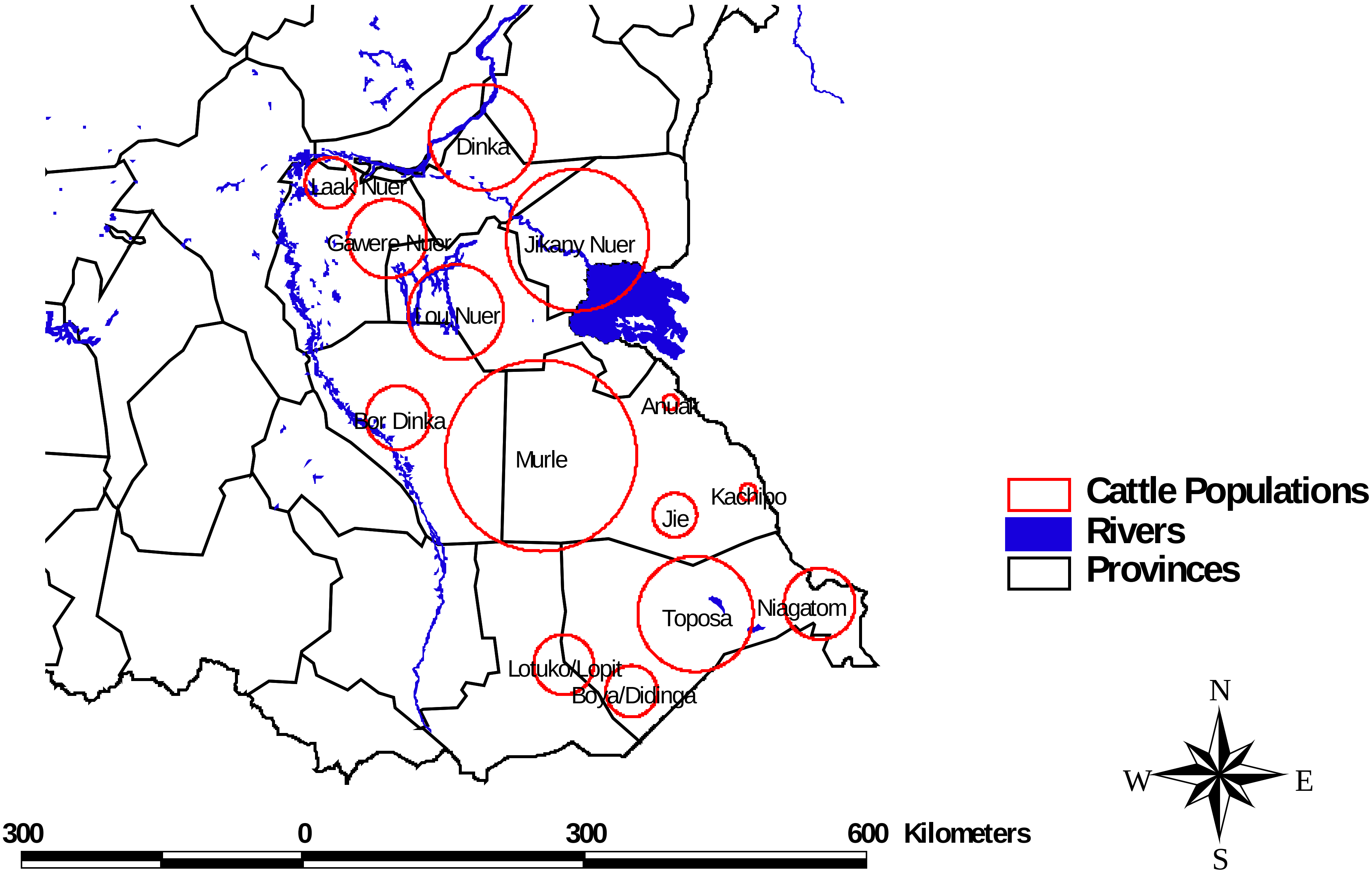
So What?

- Prevalence of Infection
  - 0.1 – 0.2 %
  - Random clinical surveillance to OIE standards (1%) not useful
  - Participatory disease surveillance
- Critical Community Size
  - ~200,000 head
  - Target vaccination to high risk populations
  - Large, remote pastoral communities
- Lineage 2 in Somalia
  - Modest herd immunity levels could eradicate

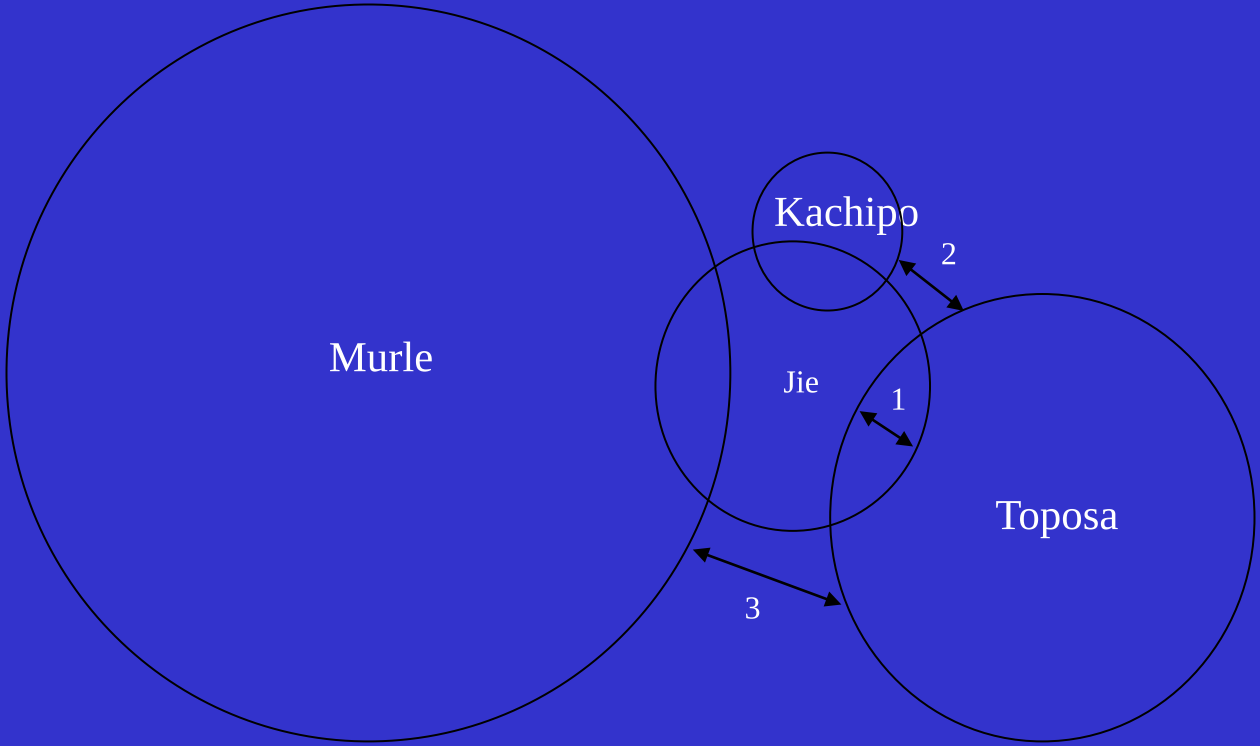
Disease Persistence as a Function of the Initial Prevalence of Immunity



East Nile Cattle Populations



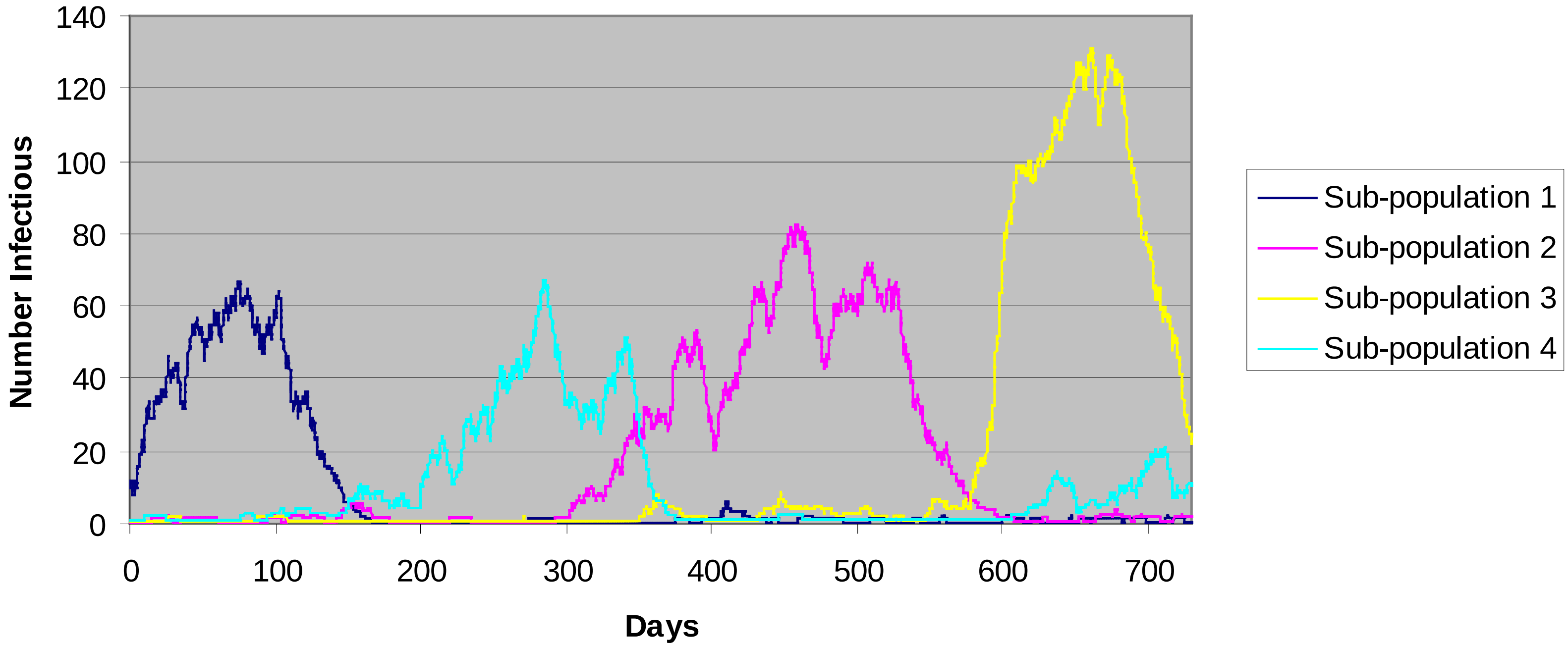
Traditional Livestock Exchange



Heterogeneous RP Model for lineage 2 in the Somali Ecosystem

- Four populations
- Multiple species
  - Parameter values can set independently
- Eight year duration
- Cattle and buffaloes
- Buffalo $R_0 \sim 8$

Four Sub-Population Epidemic Curves from a Heterogeneous Population Model for Rinderpest in Cattle Where the Between Population Contact Rate is 1% of the Within Population Contact Rate



Results Over 2 Years

- Mean mortality 0.85% per year
- 34% of iterations ended with a prevalence of infection of 0.1 to 1%
- Maximum prevalence 2%
- Final average immunity 26%

Eight Year Model
$\eta = 0.005$ and R = 35%

	Duration			
	Mean	95^{th} %	Max	Persistence (%)
10,000	137	323	603	0
20,000	227	532	1100	0
30,000	329	878	1571	0
40,000	408	948	1915	0
50,000	477	1418	2633	0
100,000	1031	2553	2920	3

The Role of Buffaloes

Buffaloes % Immune	Cattle - Day of Last Case	Overall – Day of Last Case
5-15	245	247
15-25	264	269
25-35	261	266
45-55	258	265
55-65	253	260

Somali Ecosystem

- Buffalo act as an indicator host and do not contribute to persistence in cattle
  - Explosive outbreaks of short duration
- Small isolated communities can maintain Lineage 2 for prolonged periods
- Intensive surveillance and time

Potential of a Combined Vaccination and Treatment Strategy for CBPP

Scenario	Baseline 1/α		75% 1/α		50% 1/α	
None	75.4	178	59.6	129	33.2	64
Annual – 5 yr	67.8	130	43.0	79	7.6	24
Biannual – 2 yr	57.2	129	-	-	4.4	20
Biannual – 5 yr	35.2	83	8.0	43	0.4	16

Indications from the CBPP Modelling

- Eradication not possible with existing vaccine without severe movement control
- The potential impact of treatment is at least great as available vaccines
  - Private sector and consumer driven application
- Research on treatment regimes merits the same level of attention and investment as vaccine development.

Conclusion

- Simple, intuitive models serve as good communications tools for underlying concepts
- Bring diverse information together to be tested as for biological coherence
- Choose between strategy options or identify new options
- Involve beneficiaries and decision-makers from the outset.