Towards the development of optimal vaccination strategies for Rift Valley fever (RVF) in East Africa

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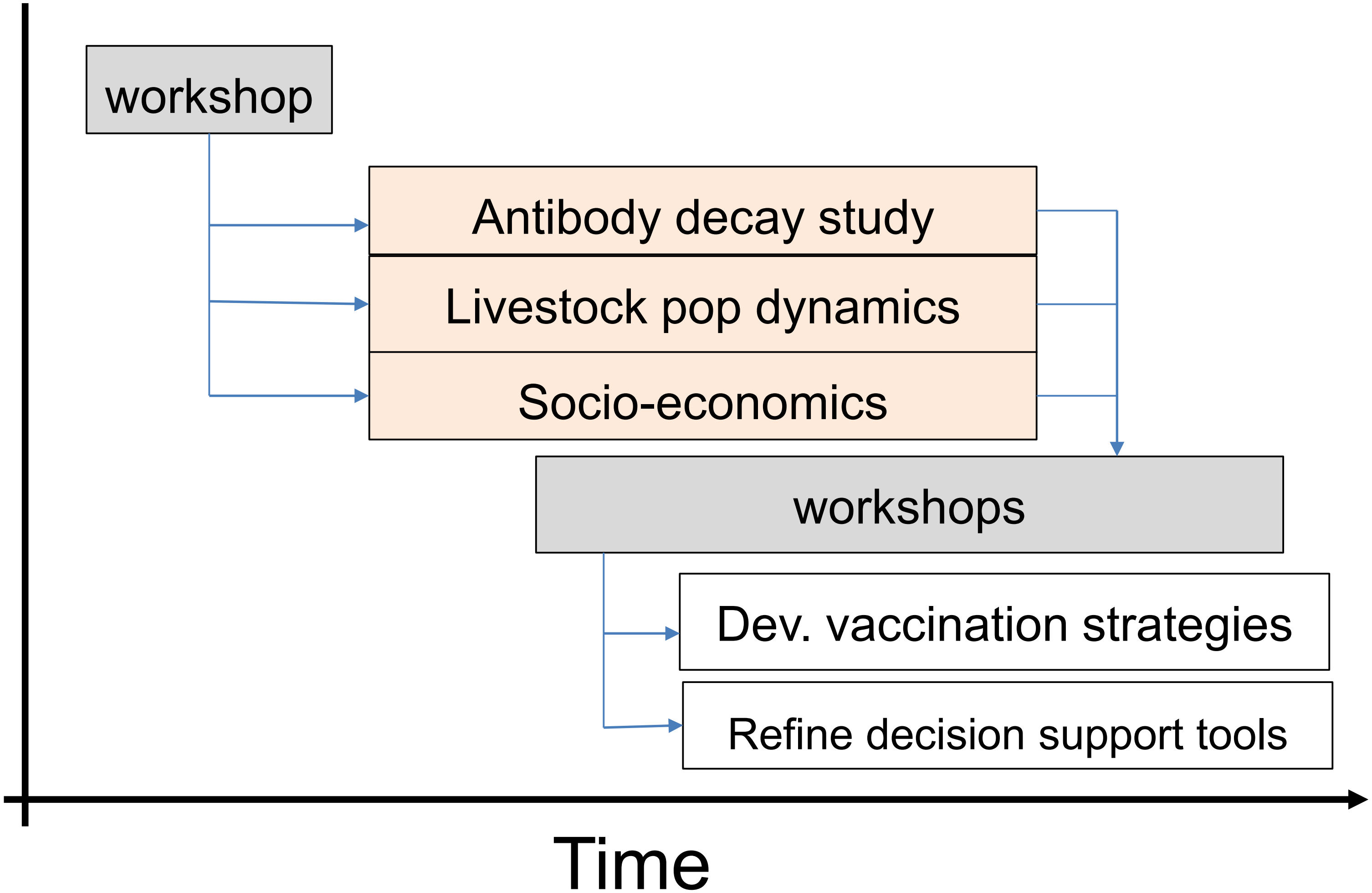
RVF vaccination – gaps

- New vaccines being developed – not much attention on vaccination strategies
- Current strategy – reactive vaccination which often fails to achieve required coverage
- RVF vaccines often delivered through state financing – can value chain actors cost share? Are they willing to pay? What influences acceptance?
- One Health dimension – economic benefits of vaccination in livestock?

Activities and their schedules timing



Stakeholder consultations – regional workshop

WORKSHOP ON DEVELOPING VACCINATION STRATEGIES FOR RIFT VALLEY FEVER IN EAST AFRICA - 4-5 OCTOBER, 2017 – NAIVASHA COUNTRY CLUB, NAIVASHA, KENYA

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Objectives

- Review RVF status in East African region
- Design RVF vaccination strategies in livestock
- Identify institutional arrangements, capacities and networks required for their implementation

Workshop recommendations: vaccination strategies

(i) Routine vaccination in high risk areas (annual*)*

- This should be based on RVF risk map. However, Uganda – no formal risk map
- This should target all animals of all ages
- Subsequent vaccinations should target animals not vaccinated -- animal identification is an issue to follow up

(ii) Vaccination ahead of predicted outbreak (During alert/ Emergency)

- Issues to consider:
    - procurement of vaccines,
    - sensitivity and accuracy of predictions,
    - resources are and how to mobilize them on short notice

(iii) Intermittent multiyear vaccination

- Once every 3 years in high risk areas
- Vaccinate yearlings once every 3 years and maintain a some level of herd immunity because vaccination is a very costly exercise

(iv) Use of multivalent vaccines

- For each of the above strategies, analyse costs and logistics of using multivalent vaccines

Longitudinal study involving vaccinated livestock

Objectives

- To determine the longevity of anti-RVF virus response in cattle, sheep, goats and camels
- To determine the effect of livestock population turn-over on herd immunity against RVF in cattle, sheep, goats and camels
- To collect demographic and socio-economic data that can be used to estimate parameters for modelling livestock population dynamics in a pastoral production system

What do we know about longevity of RVF response?

Daouam et al. BMC Veterinary Research (2016) 12:154
DOI 10.1186/s12917-016-0775-8

BMC Veterinary Research

RESEARCH ARTICLE Open Access

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Safety and immunogenecity of a live attenuated Rift Valley fe
in camels

S. Daouam[1,2*], F. Ghzal[1], Y. Naouli[1], K. O. Tadlaoui[1], M.

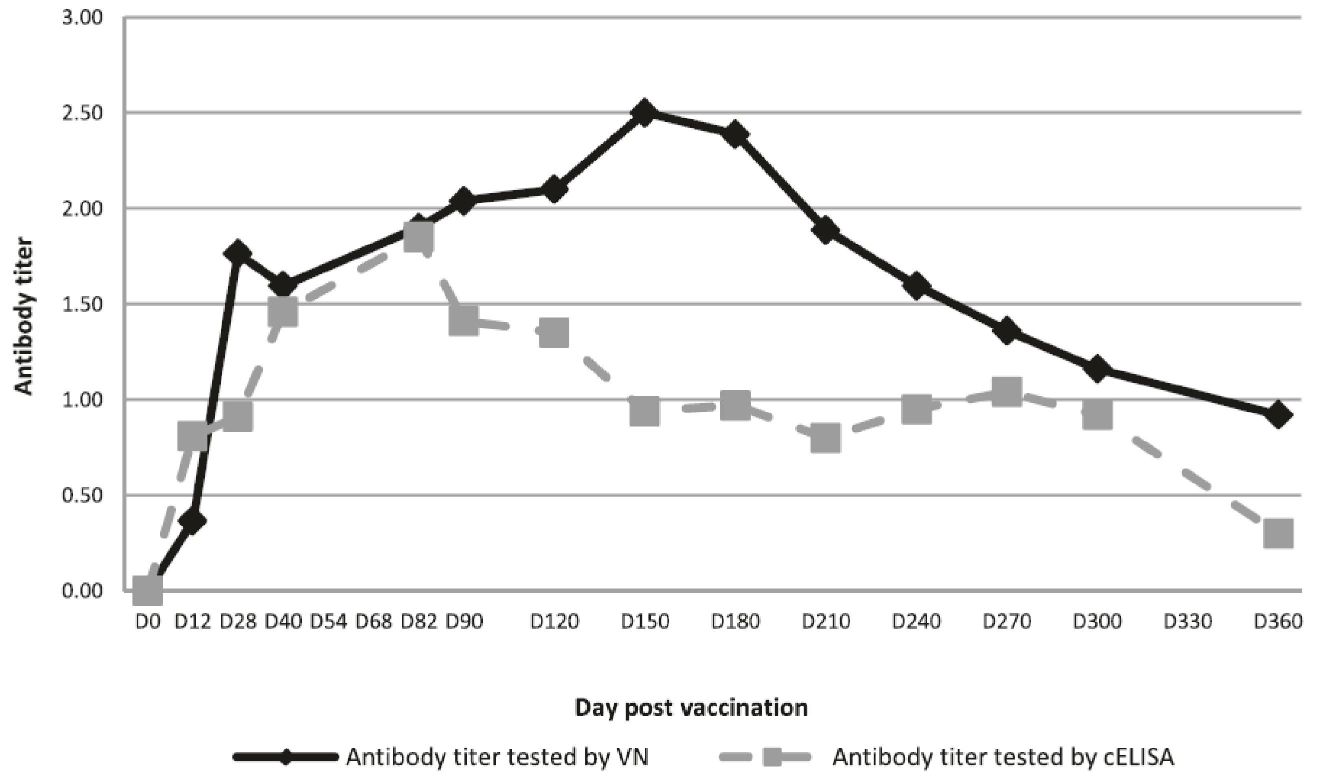

Fig. 2 Antibody titres of camels vaccinated with a live CL13T RVF vaccine tested by VN and cELISA. Neutralizing antibody were tested in all vaccinated camels by VN and cELISA test, a significant differences ($p < 0.05$) in antibody titers were observed

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Vaccination study – Sampling design

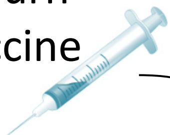
- Two sampling designs:
  - Longitudinal study using 30 cattle, 30 sheep/goats and 30 camels
  - Repeated cross sectional sampling of 22 herds from which these animals come from

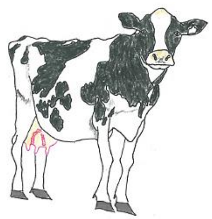
- Sample size considerations
  - 75% of the animals develop neutralizing Abs following vaccination and about 50% retain protective levels after 1 year
  - One sample comparison of proportions
  - Clustering in herds, assume correlation coefficient of 0.04
  - Level of confidence 95% and a power of 80%

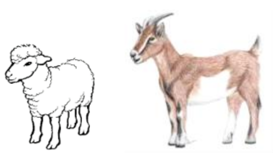
- Vaccinate all the animals with Smithburn vaccine at day 0

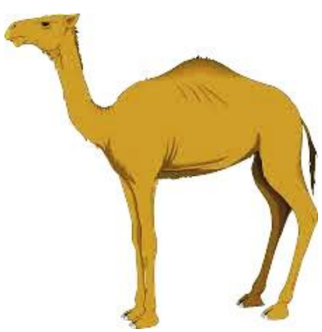
Work Plan / Study Design

Smithburn RVF vaccine



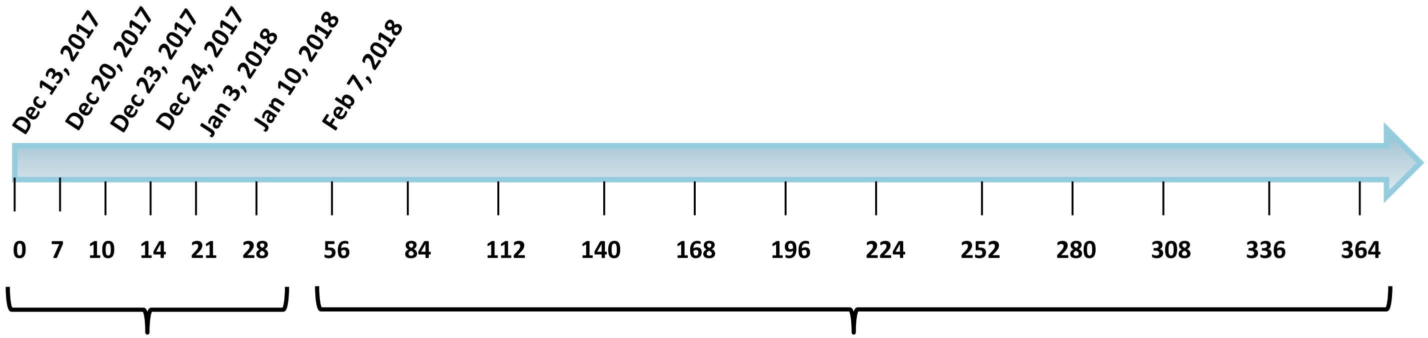






N = 30

Time plan [days]



- ❑ Serum
- ❑ White blood cells in RNAlater

- ❑ Serum

- Collect WBC at early time-points for transcriptomics
- Collect sera at all time-points
  - cELISA
  - VNT

Vaccination study – Data collection

- Baseline sampling – all animals
- Vaccination with Smithburn – all animals
- Sampling – longitudinal
- Population changes – entries and exits
- Drug use

Modelling

Modelling tool is available

PLOS | NEGLECTED TROPICAL DISEASES

RESEARCH ARTICLE

Modelling Vaccination Strategies against Rift Valley Fever in Livestock in Kenya

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Abstract

Model structure – explicit livestock, mosquitoes and rainfall dynamics

Improve and expand models – epi and econ

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Modelling

Impacts – vaccination coverages vs time to outbreak

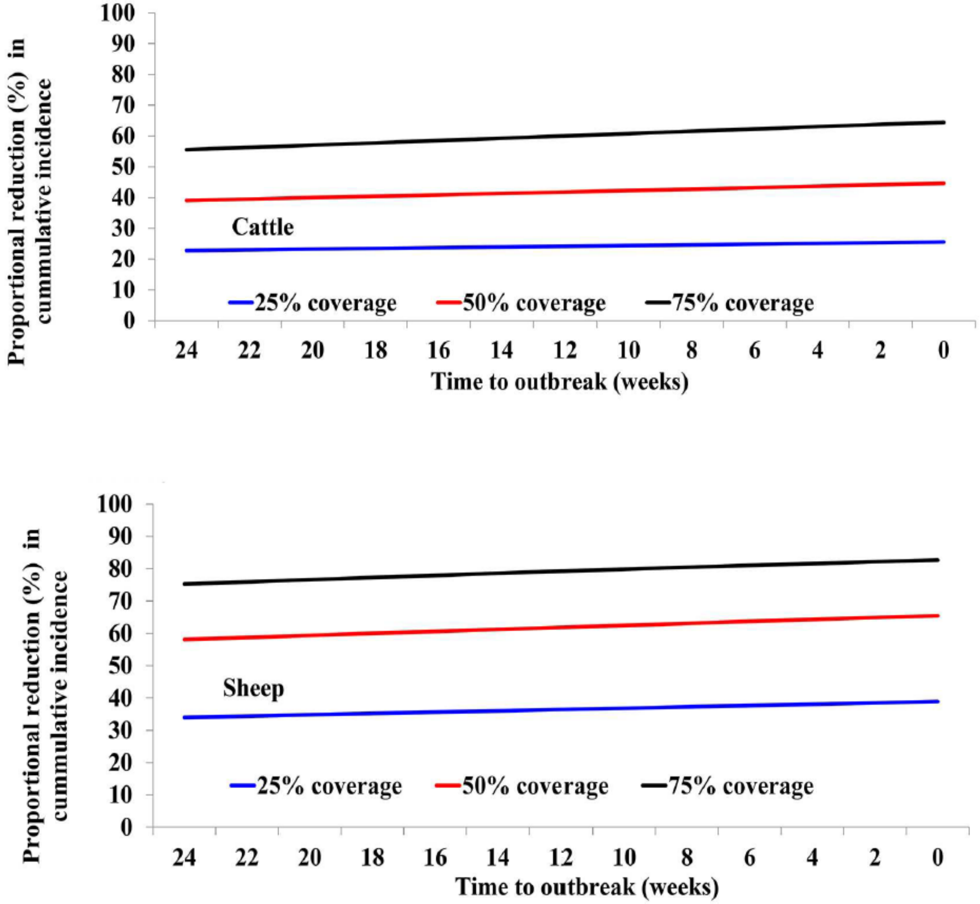

Fig 4. Estimated proportion of cases averted for different vaccination coverages and at different times to the outbreak in cattle (top panel) and sheep (bottom panel).

Impacts a function of coverage, time to outbreak and perhaps the host spp ecology

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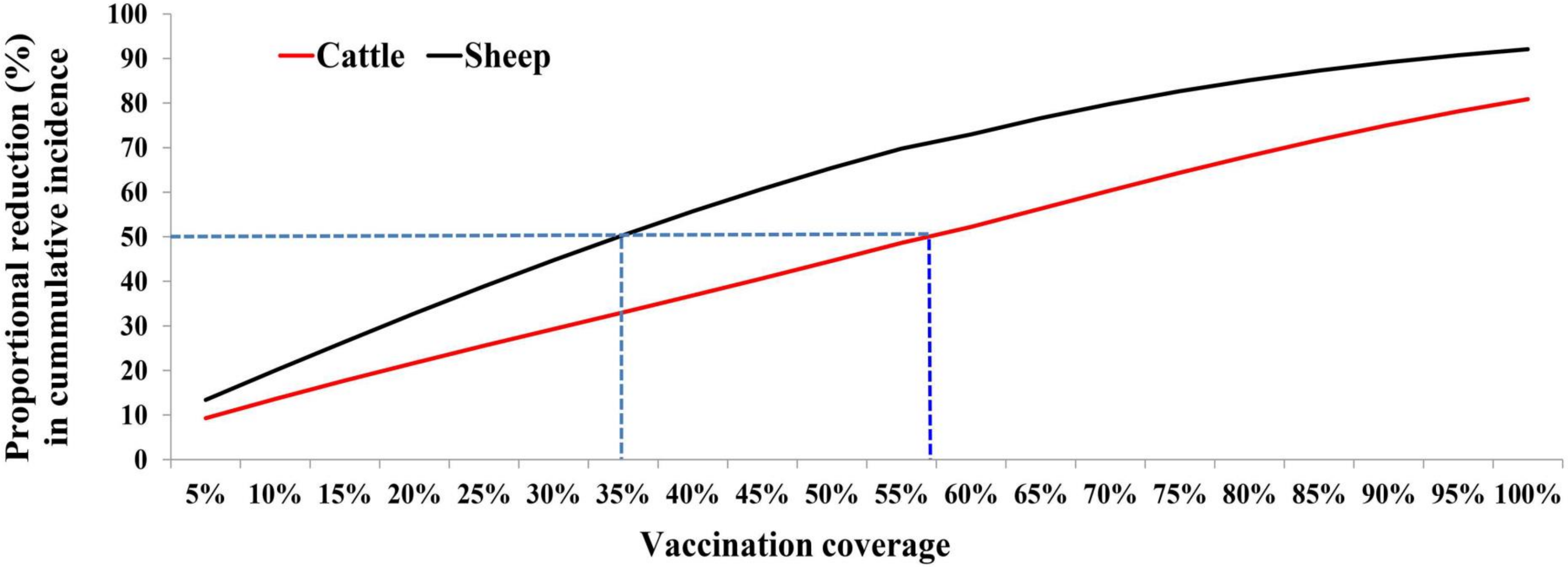
Modelling

Impacts – vaccination coverages at outbreak onset



Modelling

Impacts – biannual and annual vaccination strategies

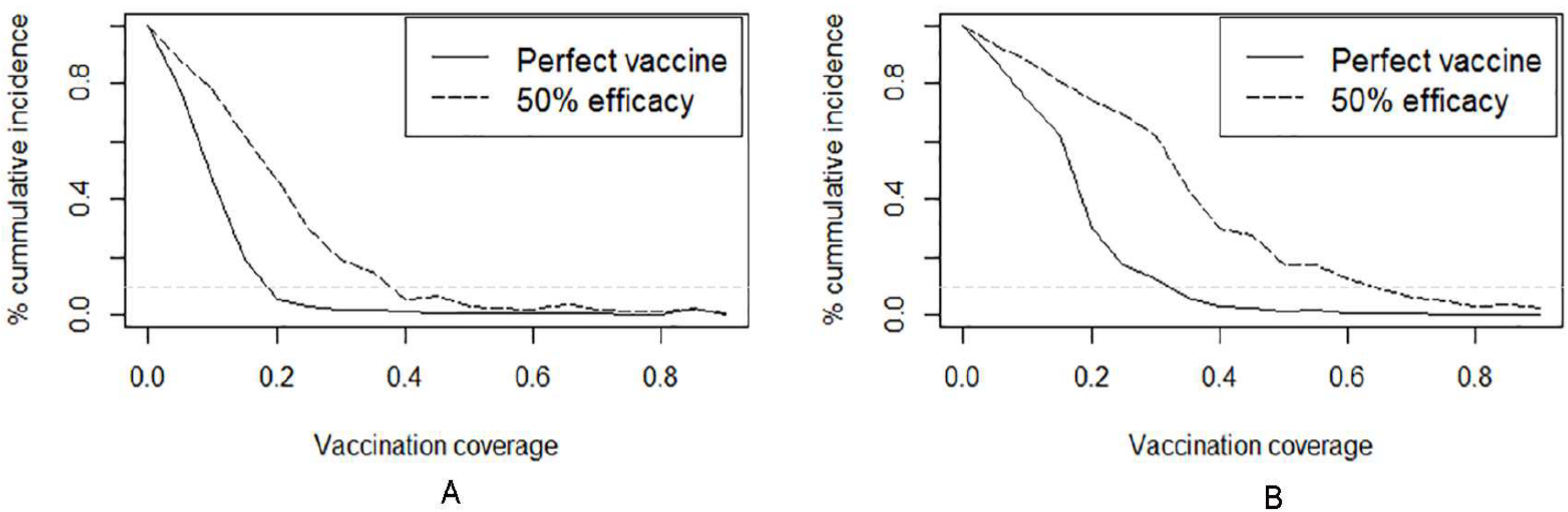
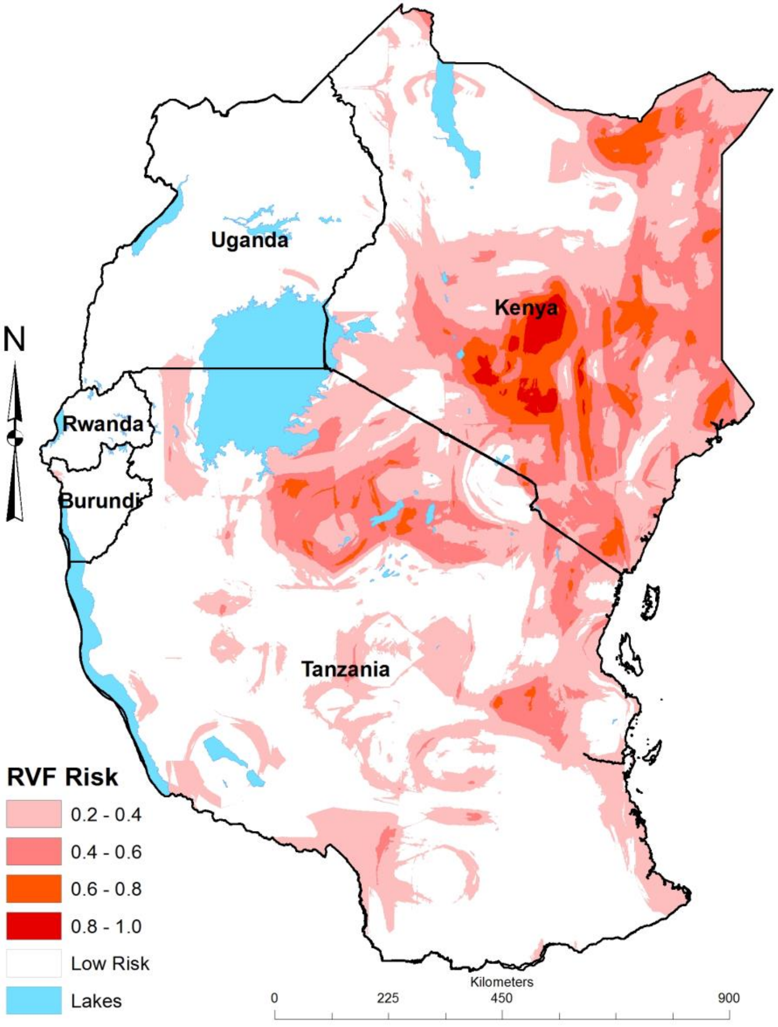


Fig 6. Expected impacts of biannual (Panel A) and annual (Panel B) periodic vaccination scenarios on the cumulative incidence of RVFV using a perfect vaccine and a vaccine with 50% efficacy.

Quantifying vaccine doses by strategy

- Decision support framework
  - Quantifying vaccine quantities
  - Coordination of campaigns

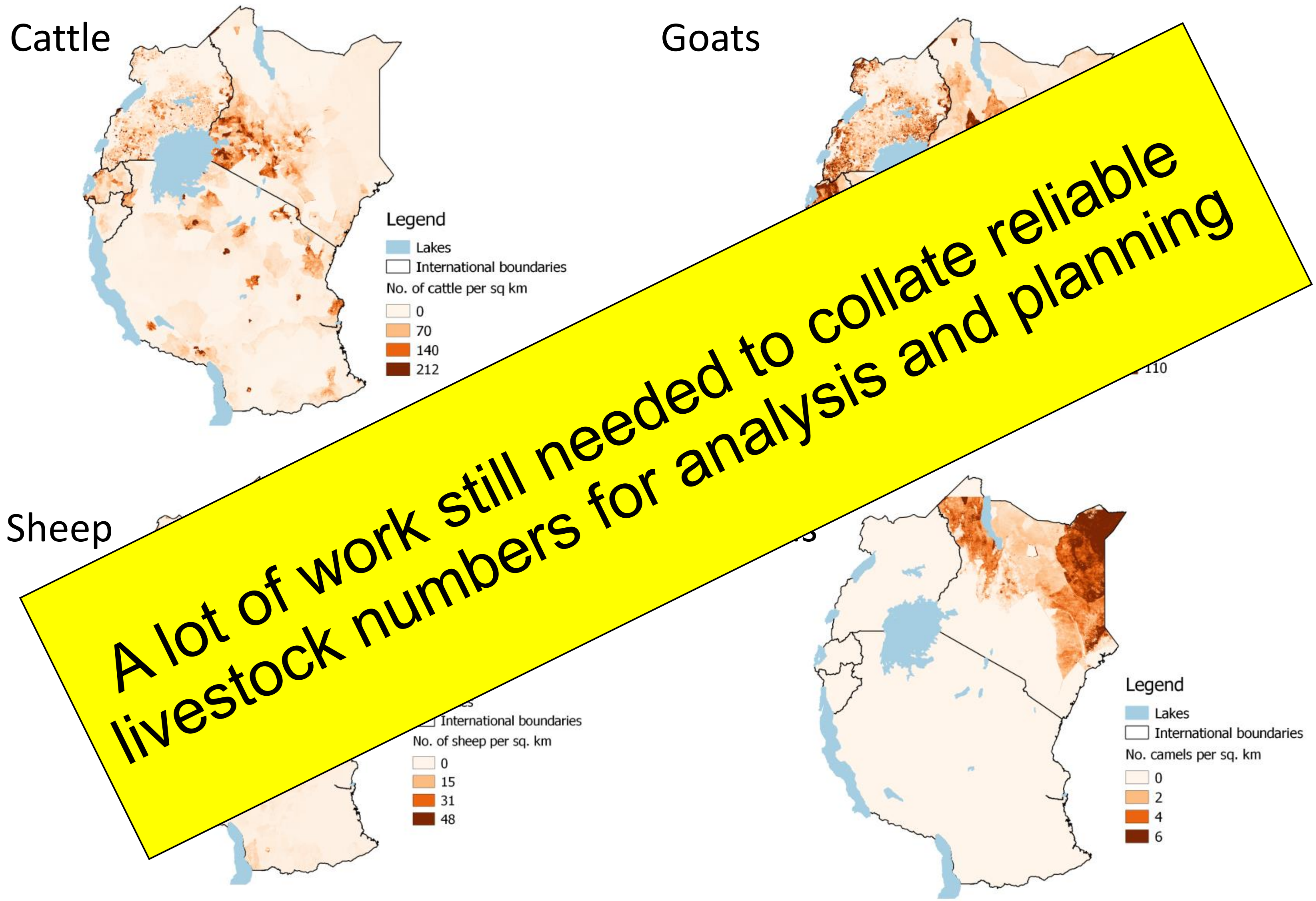
- Risk maps
  - Impacts:
    - 33% of East Africans (51.5 out of 155 million in high risk areas)



Rift Valley fever risk map

Distribution of the target livestock species

Robinson TP, et al. Mapping the global distribution of livestock. PLoS One. 2014;9. doi:10.1371/journal.pone.0096084



Crude estimates of livestock numbers by risk

Crude numbers of livestock species by risk level that can be used to guide Estimation of the number of RVF vaccine doses in East Africa

Risk	Cattle		Goats		Sheep		Camels	
	n	%	n	%	n	%	n	%
High risk (≥60%)	2,153,761	5	1,940,620	5	1,309,529	7	248,529	20
Moderate risk (≥30-60%)	11,500,000	26	8,705,384	21	5,138,936	28	477,426	39
Low risk (<30%)	31,300,000	70	31,300,000	75	12,000,000	65	505,585	41
	44,953,761		41,946,004		18,448,465		1,231,540	

Potential sources of bias:

- RVF risk is underestimated in Uganda

  efforts to develop the risk map in Uganda on-going

- Livestock estimates for Tanzania generally poor

  Project will convene Workshops to obtain more accurate livestock numbers

Acknowledgements

- Range of stakeholders including those involved in designing the studies during the inaugural workshop

- Pastoralists participating in the longitudinal study in Isiolo, Kenya

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