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Evidence-based options for foot-and-mouth disease management in Tanzania

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The Boyd Orr Centre for Population and Ecosystem Health, University of Glasgow, UK

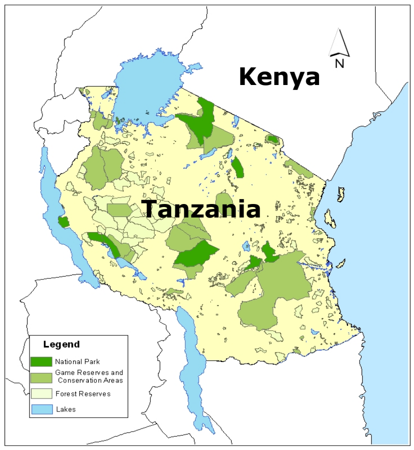
The Queen's Anniversary Prizes For Higher and Further Education 2013

VIA VERITAS VITA

University of Glasgow, UK
The Pirbright Institute, UK
University of Edinburgh, UK
Onderstepoort Veterinary Institute, SA
Directorate Veterinary Services, Tanzania
Tanzania Veterinary Laboratory Agency, Tanzania
Zonal Veterinary Investigation Centres (Arusha & Mwanza), Tanzania
Tanzania Wildlife Research Institute
Tanzania National Parks
Ngorongoro Conservation Area Authority, Tanzania
Sokoine University of Agriculture, Tanzania
Washington State University, USA
Department of Agriculture, Food and Marine, Ireland
Merck Animal Health/Intervet

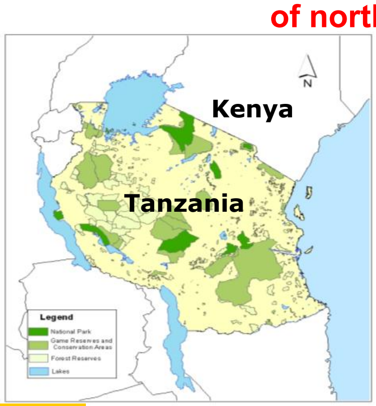
Miriam Casey, formerly University of Glasgow, currently Department of Agriculture, Food and Marine (Ireland)

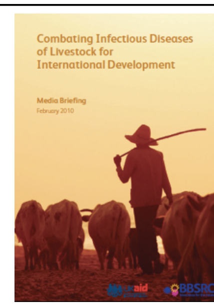
Network of wildlife protected areas in Tanzania



- Network of wildlife protected areas covering 28% of the total land surface area
- National parks (15), conservation areas (1), game reserves (33) and game controlled areas (43)
- Lack of physical barriers, multiple land-use initiatives

FMD studies in interface areas of northern Tanzania

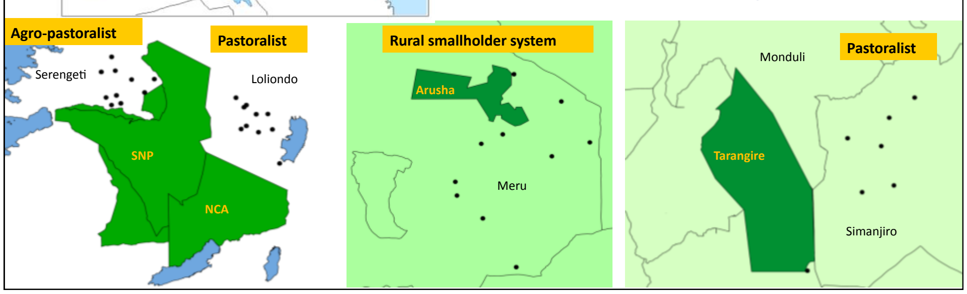




BBSRC bioscience for the future

DFID Department for International Development

The Scottish Government



FMD impacts in these communities

- Ranked amongst the most important livestock diseases
- Lactating cattle especially affected
- Significantly lower milk yield…
- …with implications for consumption and sales
- Loss of traction capacity

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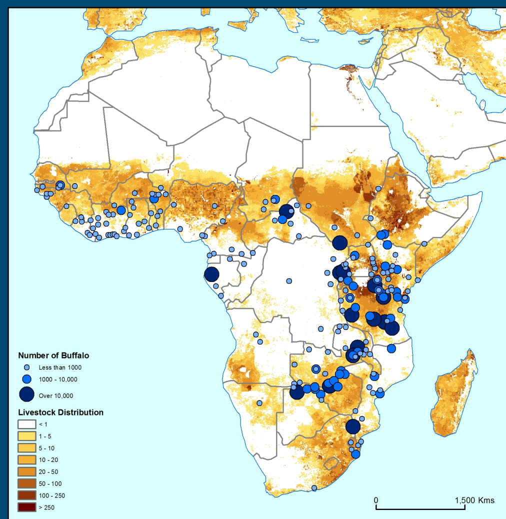
FMD epidemiology

Relative importance of livestock- and wildlife-related factors in maintenance and transmission?

How much cattle infection is associated with spill-over from wildlife?

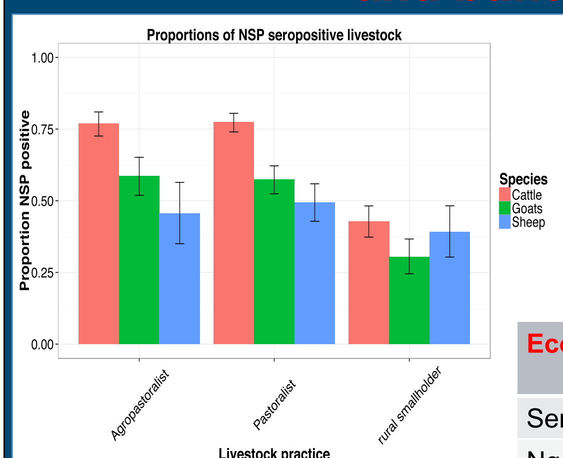
Highest buffalo population in Africa occurs in Tanzania



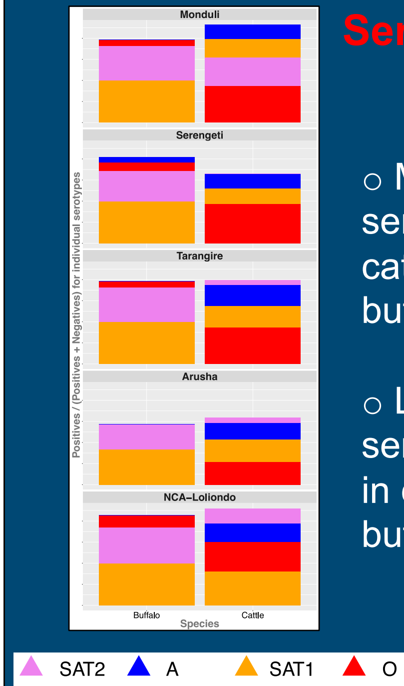
Buffalo – East 1999
Cattle – Robinson et al. 2007

Tanzania buffalo > 342,400 in 1998

Sero-prevalences in livestock and buffalo

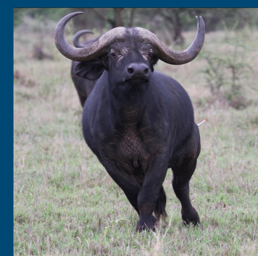


Ecosystem	Buffalo seroprevalence
Serengeti	75.0% (57.8-87.9)
Ngorongoro	86.2% (78.6-91.9)
Tarangire	95.8% (78.9-99.9)
Arusha	47.8% (26.8-69.4)



Serotype-specific patterns in livestock and buffalo

- Most prevalent serotypes - O in cattle and SAT1 in buffalo
- Least prevalent serotypes - SAT2 in cattle and A in buffalo



Significant risk factors

	LRT Chi squared	Probability < Chi squared	Coefficient (95% CI)	Odds Ratio (95% CI)
Age (per extra year)	219.6	<10^-6	0.4 (0.3-0.4)	1.4 (1.4-1.5)
Species	144.9	<10^-16		
Cattle compared to small ruminants			1.2 (1-1.4)	3.3 (2.7-4)
Livestock practice	17.1	0.0002		
Agropastoral compared to smallholder			2.1 (1-3.2)	8.1 (2.8-23.6)
Pastoral compared to smallholder			2 (1.1-2.9)	7.1 (2.9-17.6)

N
85 herds
1,410 cattle
877 goats
451 sheep

	LRT Chi squared	**Probability < Chi squared**	**Coefficient (95% CI)**	**Odds Ratio (95% CI)**
Cattle in herd (per extra bovine)	12.9	<10^-3	0.02 (0-0.03)	1.02 (1-1.03)
New animals acquired in risk period (yes versus no)	4.6	0.03	1.72 (0.01-3.431)	5.57 (1.01-30.91)

N
69 herds
- 36 cases
- 33 controls

Non-significant variables

	LRT Chi squared	Probability < Chi square	Coefficient (95% CI)	Odds Ratio (95% CI)
Log (total cattle)	2.76	0.1	0.3 (0-0.6)	1.3 (1-1.8)
Log (maximum minutes walked to reach grazing and water)	2.37	0.12	0.1 (0-0.3)	1.1 (1-1.3)
Buffalo sighting weekly or more often	1.32	0.3	-0.4 (-1-0.3)	0.7 (0.4-1.4)
Log (distance to buffalo area)	0.09	0.75	0 (-0.3-0.2)	1(0.7-1.3)
Acquired livestock in the past four months (Y or N)	0.6	0.44	0.2 (-0.3-0.8)	1.2 (0.7-2.1)

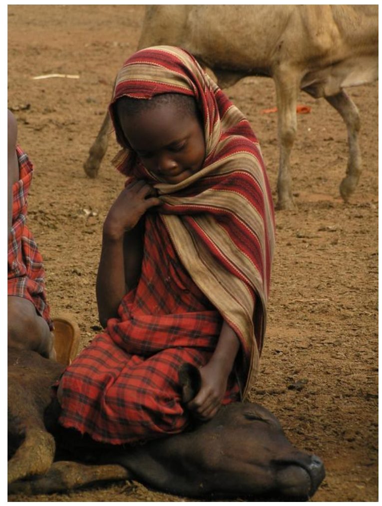
	LRT Chi squared	Probability < Chi square	Coefficient (95% CI)	Odds Ratio (95% CI)
Buffalo sighting weekly or more often	1.26	0.26	0.8 (-0.635-2.227)	2.22 (0.53-9.27)
Grazing or watering area different to usual	1.03	0.31	-0.62 (-1.833-0.582)	0.54 (0.16-1.79)
Measure of livestock contacts during grazing and watering	1.3	0.26	0.04 (-0.03-0.122)	1.05 (0.97-1.13)
Measure of livestock contacts during dipping	0.19	0.66	-0.08 (-0.431-0.278)	0.92 (0.65-1.32)
Visitors in past month	0.03	0.87	0.11 (-1.204-1.418)	1.12 (0.3-4.13)

Vaccine-based control strategies

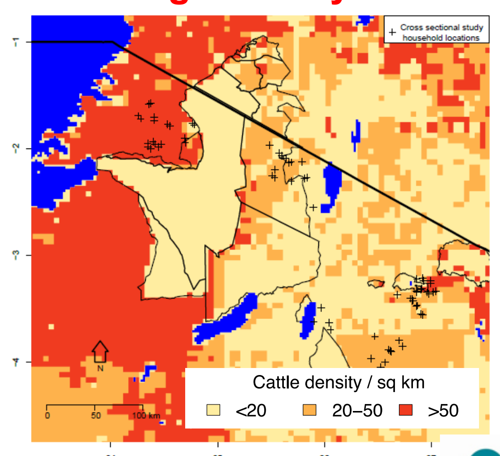
- Vaccination provides a potential solution for controlling disease in these communties and…
- …would be culturally and politically acceptable

But constraints still exist

- Limited capacity locally for field surveillance and serotype-specific diagnostics
- Limited data on circulating strains for vaccine selection:
    - » High diversity of viruses and little cross-protection
- Insufficient understanding of temporal and spatial patterns of virus circulation to devise strategies for vaccine delivery
- Lack of effective polyvalent vaccines against such a large range of serotypes



More intensive studies in the Serengeti ecosystem



BILL & MELINDA GATES foundation

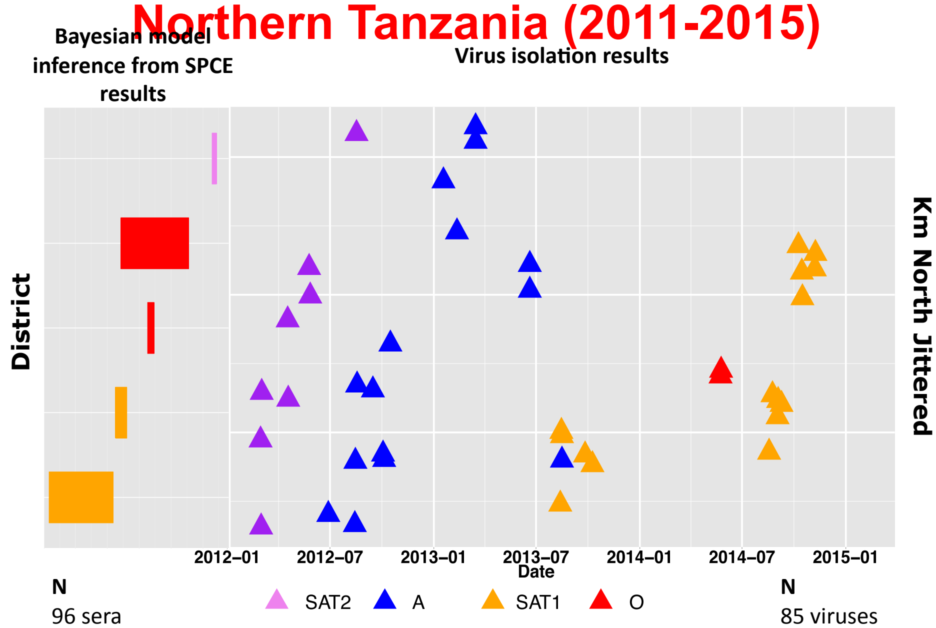
AfricanBioServices

MSD Animal Health

SULSA

Scottish Universities Life Sciences Alliance

Northern Tanzania (2011-2015)



N
96 sera
60 herds
36 villages

N
85 viruses
37 herds
23 villages

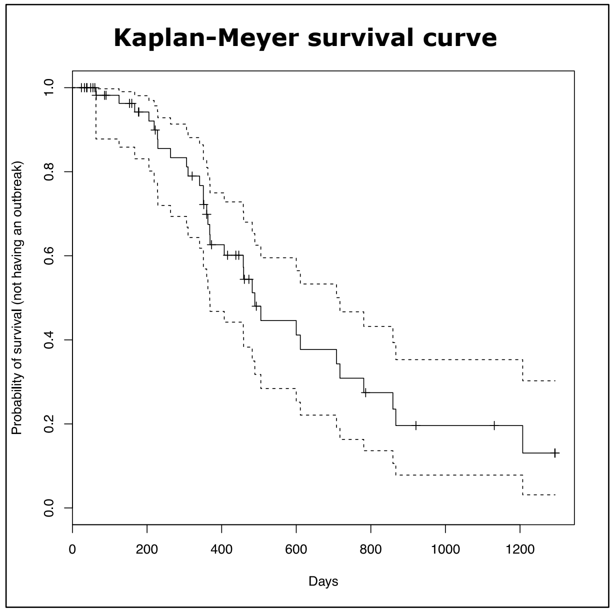
Northwards direction in Serengeti

Days since first outbreak ~Km north

	Dependent variable		
	Days (SAT2)	Days (A)	Days (SAT1)
Km North	6.553***	7.581***	23.541***
(SE)	(1.211)	(1.965)	(3.139)
Constant	-21.923	71.688**	95.283***
(SE)	(16.104)	(32.063)	(33.398)
Observations	13	23	40
R^2	0.727	0.415	0.597
Adjusted R^2	0.702	0.387	0.586
Residual Std Error	26.912 (df = 11)	92.151 (df = 21)	108.237 (df = 38)
F Statistic	29.290*** (df = 1; 11)	14.879*** (df = 1; 21)	56.259*** (df = 1; 38)
			*p<0.1; **p<0.05; ***p<0.01

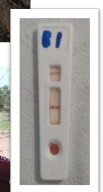
Frequency of outbreaks

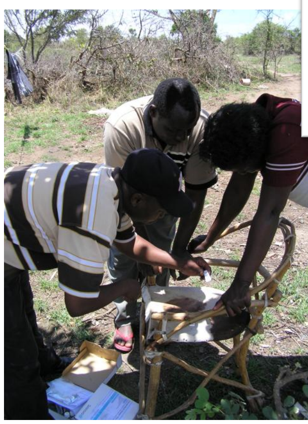
- Median time between outbreaks - **489 days** (IQR: 351-859 days) in 34 longitudinally tracked herds
- Four herds tracked through 4 outbreaks over < 3 years
- Sequential outbreaks caused by **different serotypes**



What does this mean in terms of FMD control and further research needs?

- Temporal patterns of antigenic dominance in Tanzania (and Kenya)
- Serotype-specific (monovalent) vaccination in advance of expected waves of infection
- BUT…
- …are the patterns we see consistent across broader geographical scales?





Field-based solutions for surveillance and high-resolution molecular epidemiology

- Nucleic acid recovered from 20 lateral-flow devices (LFDs) from clinical cattle two years after collection

- Typing successful on all samples (various % of genome recovered)

Research priorities – grassroots-level surveillance and in-country diagnostics

- Local-level information networks (mobile phone technologies? WhatsApp?)

- Strategies for deployment and recovery of LFDs

- Serotype-specific LFDs

- Diagnostic and molecular platforms in the field and local laboratories

- Sharing connections across Africa to characterise large-scale circulation patterns