Revisiting foot-and-mouth disease epidemiology

Transmission and disease dynamics

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NC STATE UNIVERSITY
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PANAFTOSA
Centro Panamericano de Fiebre Aftosa y Salud Pública Veterinaria

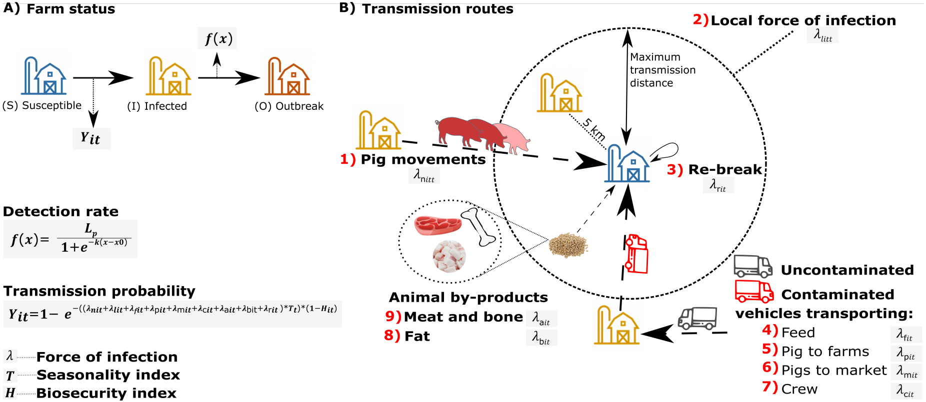
Motivation

2000, FMD in Rio Grande do Sul, Brazil

[1]Credits. Fernando Groff

Between-farm porcine epidemic diarrhea virus transmission dynamics

Modeling between-farm transmission dynamics of PRRSV.

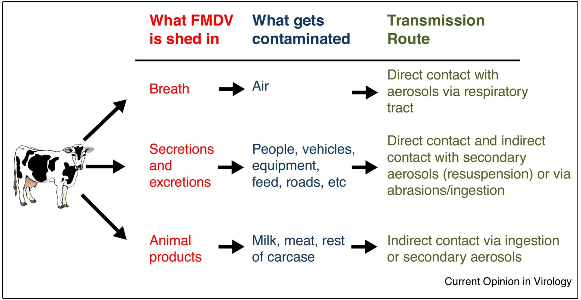


[3, 2]

Revisiting foot-and-mouth disease epidemiology

FMD epidemiology

1. FMD affects cloven-hoofed animals (including cattle, sheep, goats and pigs).



[5]

FMD epidemiology

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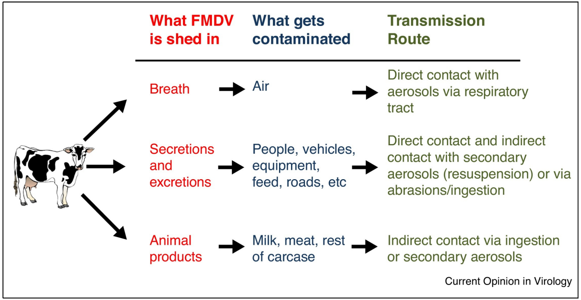
2. Infection is facilitated via vesicles and bodily excretions and secretions, including breath, milk, and semen.



[5]

FMD epidemiology

1. FMD affects cloven-hoofed animals (including cattle, sheep, goats and pigs).
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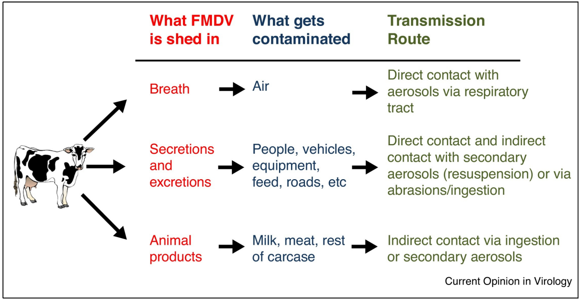
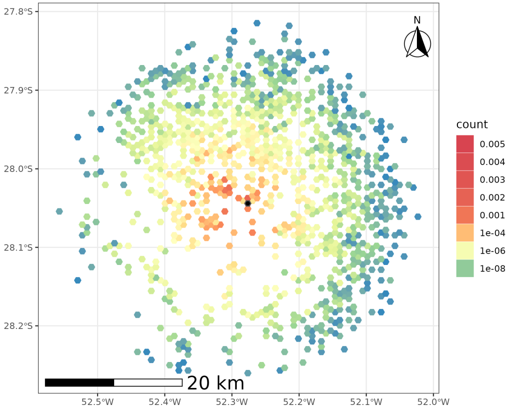
3. Transmission routes.

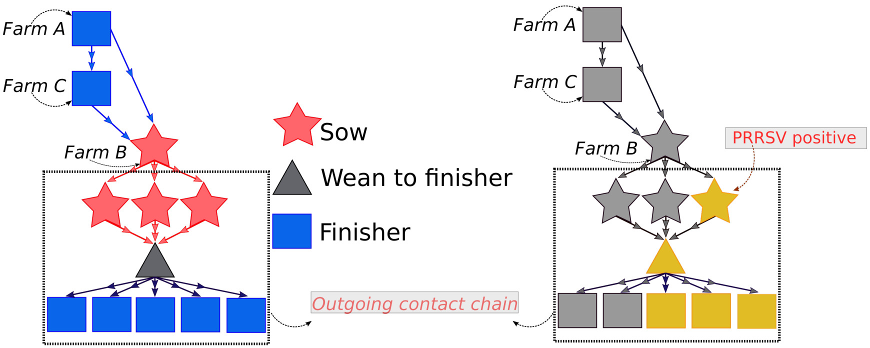


[5]

Local spread/dissemination

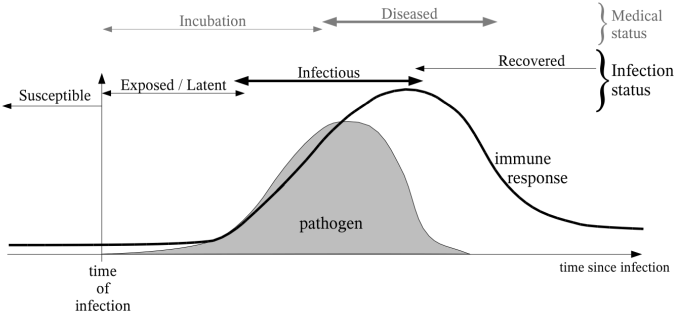


Between-farm movements, animals, vehicles and people



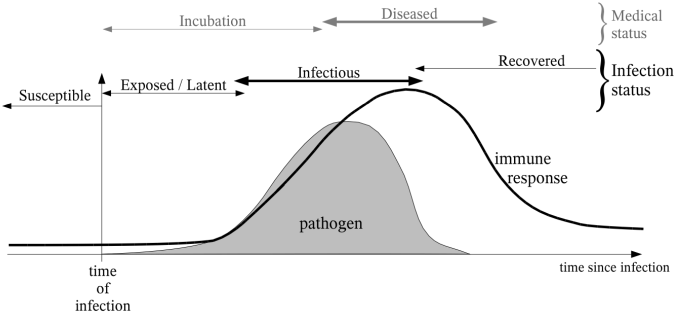
FMD transmission dynamics

1. Experimental studies under controlled conditions contributed to understanding parthenogenesis and transmission dynamics.



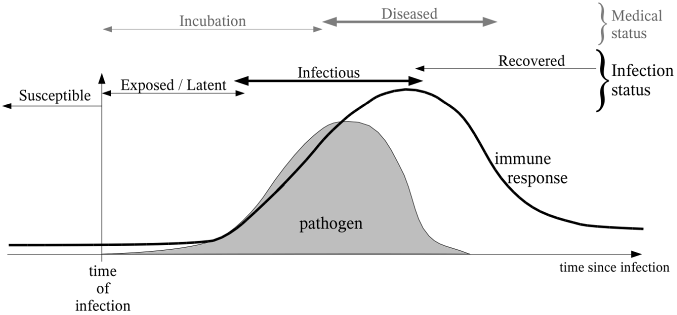
FMD transmission dynamics

1. Experimental studies under controlled conditions contributed to understanding parthenogenesis and transmission dynamics.
2. Small-scale studies cannot quantify low-probability transmission routes, e.g., fomites, contaminated feed, or carriers.

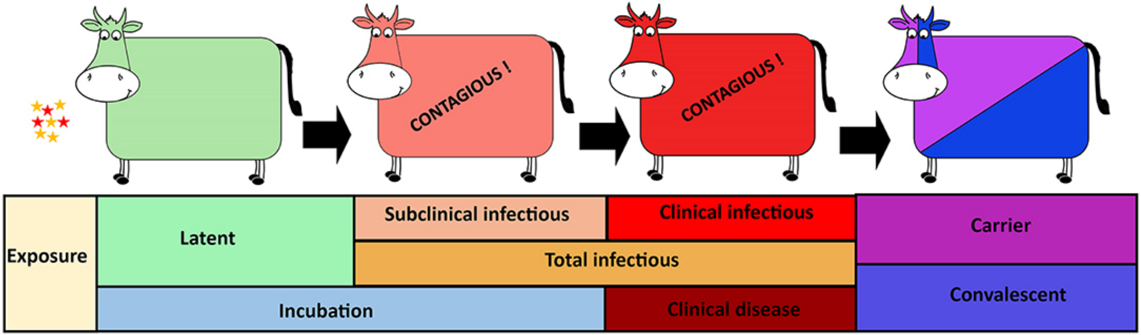


FMD transmission dynamics

1. Experimental studies under controlled conditions contributed to understanding parthenogenesis and transmission dynamics.
2. Small-scale studies cannot quantify low-probability transmission routes, e.g., fomites, contaminated feed, or carriers.
3. Ideally, we would need good data from real epidemic!!!



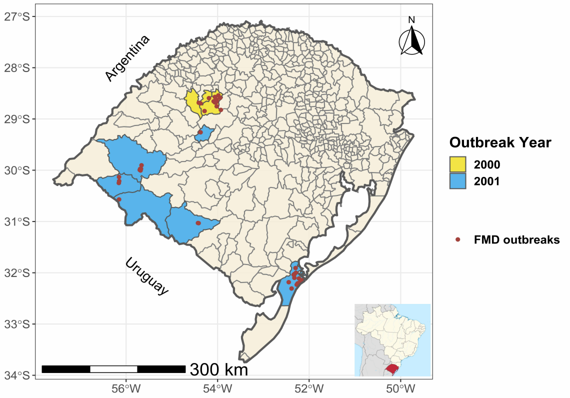
FMD progression cattle

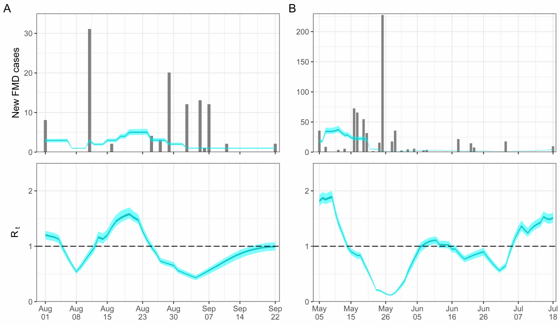


[5]

FMD transmission dynamics

We need good data from real epidemics!!! [1]

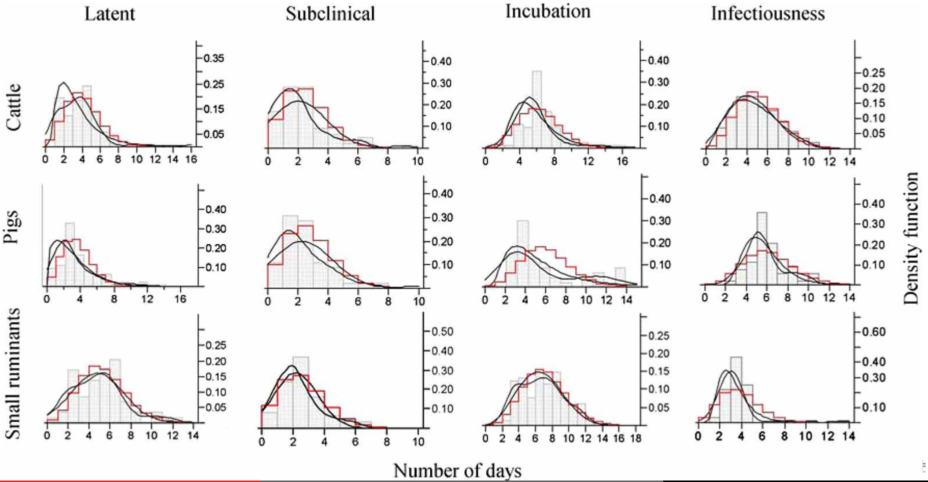




FMD transmission parameters

FMD progression cattle

If we are missing a parameter that only real epidemics can provide? meta-analysis? [4]



FMD progression

If we are missing a parameter that only real epidemics can provide? meta-analysis? [4]

[4]

FMD stage	Animal species	No.	Mean, median (25th, 75th percentile)	Distribution (parameters)	Poisson (λ)
Latent	Cattle	136	3.6, 3 (2, 5)	Weibull (α = 1.782, β = 3.974)	3.59
	Pig	72	3.1, 2 (2, 4)	Gamma (α = 1.617, β = 1.914)	3.07
	Small ruminant	58	4.8, 5 (3, 6)	**Pert** (*m* = 3.963, *a* = 0, *b* = 13.983)	4.79
Subclinical	Cattle	119	2.0, 2 (1, 3)	**Gamma** (α = 1.222, β = 1.672)	2.04
	Pig	45	2.3, 2 (1, 3)	**Inverse Gaussian** (μ = 2.3, λ = 3.045)	2.27
	Small ruminant	62	2.2, 2 (1, 3)	Gamma (α = 2.4, β = 0.898)	2.16
Incubation	Cattle	59	5.9, 5 (5, 6)	Log logistic (γ = 0, β = 5.3, α = 4.02)	**5.9**
	Pig	46	5.6, 4 (3, 9)	Pearson 5 (α = 3.05, β = 11.72)	5.58
	Small ruminant	128	6.6, 6 (4, 8)	Weibull (α = 2.784, β = 7.426)	**6.59**
Infectious	Cattle	71	4.4, 4 (3, 6)	**Gamma** (α = 3.969, β = 1.107)	**4.39**
	Pig	53	5.7, 5 (5, 6)	**Log logistic** (γ = 0, β = 5.39, α = 5.474)	5.69
	Small ruminant	59	3.3, 3 (2, 4)	Pearson 5 (α = 6.188, β = 17.192)	3.32

FMD progression

The **process** of disease transmission drives all mathematical transmission models

Examples of observable parameters

1. **e.g., infectious period**: average period for an animal to be infectious.

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1. **e.g., infectious period**: average period for an animal to be infectious.
2. **e.g., incubation period**: a period of time between infection to the occurrence of symptoms

FMD and most disease control actions

We follow national and local control and eradication plans.

1. Vaccination.

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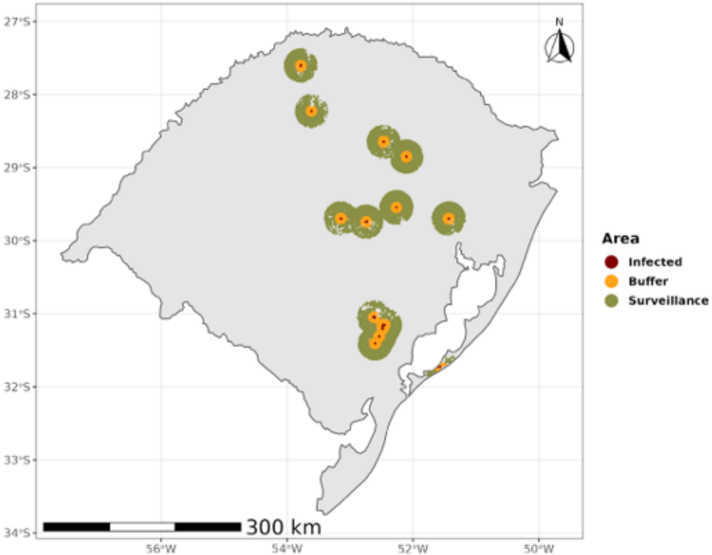
4. Control zones.

FMD and most disease control actions



Thanks for listening

Questions?

References

[1] Joao Marcos Nacif da Costa et al. "Assessing epidemiological parameters and dissemination characteristics of the 2000 and 2001 foot-and-mouth disease outbreaks in Rio Grande do Sul, Brazil". In: *bioRxiv* (2022).

[2] Jason A Galvis et al. "Modeling between-farm transmission dynamics of porcine epidemic diarrhea virus: characterizing the dominant transmission routes". In: *arXiv preprint arXiv:2201.04983* (2022).

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[4] Fernando Mardones et al. "Parameterization of the duration of infection stages of serotype O foot-and-mouth disease virus: an analytical review and meta-analysis with application to simulation models". In: *Veterinary research* 41.4 (2010), p. 45.

[5] Shankar Yadav et al. "Parameterization of the durations of phases of foot-and-mouth disease in cattle". In: *Frontiers in veterinary science* 6 (2019), p. 263.