Structuring the mess:
Disentangling disease models for cattle populations

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Objective & Material

Can we structure key characteristics of cattle disease models that have been developed to assist with animal health decision-making?

Searching for papers

Systematic literature review

Searching	Eligibility	Included
Web of Science***	Articles retained (- 1167)	Articles included (- 50)
n = 1290	n = 123	n = 73

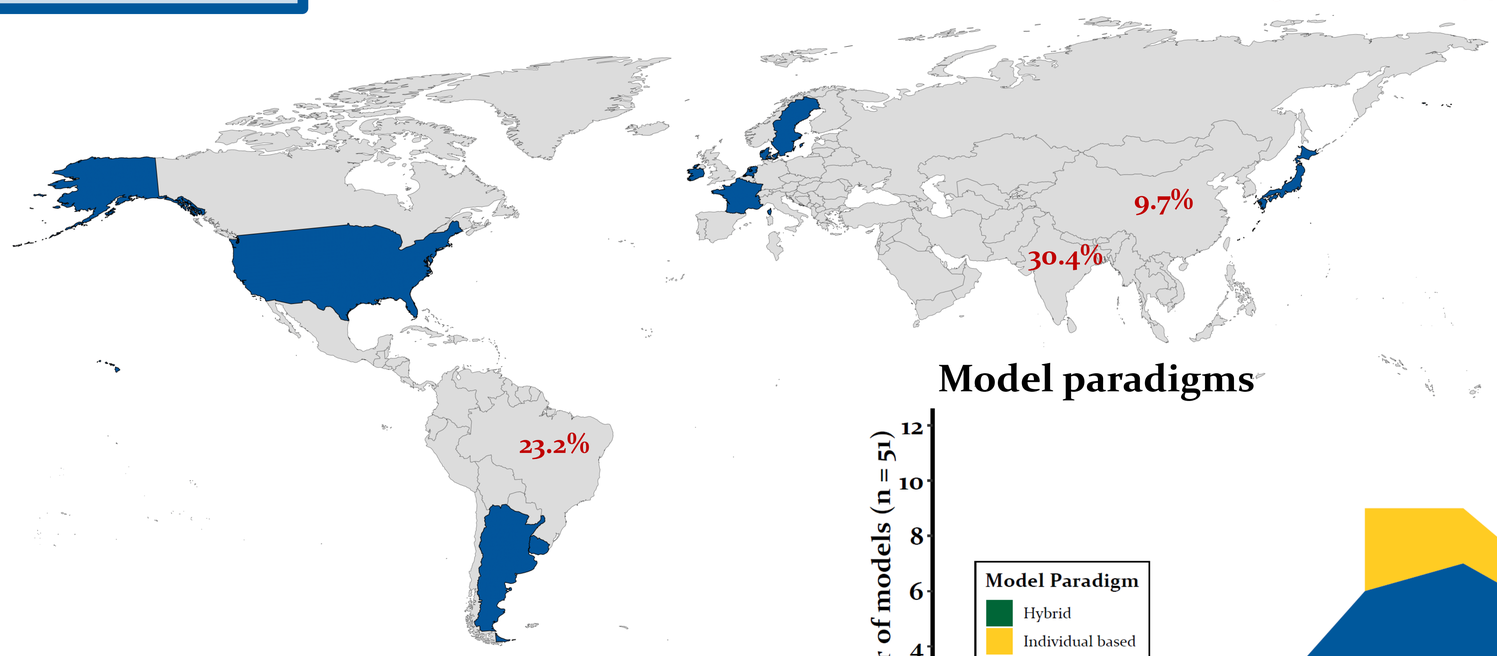
Abstract screening | Full text screening

General Model Characteristics

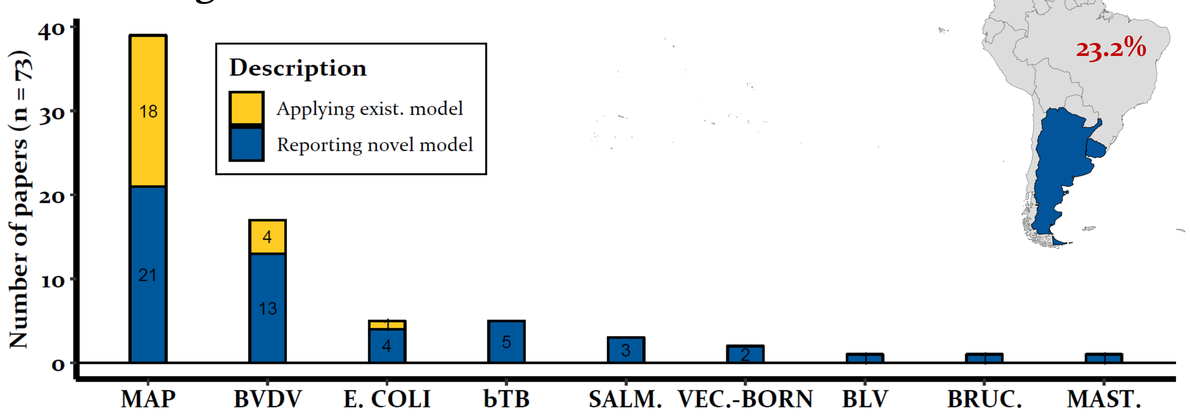
Journals

Prev. Vet. Med.:	39.2%
J. Theor. Biol.:	11.8%
Vet. Research:	11.8%
Other:	37.3%

Countries where cattle disease models have been developed
Percentage of world's cattle population

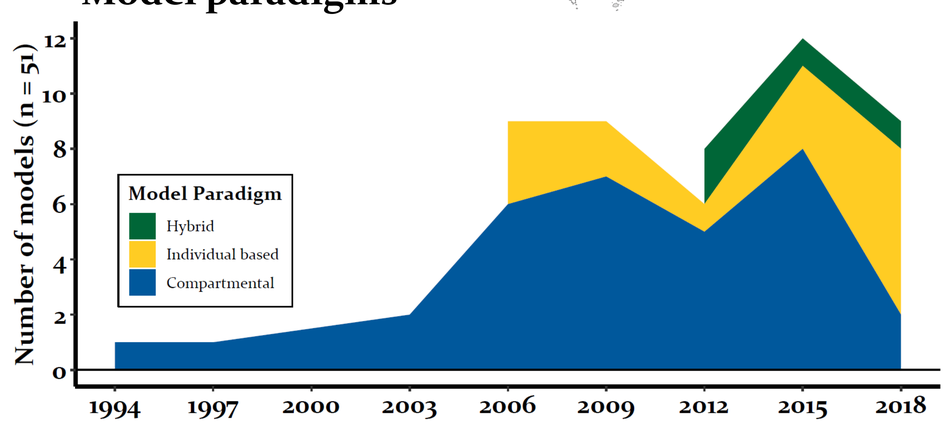


Pathogen distribution



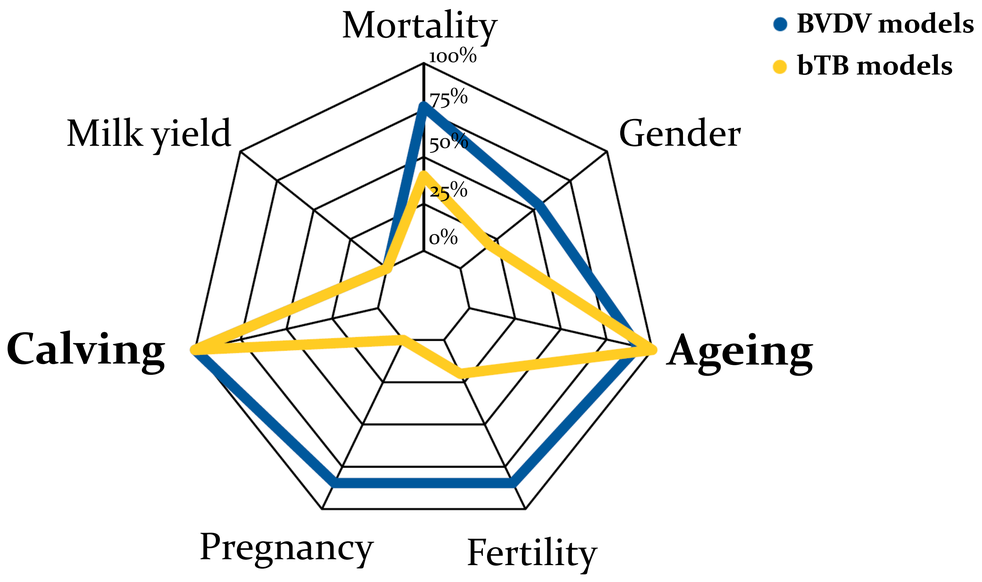
Number of papers (n=73) and models (n=51) per pathogen

Model paradigms



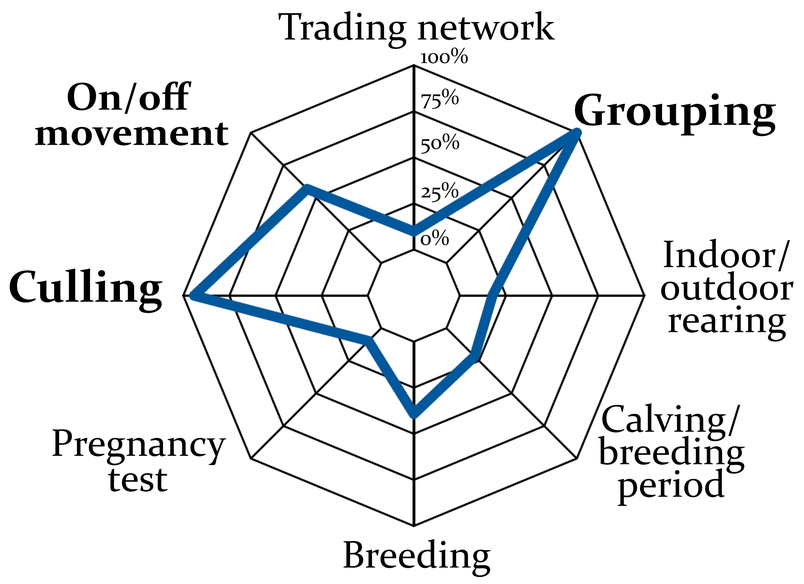
Stacked number of models

Biological Processes



Cattle related processes & proportional consideration in BVDV and bTB models

Farmer's Processes



Farming related processes & proportional consideration in all 51 models

Direct Disease Transmission

Individual probability (frequency [N] | density [1] dependent):

$$P_{inf} = 1 - exp^{-\left(\beta_{I(x)} \frac{N_{I(x)}}{N|1} + \cdots\right)}$$

35%

$\beta_{I(x)}$ = Transmission coefficient for infectious state x
$N_{I(x)}$ = Number of infected animals in state x
N = Number of all animals

Individual probability (Reed-Frost):

$$P_{inf} = 1 - \left(1 - \frac{k \cdot s}{N}\right)^{N_{I(x)}}$$

28%

k = Number of effective contacts
s = Susceptibility of each animal
$N_{I(x)}$ = Number of infected animals in state x
N = Number of all animals

Cohort rate of transmission:

$$\Delta I \sim N_S \cdot \beta_{I(x)} \frac{N_{I(x)}}{N|1}$$

37%

N_S = Number of susceptible animals
$\beta_{I(x)}$ = Transmission coefficient for infectious state x
$N_{I(x)}$ = Number of infected animals in state x
N = Number of all animals

Conclusion

We propose structuring the complexity of cattle disease models by four main features:

General model characteristics | **Biological processes** | **Farmer's processes** | **Disease transmission**

It would be of benefit if future model descriptions were to follow this structure.

***Search Strategy: TS=(cattle) OR TS=(beef herd*) OR TS=(dairy herd*) AND TS=(model*) AND TS=(control* program*) OR TS=(control* strategy*) OR TS=(contact structure*) OR TS=(transmis*) OR TS=(outbreak*) AND TS=(decision* support*) OR TS=(evaluat* efficacy) OR TS=(hypothesis test*) OR TS=(herd dynamic*) OR TS=(herd management) OR TS=(scenario*) OR TS=(strategy*) OR TS=(decision make*)

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