



HAL
open science

Evaluation using latent class models of the diagnostic performances of three ELISA tests commercialized for the serological diagnosis of *Coxiella burnetii* infection in domestic ruminants

Thibaut Lurier, Elodie Rousset, Patrick Gasqui, Carole Sala, Clément Claustre, David Abrial, Philippe Dufour, Renée de Crémoux, Kristel Gache, Marie Laure Delignette-Muller, et al.

► To cite this version:

Thibaut Lurier, Elodie Rousset, Patrick Gasqui, Carole Sala, Clément Claustre, et al.. Evaluation using latent class models of the diagnostic performances of three ELISA tests commercialized for the serological diagnosis of *Coxiella burnetii* infection in domestic ruminants. ESCCAR International congress on Rickettsiae and 9th Meeting of the European Society for Chlamydia Research (ESCR), Aug 2022, Lausanne, Switzerland. , pp.#231. hal-03757978

HAL Id: hal-03757978

<https://hal.inrae.fr/hal-03757978v1>

Submitted on 2 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Evaluation using latent class models of the diagnostic performances of three ELISA tests commercialized for the serological diagnosis of *Coxiella burnetii* infection in domestic ruminants

Thibaut Lurier^{1,2}, Elodie Rousset³, Patrick Gasqui¹, Carole Sala⁴, Clément Claustre¹, David Abrial¹, Philippe Dufour³, Renée de Crémoux⁵, Kristel Gache⁶, Marie Laure Delignette-Muller⁷, Florence Ayrat², Elsa Jourdain¹
1- UMR EpiA; 2- USC 1233; 3- Q fever NRL; 4- EAS Unit ; 5- UMT PSR; 6- GDS France; 7- UMR 5558

Context and objectives

Context

- ELISA methods are recommended for the serological diagnosis of *Coxiella burnetii* infection in ruminants
- Without Gold Standard, accurate estimates of their Sensitivity (Se) and Specificity (Sp) are lacking

Objectives

- Assess Se and Sp of the ELISA tests available in France in sheep, goats and cattle
- Estimate optimal sample sizes considering sensitivity and specificity at herd level

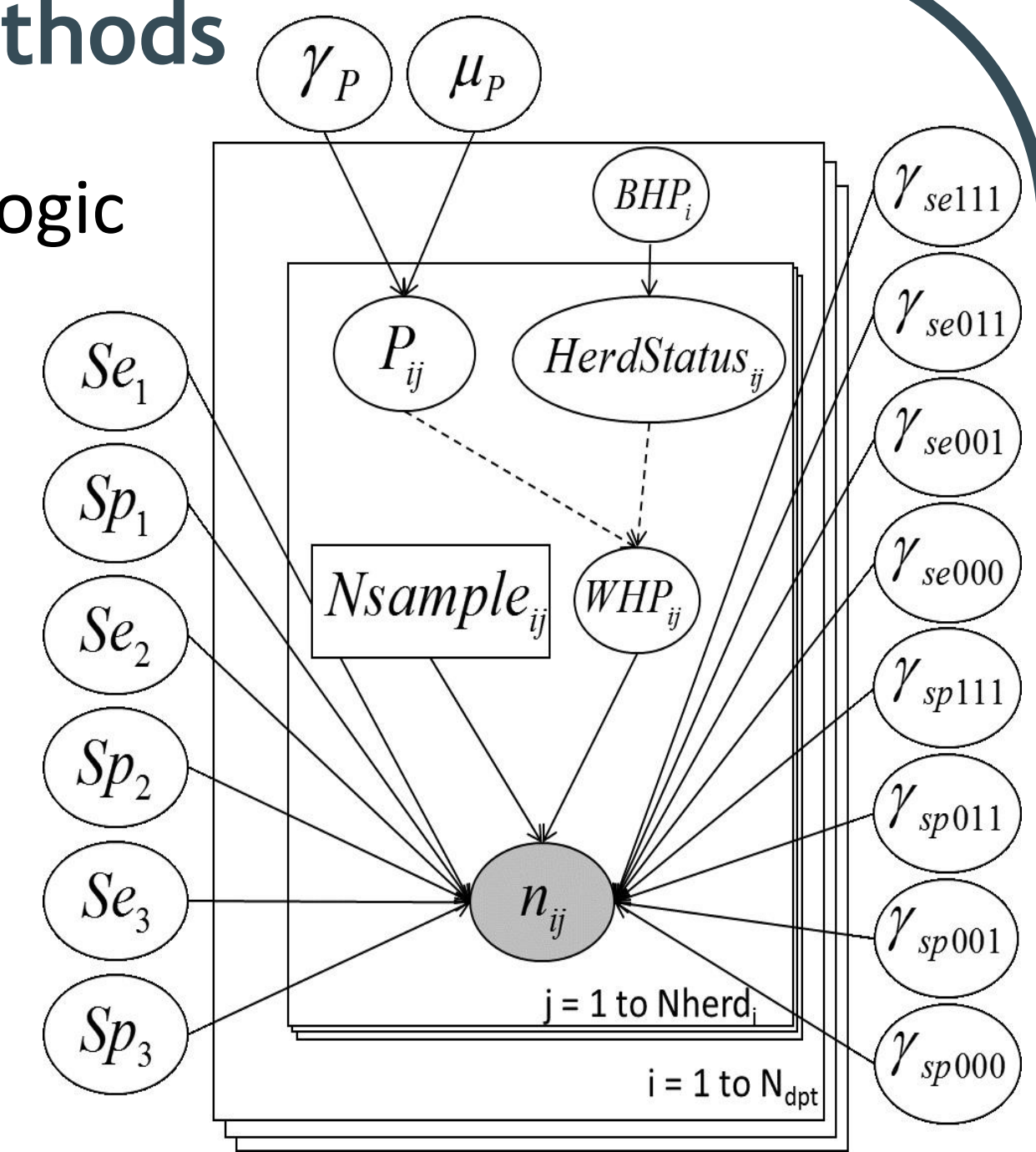
Name used in the current study	Test 1	Test 2	Test 3
Commercial name	IDEXX Q fever Ab test	PrioCHECK™ Ruminant Q Fever	ID.Vet ID Screen® Q fever indirect multi-species
Manufacturer	IDEXX	ThermoFisher Scientific	Innovative Diagnostics
Strain used for antigen production	Isolated from ticks (Nine Mile reference strain)	Isolated from an ewe	Isolated from a cow
Conjugate	Secondary antibodies binding to ruminant IgG	G protein	G protein

Characteristics of the three ELISA tests commercialized in France

Material and methods

Data

- Sub-sample of a larger epidemiologic study (Gache *et al* 2017)
1 413 **cows** from 106 herds
1 474 **goats** from 103 herds
1 432 **ewes** from 99 herds
- Serum collected and analyzed with the three ELISA tests at the NRL for Q fever



Directed Acyclic Graph of the latent class model
See Lurier *et al.* 2021* for complete specification of the model

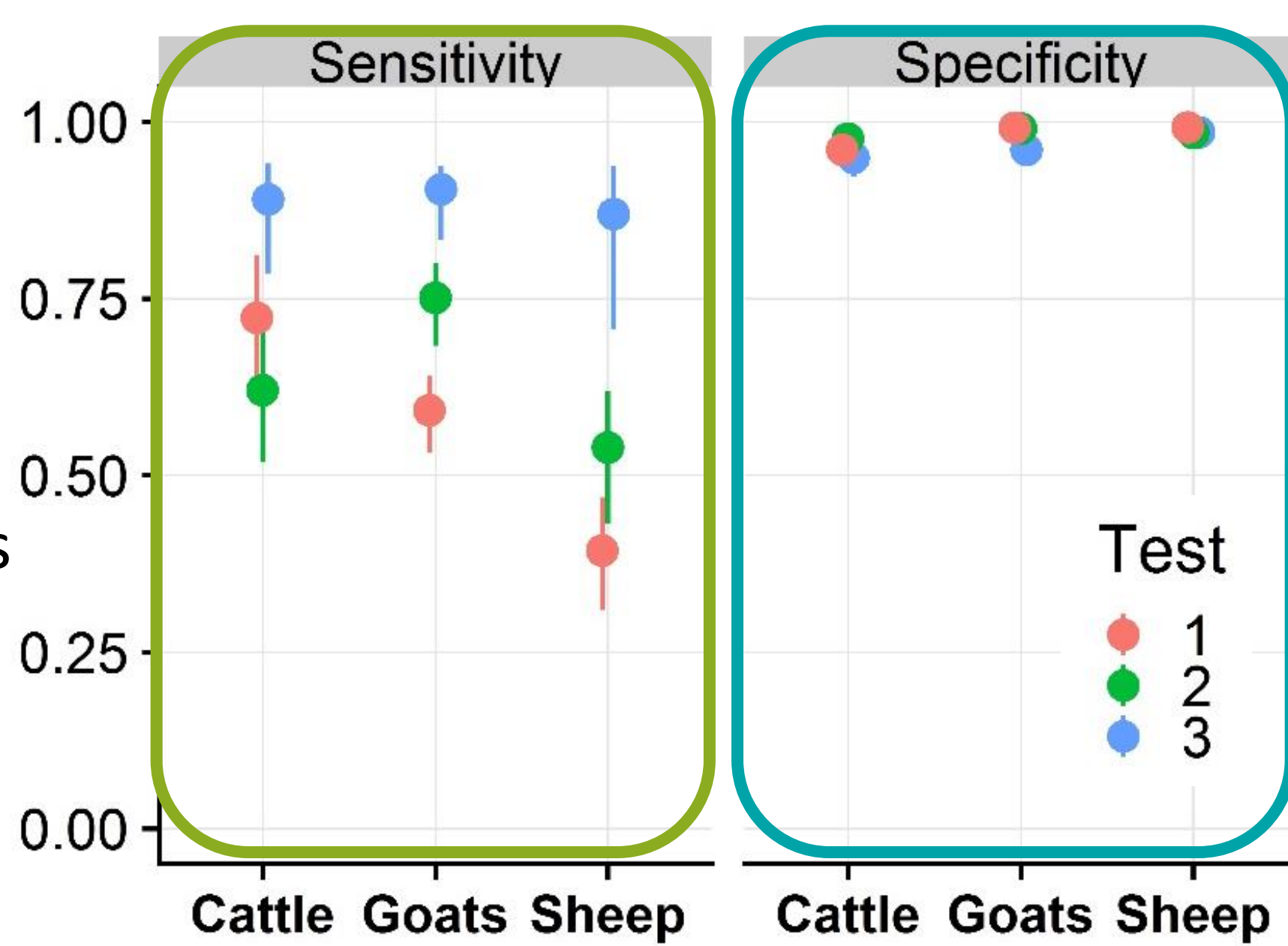
Latent class model

- Modeling of the cross-classified test results (n_{ij})
- Accounting for conditional dependence between tests ($\gamma_{se...}$ and $\gamma_{sp...}$)
- One model for each ruminant species

Results at individual level

Se and Sp estimates

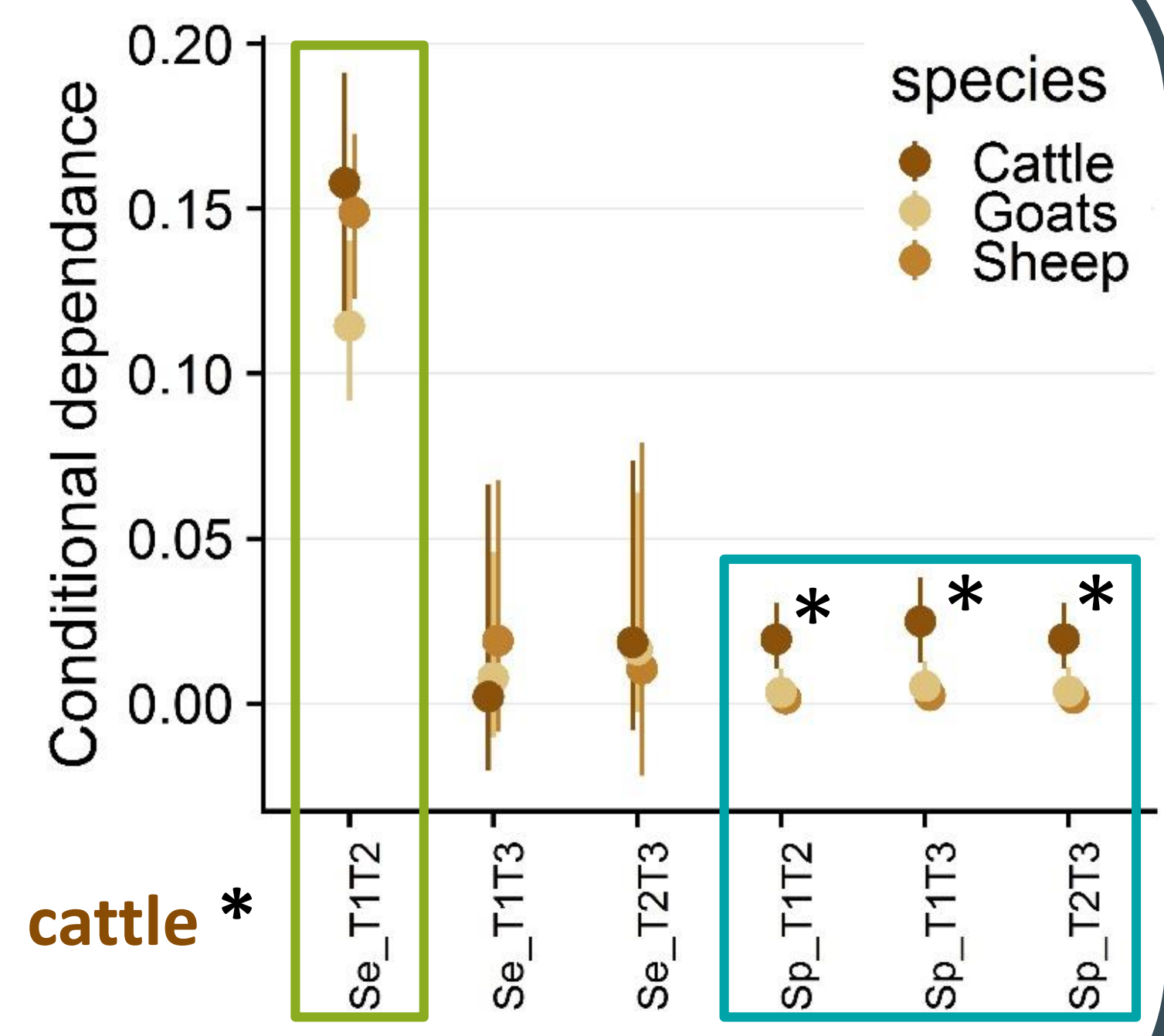
- **Low Se** especially in sheep
- **High Sp** but lower in cattle
- **Test 3** was the most sensitive in all species but also the least specific
- Tests were **not equivalent** for each ruminant species



Diagnostic accuracy of the three ELISA tests

Conditional dependence (CD)

- **High CD between tests 1 and 2** in seropositive animals
⇒ Tests 1 and 2 tended to be **falsely negative at the same time**
- **Negligible CD in seronegative sheep and goats**
⇒ False positive results were **rare and independent** for the three tests
- **Low but positive CD in seronegative cattle** *
⇒ False positive results were **rare but dependent in cattle**



Pairwise conditional dependence in truly seropositive ($Se_{T \cdot T \cdot}$) or seronegative ($Sp_{T \cdot T \cdot}$) animals

Results at herd level

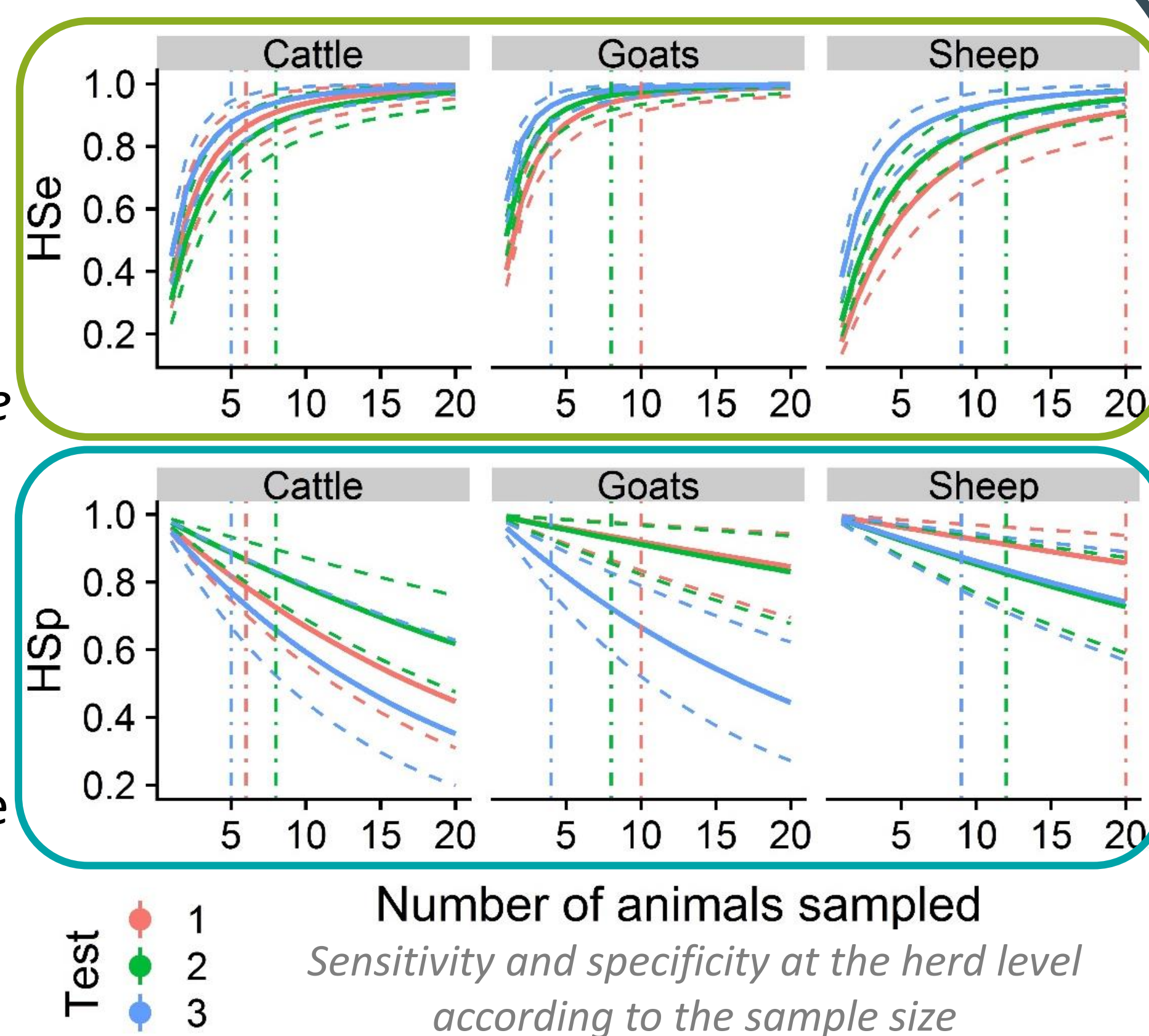
Definitions

- **HSe** = Probability that **at least one** animal sampled is positive using one test in a **positive herd**
- **HSp** = Probability that **none** of the animals sampled is positive using one test in a **negative herd**
- ⇒ Calculated with a sample size varying from 1 to 20 animals

Results

- **HSe increased** with the sample size while **HSp decreased**
- **Test 3** had the worse HSp

⇒ The **optimal sample size** maximizing both HSe and HSp **varied from 3 to at least 20** animals depending on the test and ruminant species



Sensitivity and specificity at the herd level according to the sample size

Discussion

- **Unbiased estimation** of Se and Sp without relying on an imperfect gold standard
- Compared to other studies : **similar Sp** but **lower Se**
⇒ Account for the high conditional dependence in seropositive animals between tests 1 and 2 (see poster #232)
- Applicability of Se and Sp estimated limited to a sero-epidemiological context (**different from herds with abortion** in which the test is often performed in practice)

Perspectives

- Account for the Se and Sp of the ELISA tests to **accurately assess the seroprevalences** of Q fever
- Need to reassess Se and Sp of the tests in an **abortive context**
- Discrepancies between tests and perspectives of application for an harmonization of the ELISA tests

* Lurier, T., Rousset, E., Gasqui, P., Sala, C., Claustre, C., Abrial, D., Dufour, P., de Crémoux, R., Gache, K., Delignette-Muller, M.L., Ayrat, F., Jourdain, E., 2021. Evaluation using latent class models of the diagnostic performances of three ELISA tests commercialized for the serological diagnosis of *Coxiella burnetii* infection in domestic ruminants. Veterinary Research 52, 56. <https://doi.org/10.1186/s13567-021-00926-w>