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# Coxiella burnetii within- and between-herd true seroprevalence assessment in domestic ruminants in France accounting for diagnostic uncertainty with latent class

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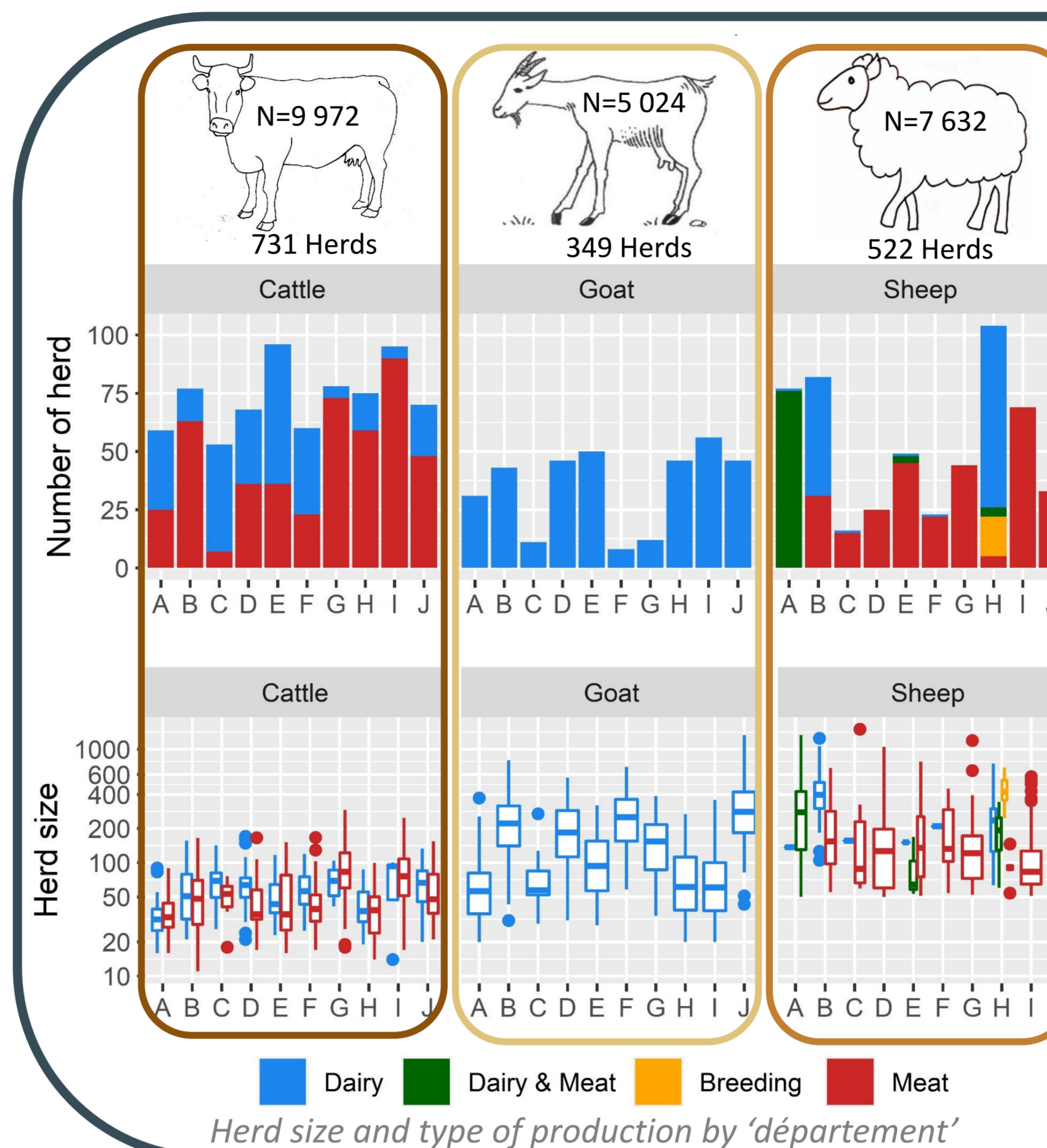
## Context and objectives

### Q fever : a worldwide zoonosis still difficult to control

- **Human outbreaks** regularly occur over the world
- In Europe, most human cases are related to **domestic ruminant exposure**
- **Unbiased estimation of the prevalence** is crucial to detect and assess epidemiological changes
- In France, **only apparent seroprevalence** were assessed;  
Yet, based on Lurier et al. 2021, **Se varied from 54% to 75% and Sp from 97% to 99%**

### Objectives of the study

- ✓ Reassess the **between-** and **within-**herd seroprevalence in cattle, sheep and goats from the results published by Gache *et al.* 2017
- ✓ Quantify the importance of two potential **risk factors of seropositivity** at the animal and herd level (type of production and herd size)



## Data

- Sampling in 10 French 'départements'
- **Random selection** of 19 to 106 herds by département and species
- **Convenience sample** of 10 to 15 animals by herd
- **Serum analysis** in 10 veterinary laboratories with **Prioncheck™ ELISA test**
- **Additional informations**  
⇒ Herd size = number of :  
Females for **cattle**  
Animals for **sheep** and **goats**  
⇒ Types of production  
**Dairy/meat/dairy & meat/breeding** for **sheep**  
**Dairy/meat** for **cattle** and **goats**

## Hierarchical logistic model

- Two intricated **regression models** :  
⇒ Logistic regression with a random intercept at the département level ( $\alpha_{0j}$ ) for the **between-herd prevalence (BHP)**  
⇒ Zero inflated logistic regression with a random intercept at the herd level ( $\beta_{0ij}$ ) for the **within-herd prevalence (WHP)**
- The **number of tested seropositive animals** ( $N_{pos_{ij}}$ ) in each herd was then supposed to follow a binomial distribution which depends on :  
⇒ the number of animals sampled ( $N_{sample_{ij}}$ )  
⇒ the **WHP** (potentially equal to 0)  
⇒ the **Sensitivity (Se)** and **Specificity (Sp)** of the ELISA test

## Model equation and directed acylique graph

$$\text{logit}(BHP_{ij}) = \alpha_{0j} + \alpha_{size} \times Herdsize_{ij} + \alpha_{Prod[Prod_{ij}]}$$

$$\alpha_{0j} \sim \text{Norm}(\mu_{BHP\_ref}, \sigma_{BHP})$$

$$HerdStatus_{ij} \sim \text{bern}(BHP_{ij})$$

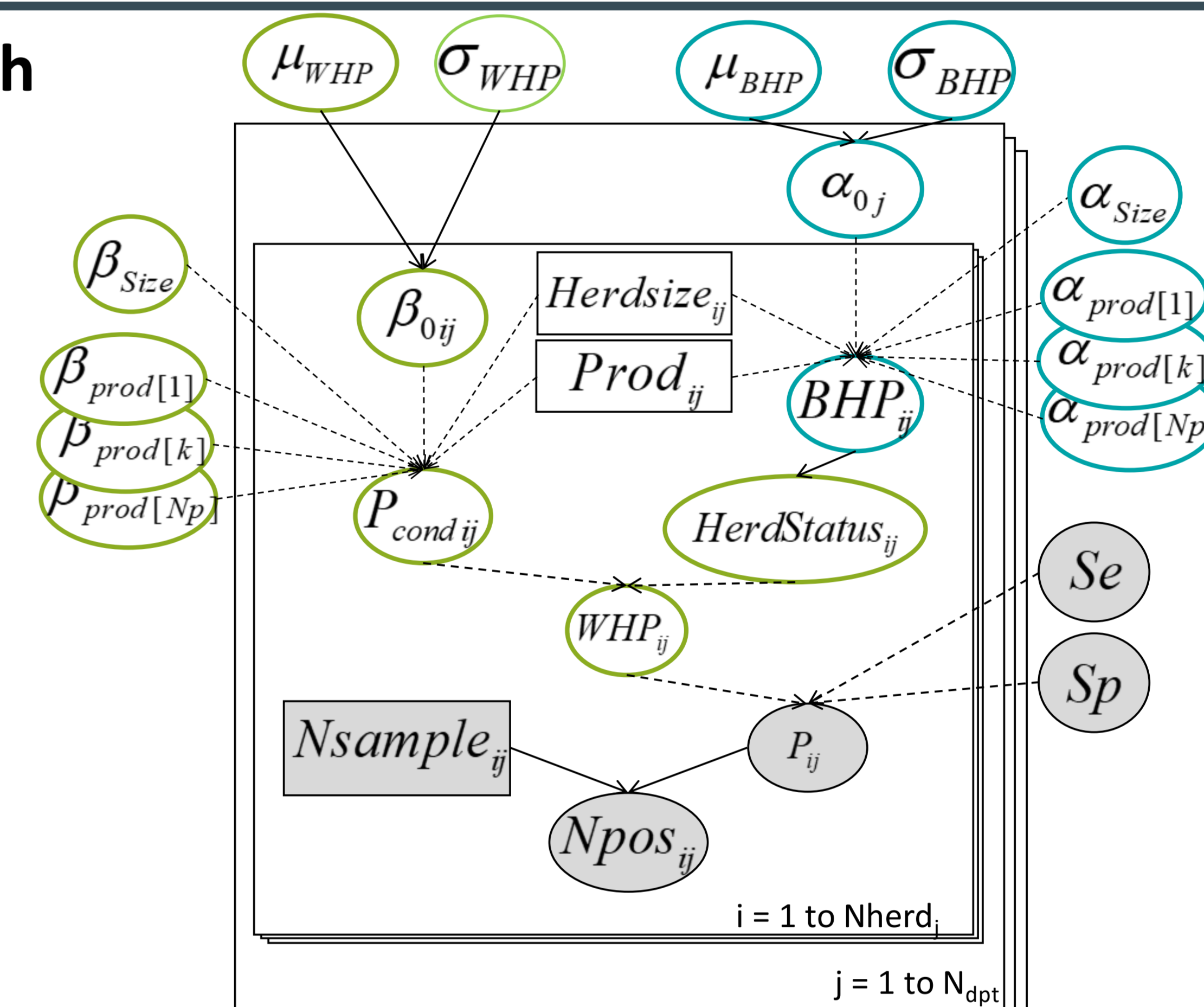
$$\text{logit}(P_{cond_{ij}}) = \beta_{0ij} + \beta_{size} \times Herdsize_{ij} + \beta_{Prod[Prod_{ij}]}$$

$$\beta_{0ij} \sim \text{Norm}(\mu_{WHP}, \sigma_{WHP})$$

$$WHP_{ij} = P_{cond_{ij}} \times HerdStatus_{ij}$$

$$P_{ij} = WHP_{ij} \times Se + (1 - WHP_{ij}) \times (1 - Sp)$$

$$N_{pos_{ij}} \sim \text{binomial}(N_{sample_{ij}}, P_{ij})$$



## Results : Seroprevalence

Median of observed and assessed seroprevalence levels in each species and type of production

	Cattle		Goat		Sheep	
	Meat	Dairy	Meat	Dairy	Meat	Dairy
<b>BHP</b>	16,3* [1,5 ; 19,5]	5,7† [20,3 ; 79,2]	63,5* [25,5 ; 67,2]	47,1†	28,0* [5,6 ; 85,5]	36,7† [21,6 ; 51,0]
					78,5* [1,3 ; 76,2]	21,6†
					75,0* [2,7 ; 87]	32,7†
					52,9* [1 ; 100]	23,5†
<b>WHP</b>	8,3* [27,3 ; 57]	39,4† [30,5 ; 49,3]	35,7* [53,4 ; 73,9]	63,6†	12,5* [17 ; 31,7]	22,9† [36,9 ; 48,6]
					20,0* [27,2 ; 48,6]	36,9†
					40,0* [44,5 ; 72]	57,8†
					13,3* [5,9 ; 52,1]	18,7†

\* Observed median of the apparent seroprevalences

† Assessed median of the true seroprevalence

**BHPs assessed†** were lower than the observed apparent\* **BHPs**

⇒ Account for the **imperfect specificity** of the ELISA test

**WHPs assessed†** were higher than the observed apparent\* **WHPs**

⇒ Account for the **moderate sensitivity** of the ELISA test

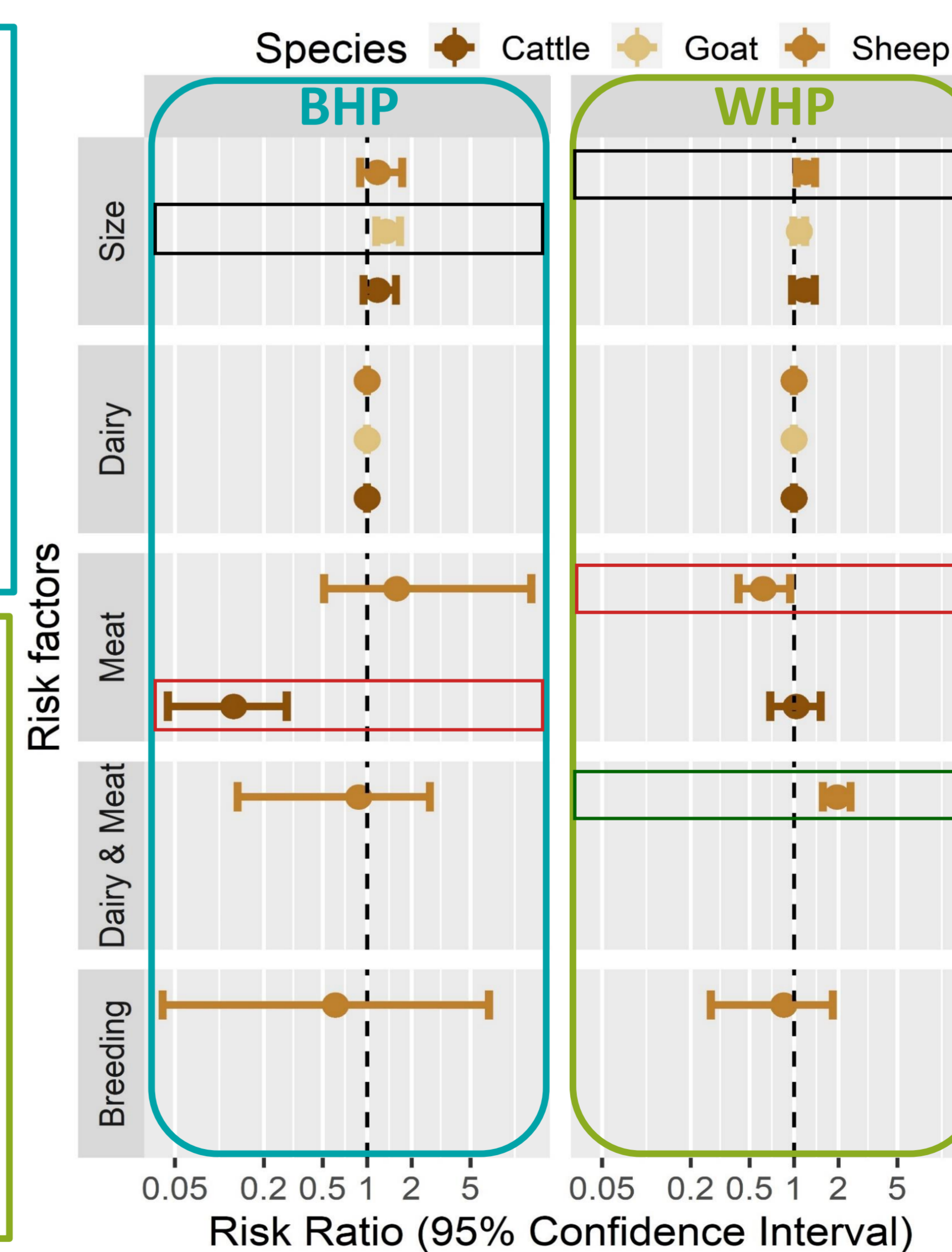
## Results : Risk factors

### BHPs

- **Cattle**
  - 7.9x higher in **dairy** vs. in **meat** herds
- **Goats**
  - 1.4x higher when herd size x2

### WHPs

- **Sheep**
  - 1.6x higher in **dairy** vs. in **meat**
  - 2.5x higher in **dairy & meat** vs. in **meat**
  - 1.3x higher when herd size x2



Risk ratio of seropositivity of the herd (between-herd) and of the animals in seropositive herds (within-herd). The reference herd is a dairy herd of medium size in each species

## Conclusion

- **Better knowledge of the true within- and between-herd seroprevalence levels in France**
- **Identification and quantification of some relevant risk factors**

## Discussion

- **Results must be carefully extrapolated**  
Potential non-representativeness of the 10 'departments' included  
Random selection of herds without information on abortion occurrence

⇒ **New insights into the epidemiology of Coxiella burnetii in domestic ruminants in France**