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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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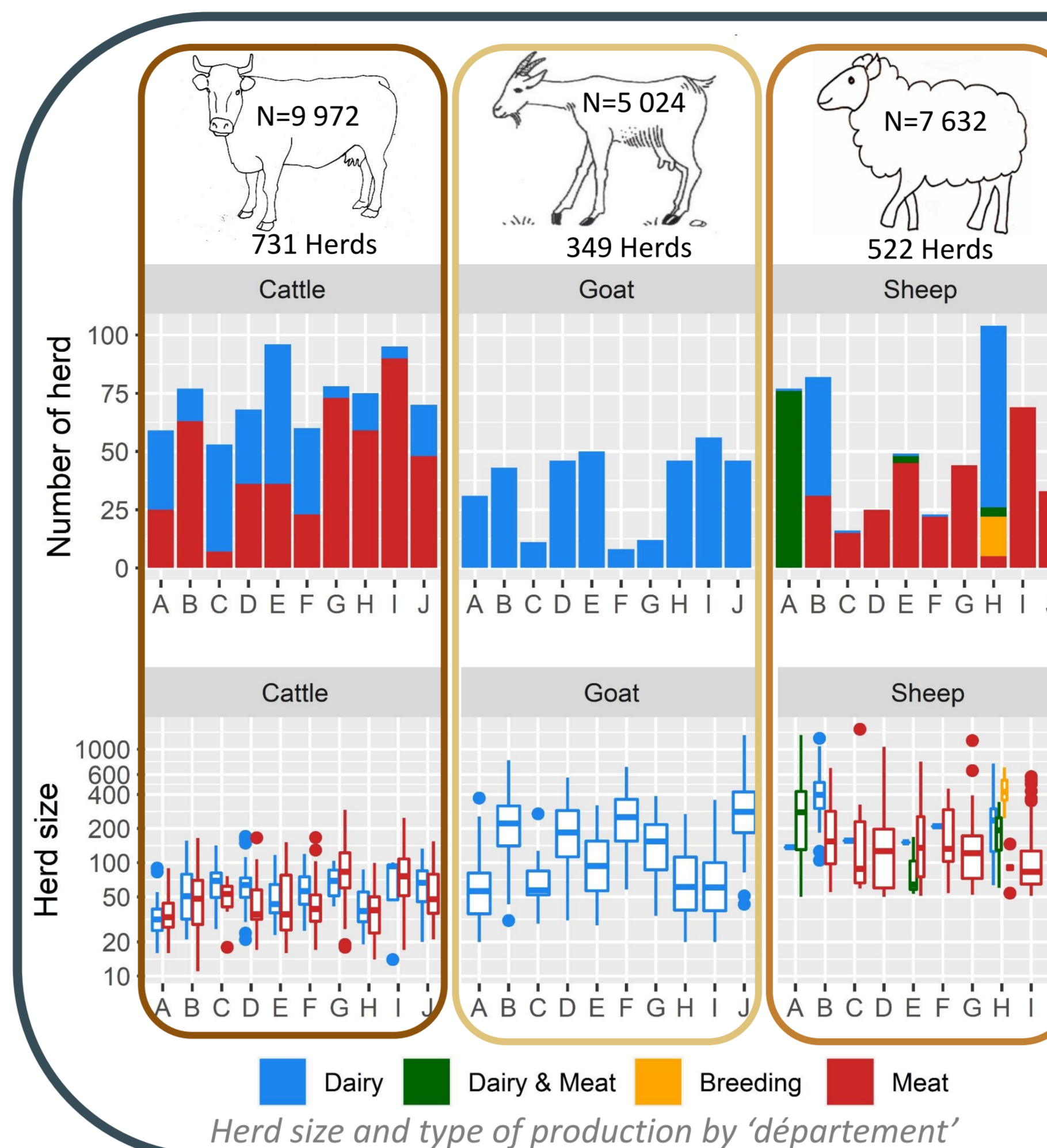
Context and objectives

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 (α_{0j}) for the **between-herd prevalence (BHP)**
⇒ Zero inflated logistic regression with a random intercept at the herd level (β_{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

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

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

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

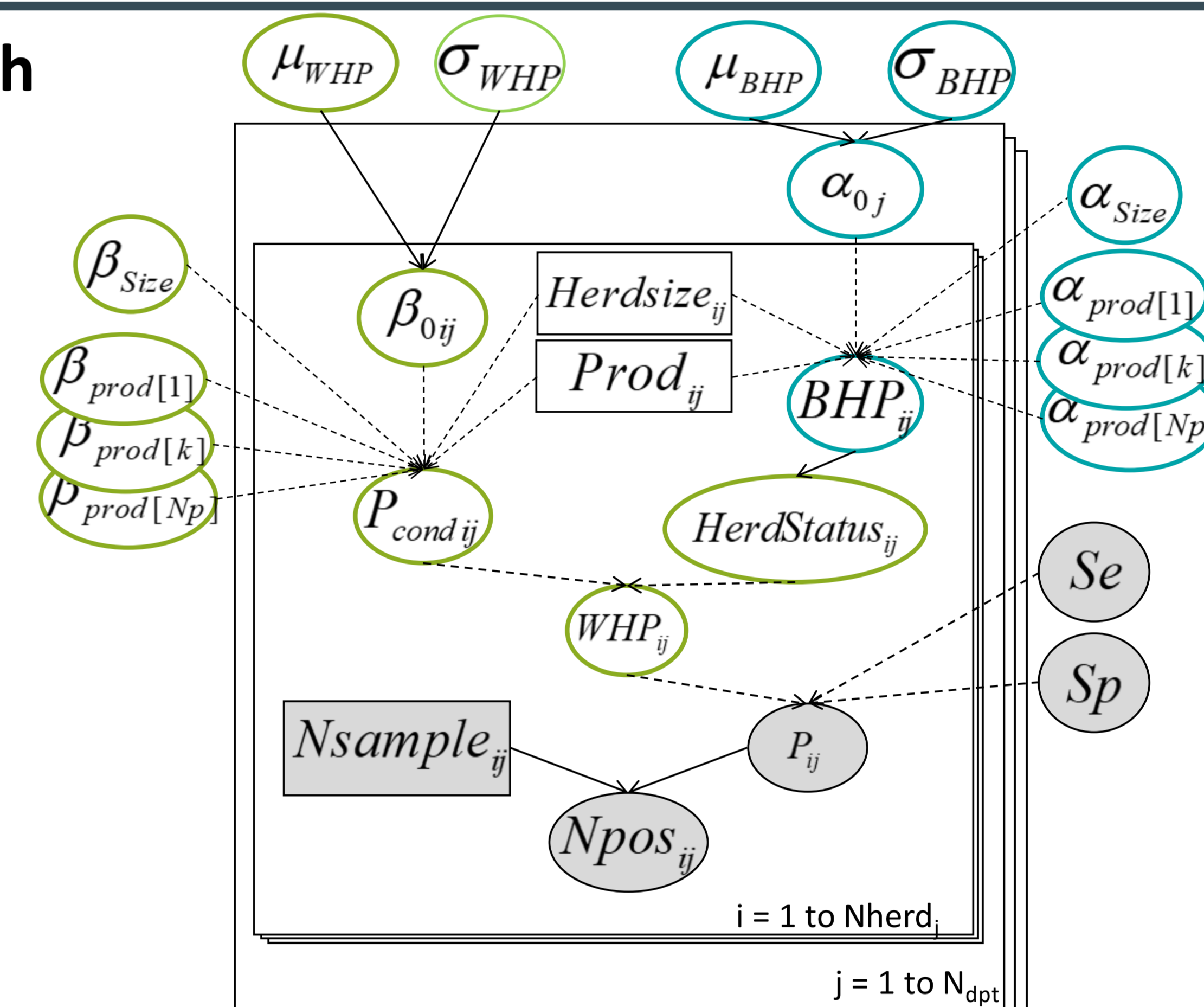
$$\text{logit}(P_{cond_{ij}}) = \beta_{0ij} + \beta_{size} \times Herdsize_{ij} + \beta_{Prod[Prod_{ij}]}$$

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

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

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

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



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
BHP	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†
WHP	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

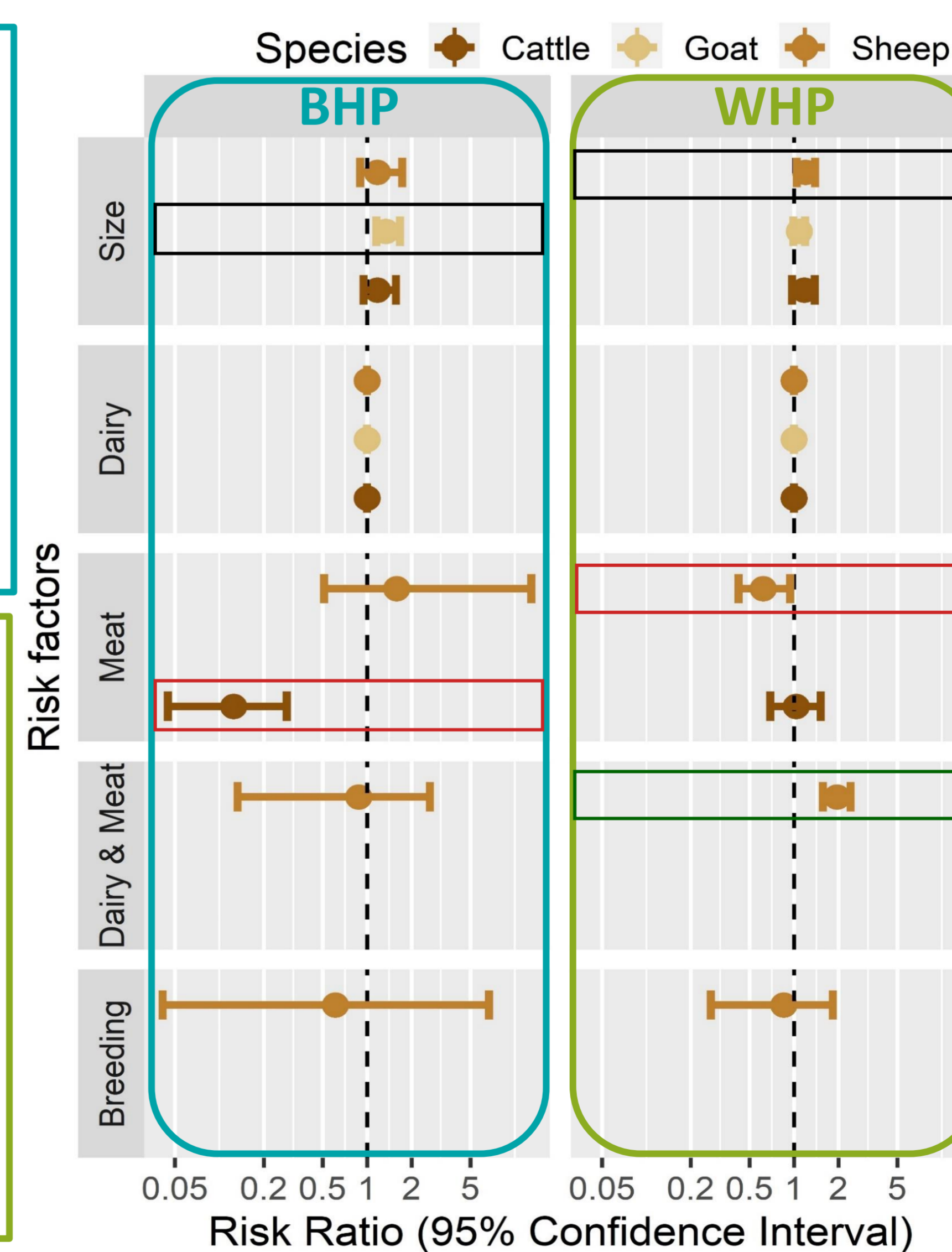
Results : Risk factors

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**