PRRSV Rosalia in Spain. What can we learn from it?

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MSD swine vet conference

Outline of the talk

1. The history of highly virulent PRRSV strains
2. Knowns and unknowns about highly virulent PRRSV strains
3. Chronology of Rosalia's epidemics in Spain
4. Origin of other highly virulent strains and Rosalia strain
5. The impact of Rosalia on the affected farms and the Spanish pig production
6. Attempts to control the impact of the infection in the affected farms
7. Vaccination and Rosalia control
8. Lessons to be learnt from Rosalia epidemics

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1. The history of highly virulent PRRSV strains

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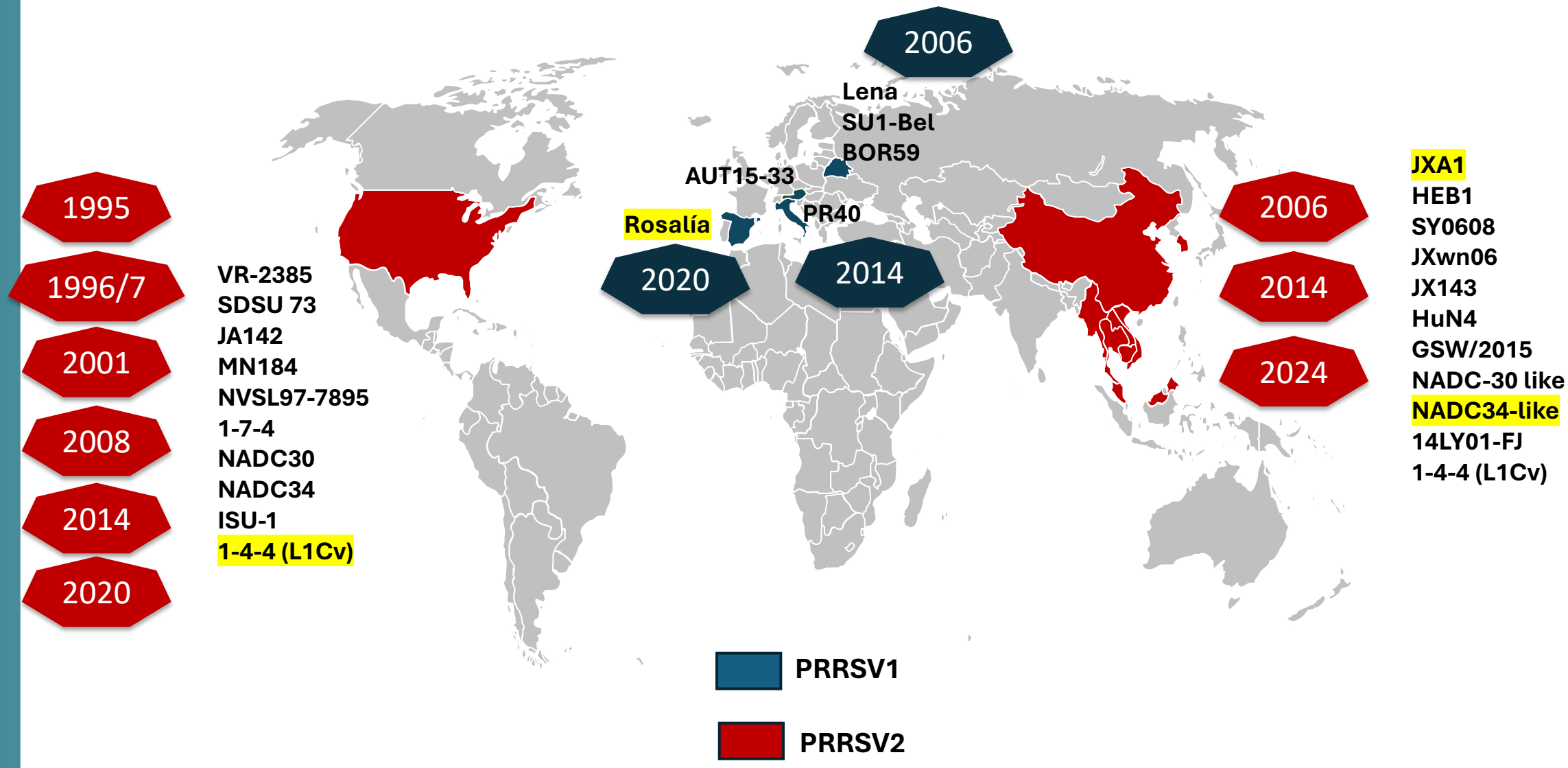
Emergence of highly virulent PRRSV strains worldwide



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2. Knowns and unknowns about highly virulent PRRSV strains

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Increased replication capability

Approx. 100/1,000-fold higher viral load

Classical Strains		HP strains	
Ct	$TCID_{50}$/ ml*	Ct	$TCID_{50}$/ ml*
10	10,000,0000	10	10,000,0000
13	1,000,000	13	1,000,000
17	100,000	17	100,000
20	10,000	20	10,000
23	1,000	23	1,000
26	100	26	100
30	10	30	10
33	1	33	1
36	0	36	0
39	0	39	0

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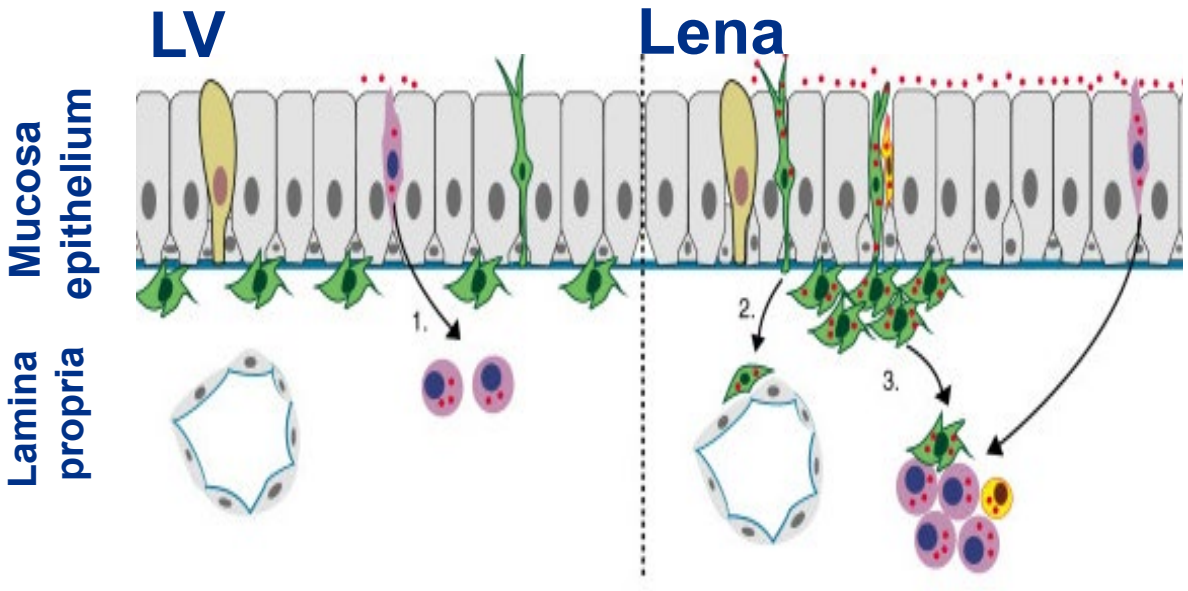
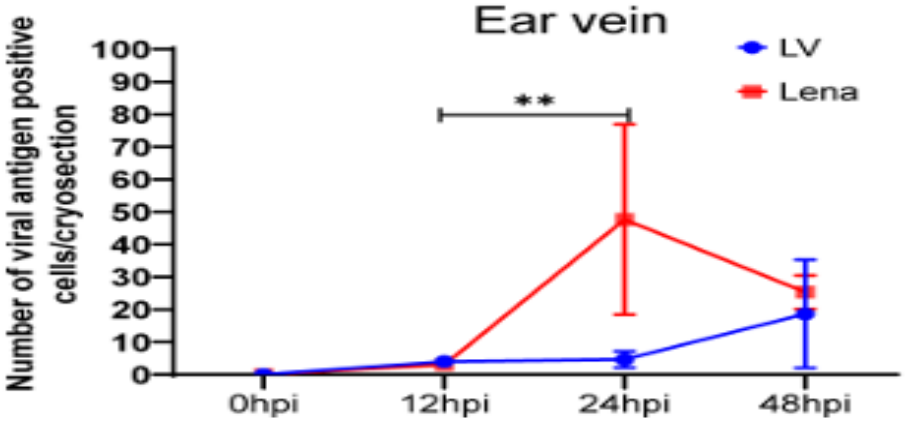
Enhanced macrophage tropism

Higher replication in nasal mucosa macrophages



Higher replication in vascular macrophages



Frydas et al., 2013; Frydas and Nauwynck, 2016; Han et al., 2023

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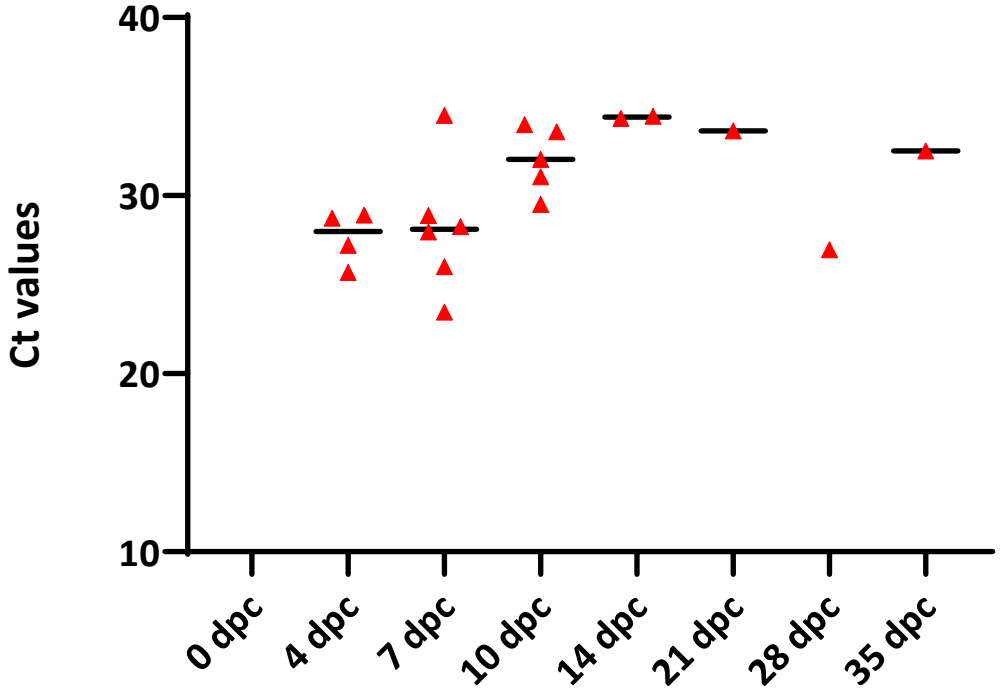
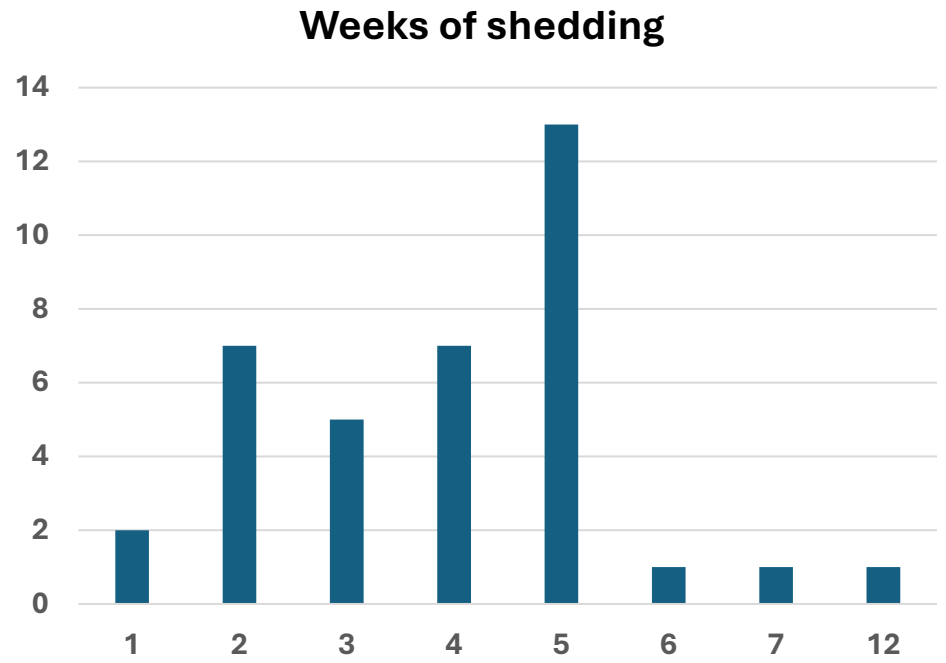
Nasal shedding

Nasal shedding in challenged 9 weeks-old pigs (n=6)



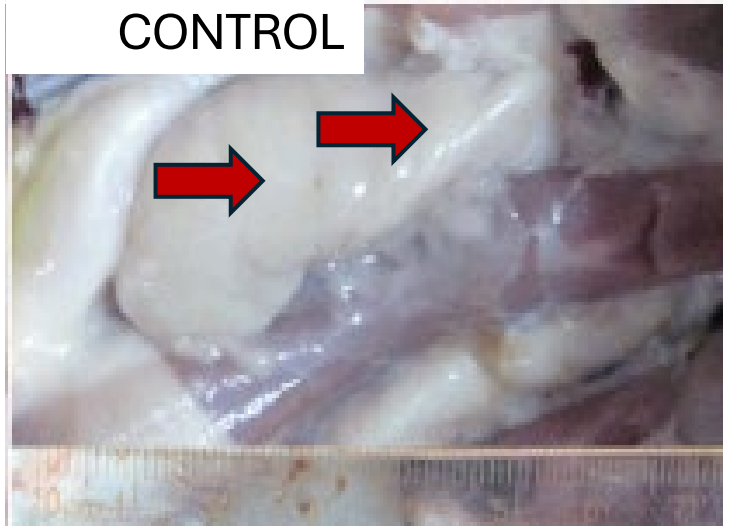
Nasal shedding in naturally infected pigs (n=40)

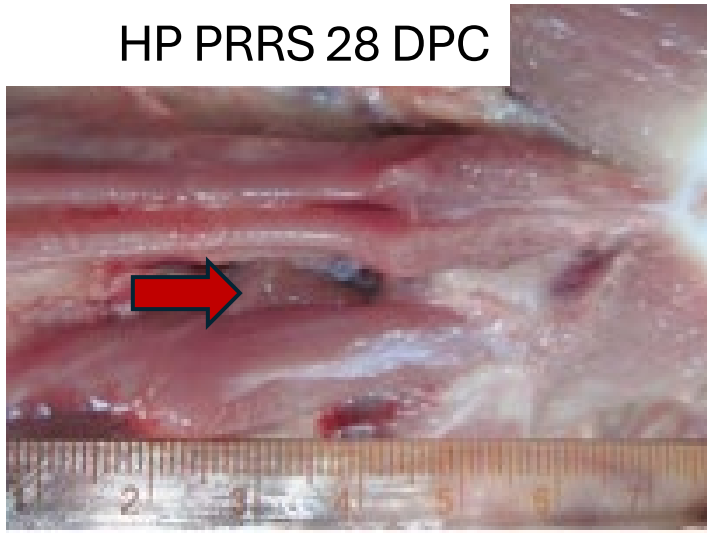


Mateu et al., 2024. IPVS

Some pigs were still shedding virus 12 weeks after the onset of the infection

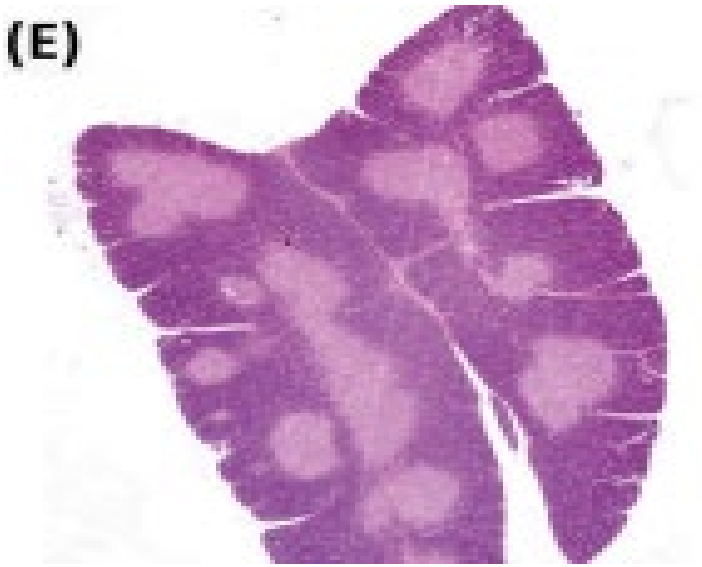
Thymus involvement

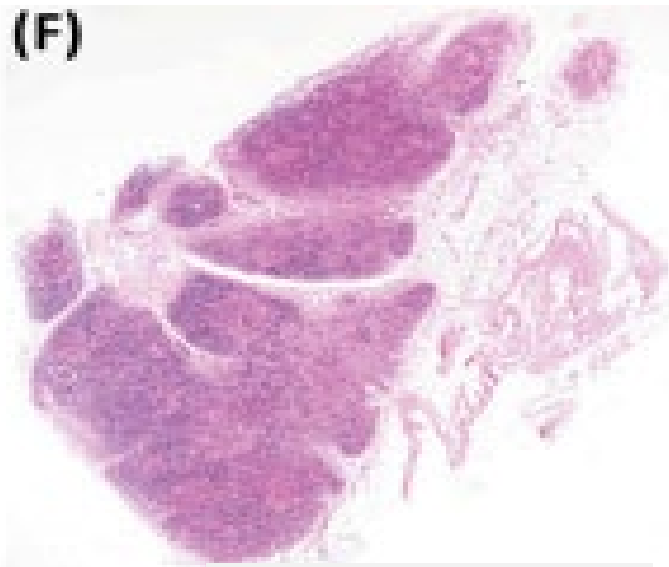




Autophagy

Depletion of T cells (apoptosis)





Wang et al., 2019

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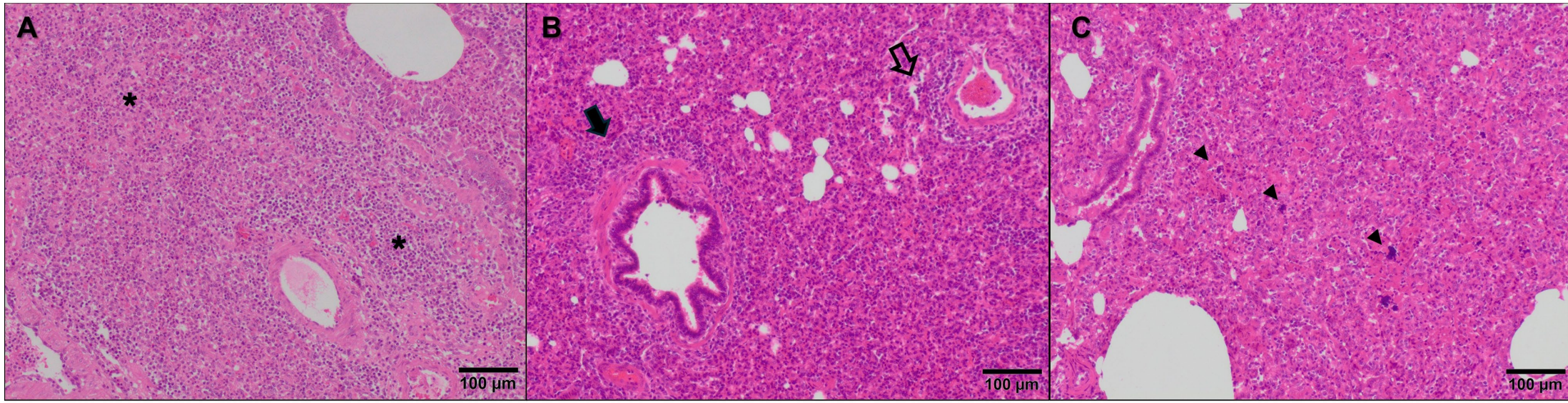
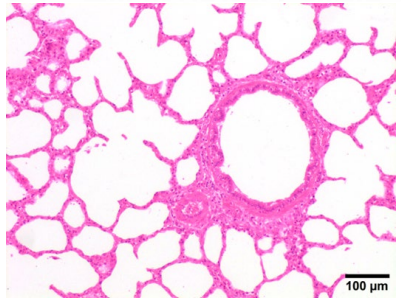
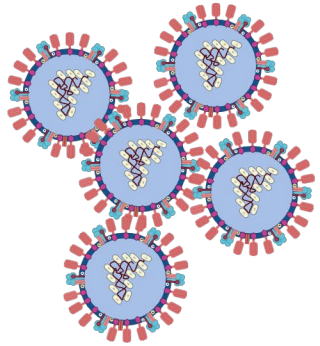
Strong inflammatory responses



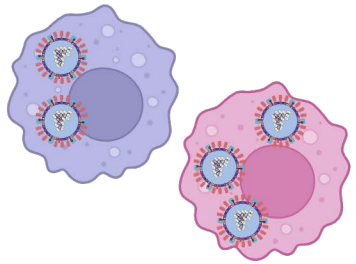


1 **Increased replication capability**

2 **Enhanced macrophage tropism**

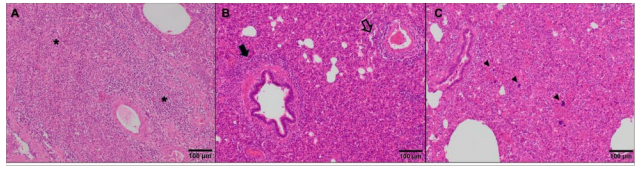


↑ depletion of macrophages
↑ Inflammatory signals
↑ Viral loads
↑ Nasal shedding
↑ Apoptosis of infected and bystander cells

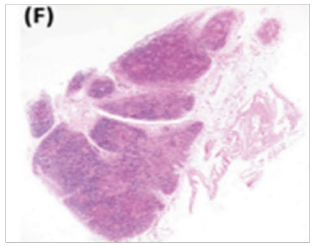


3 **Strong inflammatory responses**

4 **Involvement of the thymus**



↑ Mortality
↑ Weight loss
Longer recovery periods



HIgher fever
More severe pneumonia
Perivascular infiltrate in the lung
More severe placentitis?

↑ Secondary infections
Impaired T-cell repertoire

Depletion of T cells and APC

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3. Chronology of Rosalia's epidemics in Spain

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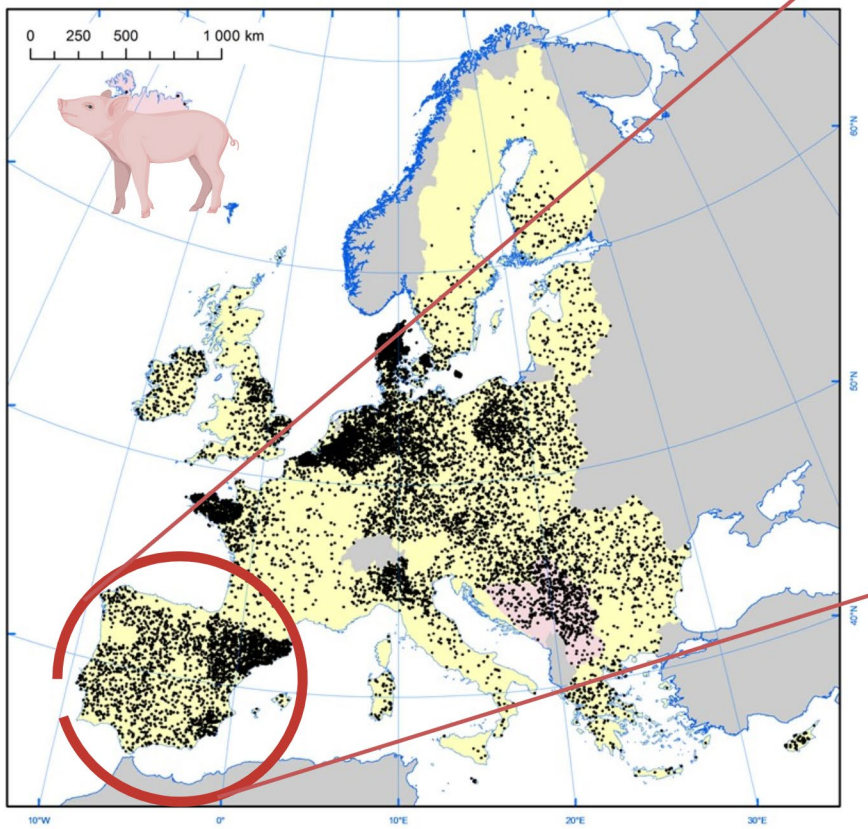
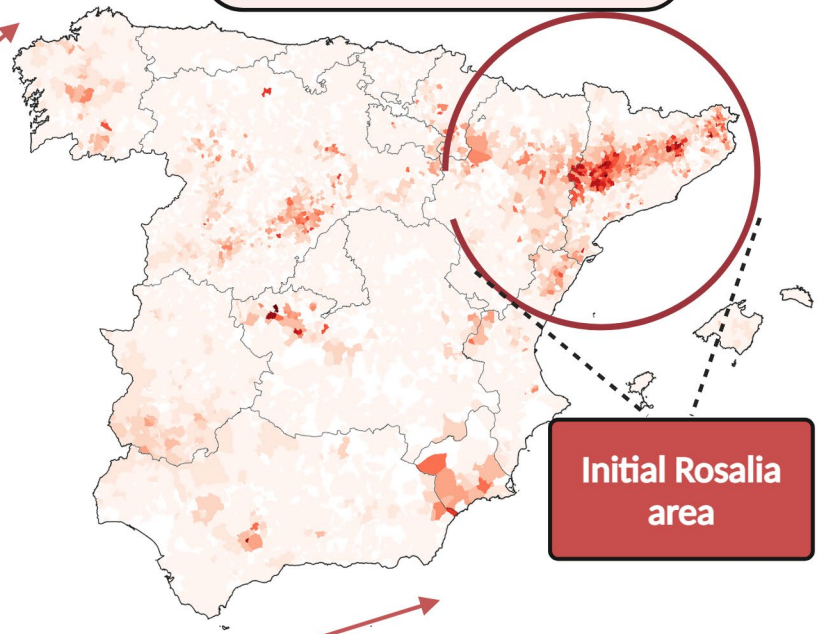
CONTEXT

EU pig census (2022) - 146 million pigs



Spanish pig census (2022) - 34 million pigs (23% EU)

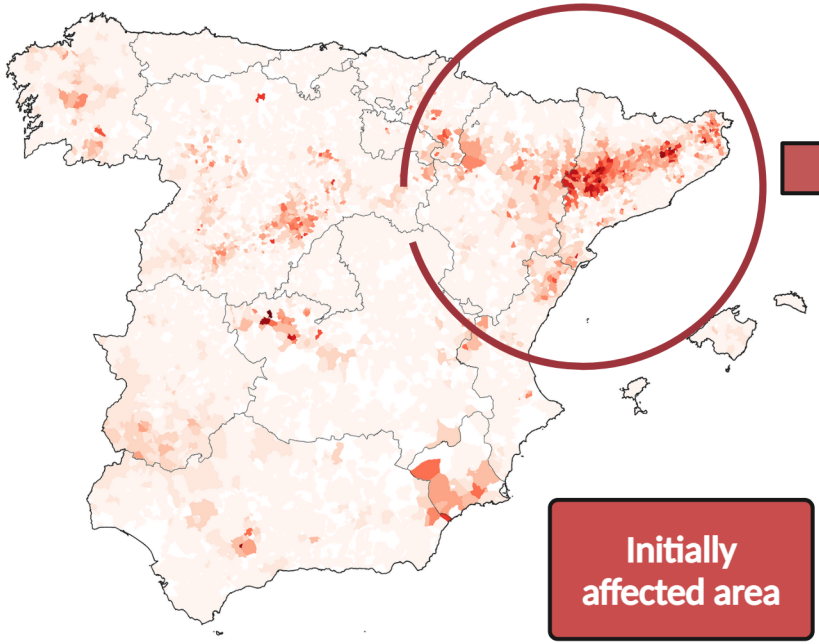


Initial Rosalia area

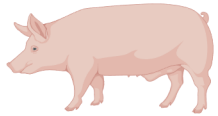
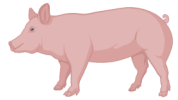
80,000 sq Km, approx. the surface of Austria

Approx. 18 million pigs

Spanish pig census (2022) - 34 million pigs (23% EU)

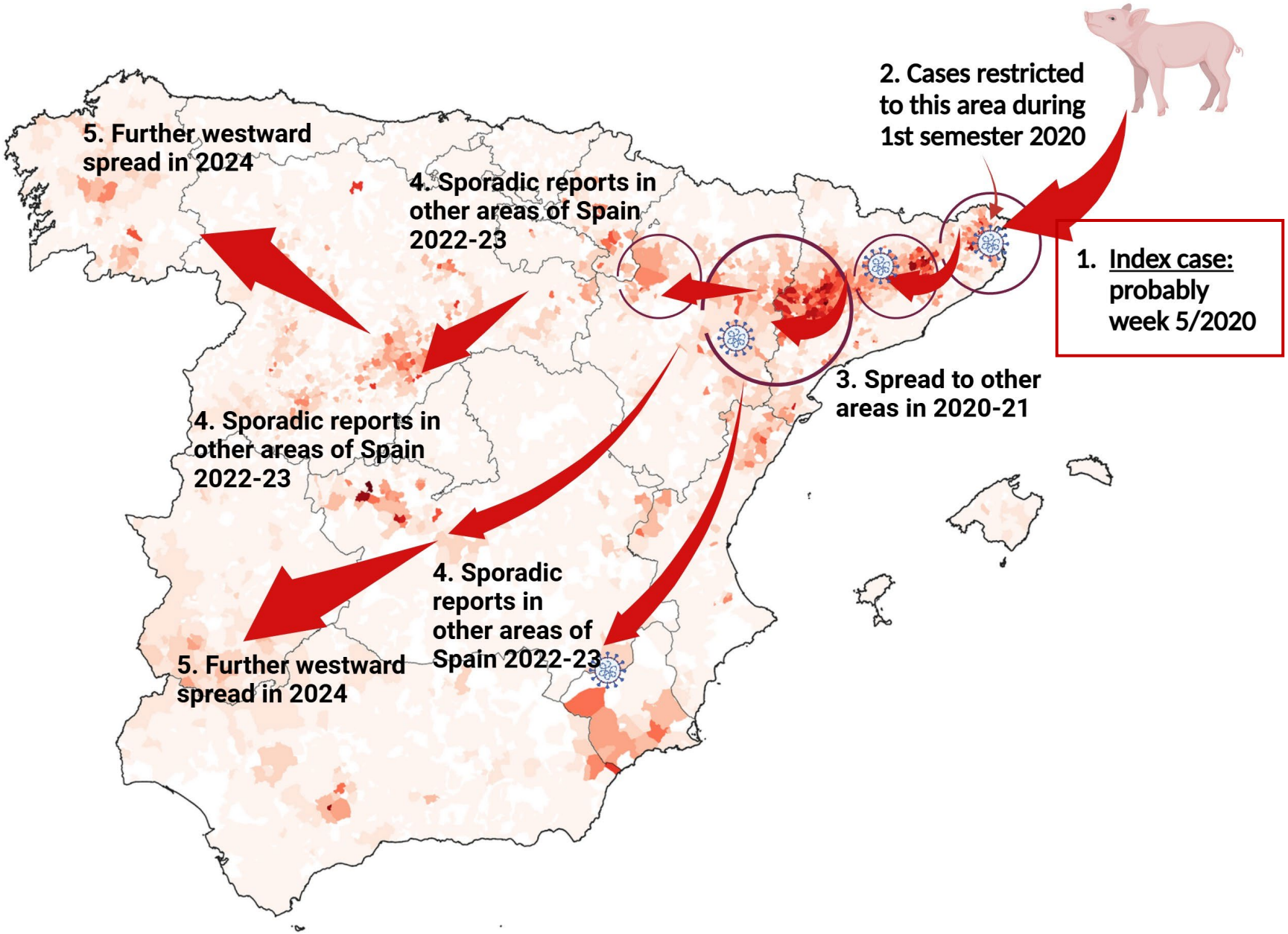


Initially affected area

Breeders	Nurseries	Fattening
		
1,000 farms	490 farms	8,000 farms
Average size 1,400 sows		

PRRSV PREVALENCE- 50-70%
PRRSV-1

Vaccination ≥70%	Vaccination ≤15-20%	Vaccination ≤5%


2. Cases restricted to this area during 1st semester 2020
1. Index case: probably week 5/2020
3. Spread to other areas in 2020-21
4. Sporadic reports in other areas of Spain 2022-23
5. Further westward spread in 2024
4. Sporadic reports in other areas of Spain 2022-23
4. Sporadic reports in other areas of Spain 2022-23
5. Further westward spread in 2024

At present, Rosalia’s progeny is predominant (>70%) in new outbreaks in the Northeastern part of the country and is spreading fast in other areas

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5. Origin of other highly virulent strains and of Rosalia

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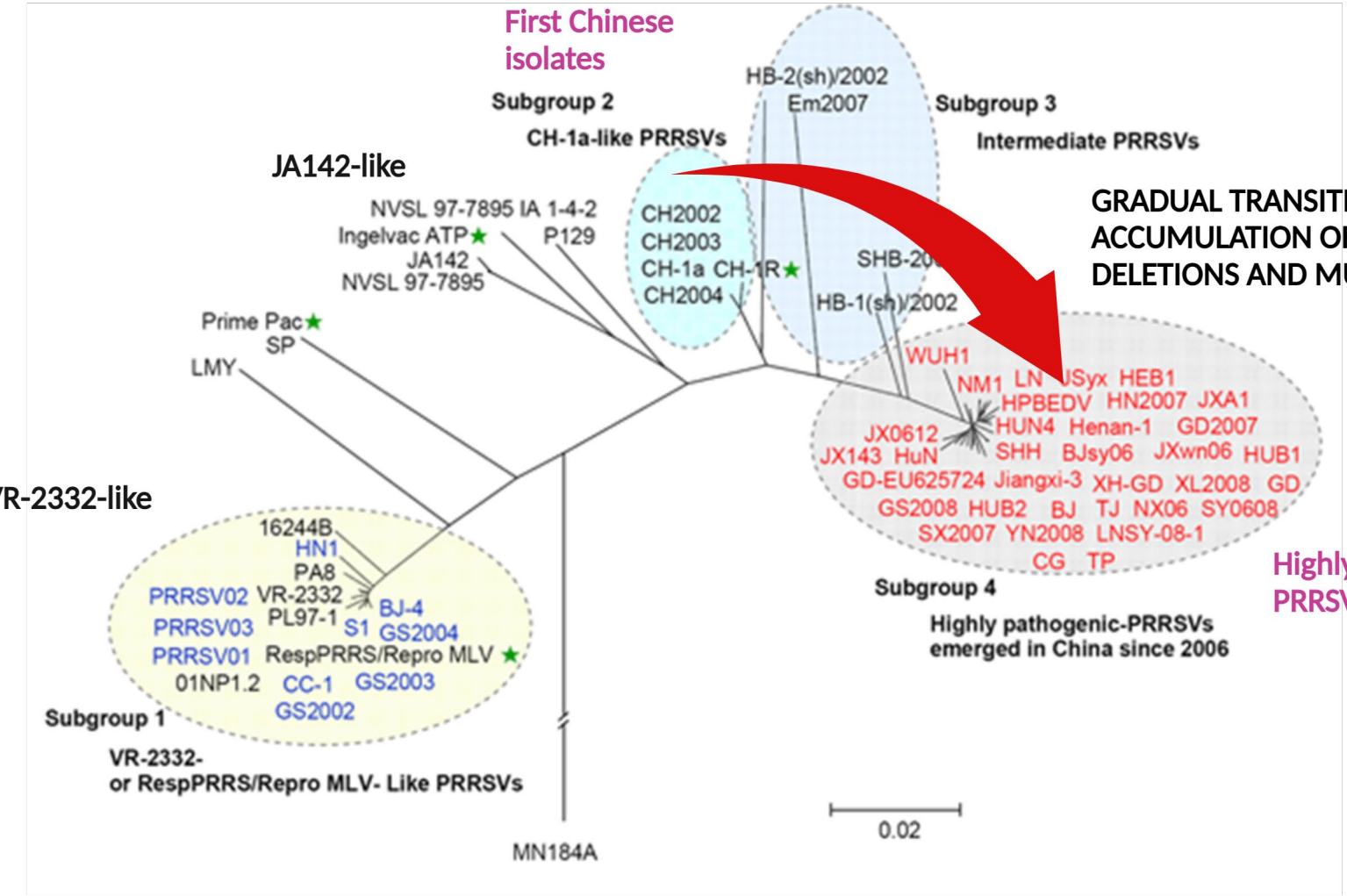
Highly pathogenic PRRSV in China 2006



An et al. Origin of highly pathogenic porcine reproductive and respiratory syndrome virus, China. Emerg Infect Dis. 2010 Feb;16(2):365-7. doi: 10.3201/eid1602.090005.

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PRRSV 1-4-4 L1C emerged in the Midwest during 2020 fall and a second wave happened in 2021

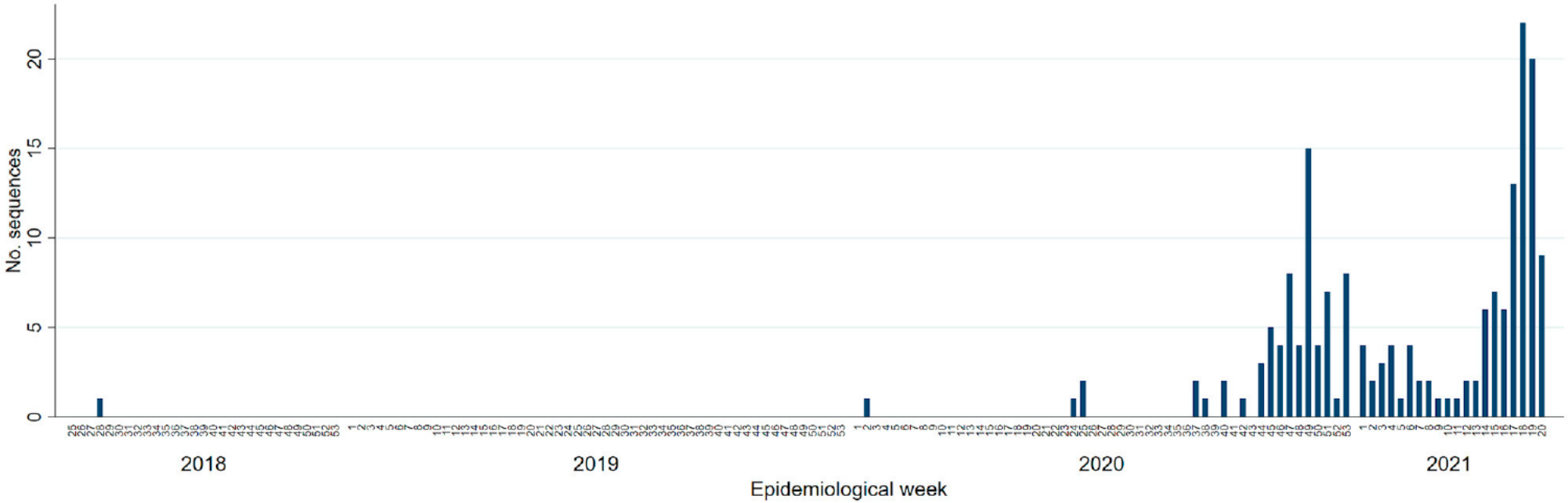

FIGURE 1 | Epidemic curve of the Porcine Reproductive and Respiratory Syndrome Virus Lineage 1C variant associated with this outbreak by epidemiological week amongst participants of the Morrison Swine Health Monitoring Project in the United States, January 2018 to May 2021.

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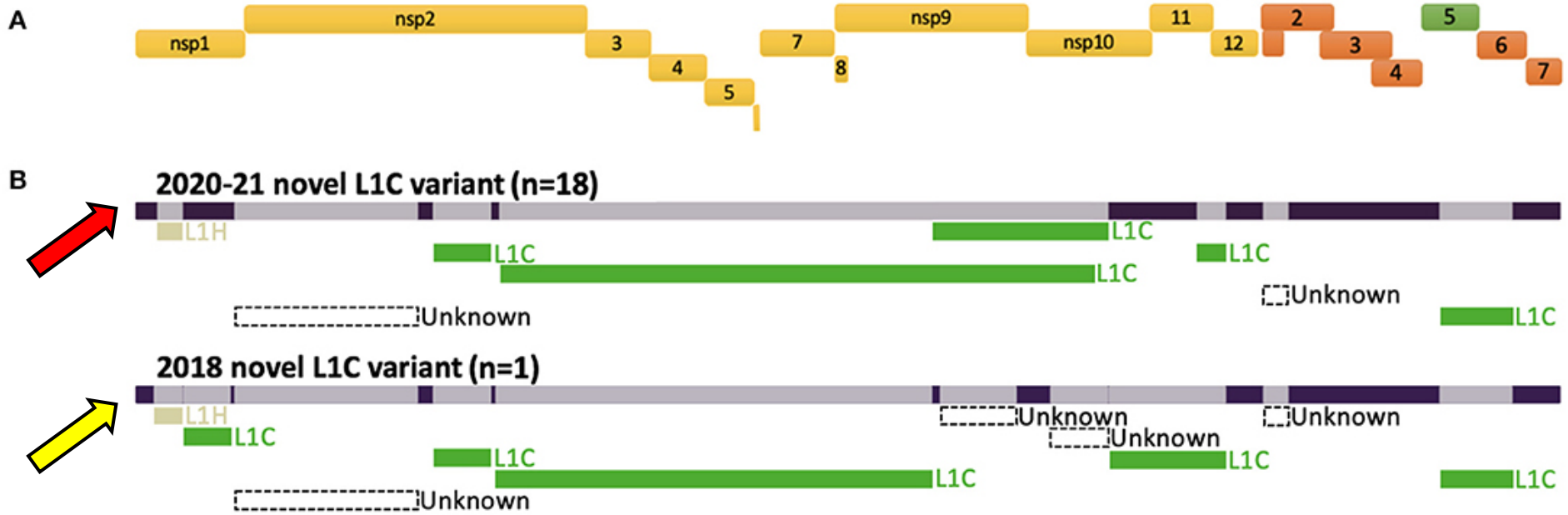
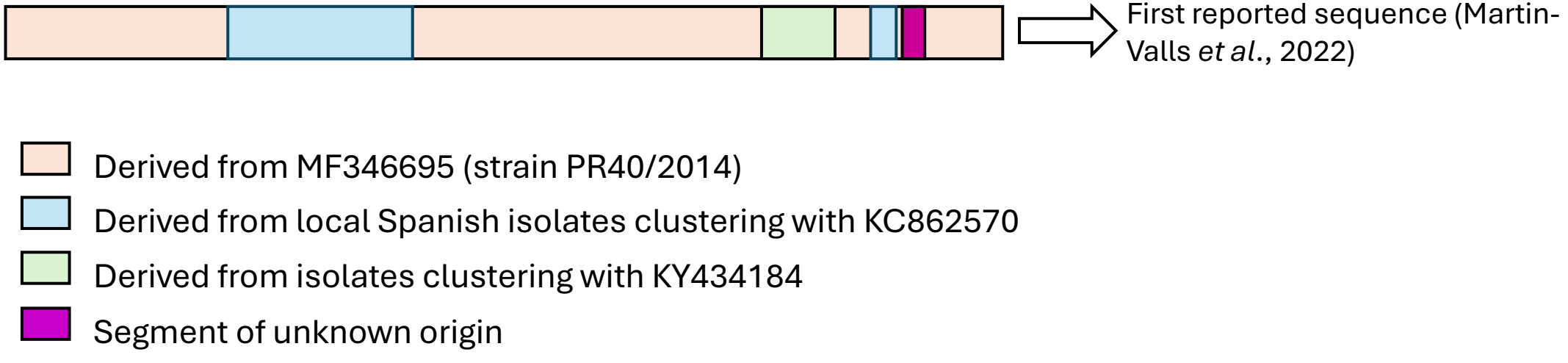
PRRSV 1-4-4 L1C in the USA is the result of several recombination events within Lineage 1



Pamornchainavakul et al. (2022). Measuring How Recombination Re-shapes the Evolutionary History of PRRSV-2: A Genome-Based Phylodynamic Analysis of the Emergence of a Novel PRRSV-2 Variant. *Frontiers in veterinary science*, *9*, 846904. https://doi.org/10.3389/fvets.2022.846904

Rosalía strain in Spain is the result of a recombination between some strain of the Italian PR40 clade emerged in 2014 and local Spanish strains



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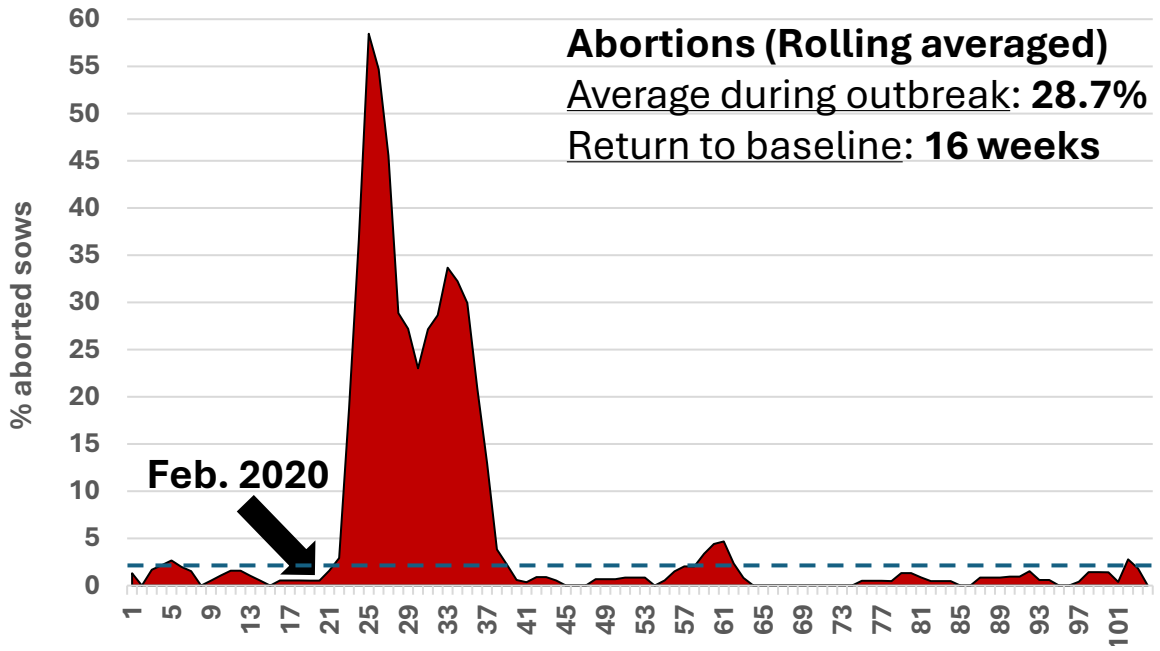
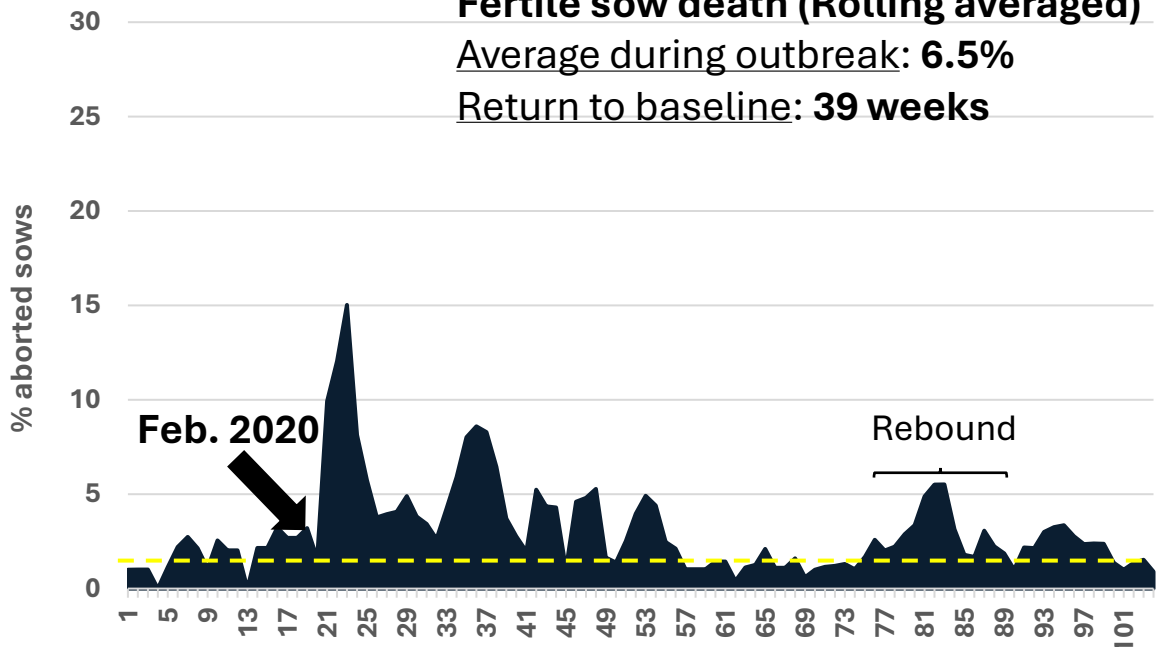
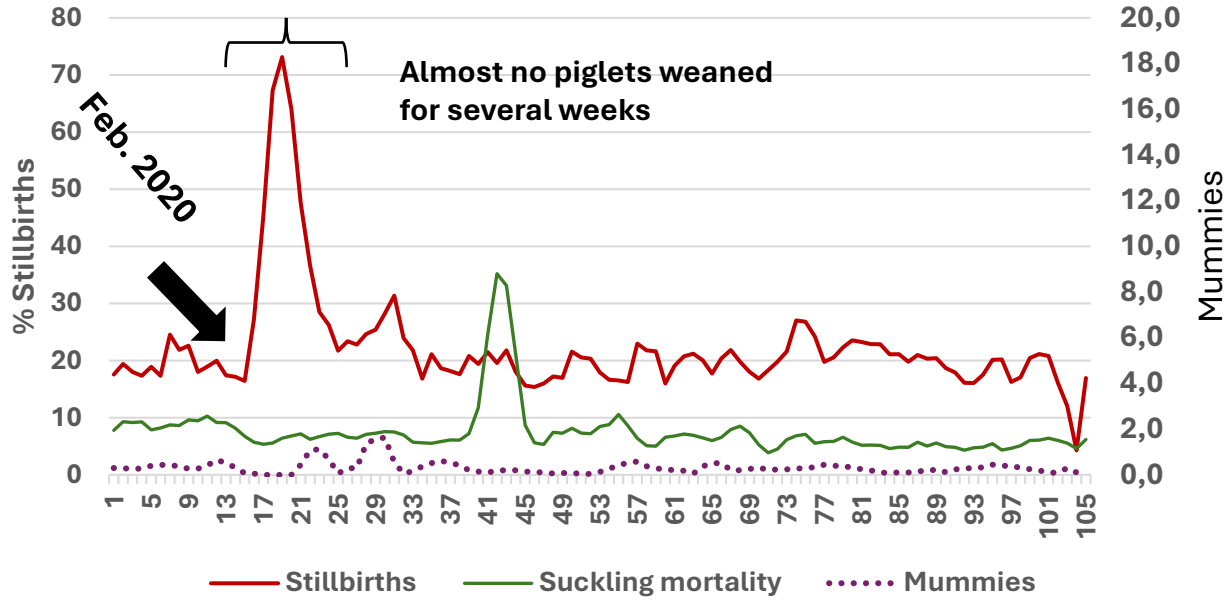
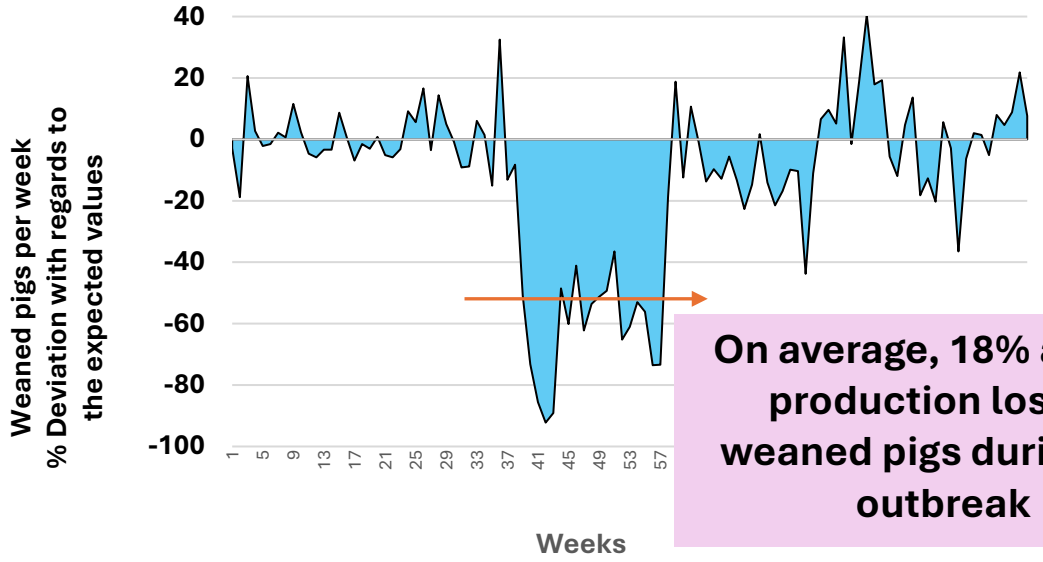
5. The impact of Rosalia on the affected farms and on ºthe Spanish pig production

A) Early outbreak (Winter-spring 2020). Example: PRRSV-1 stable farm (M2, 1,330 vaccinated shows)









On average, 18% annual production loss of weaned pigs during the outbreak

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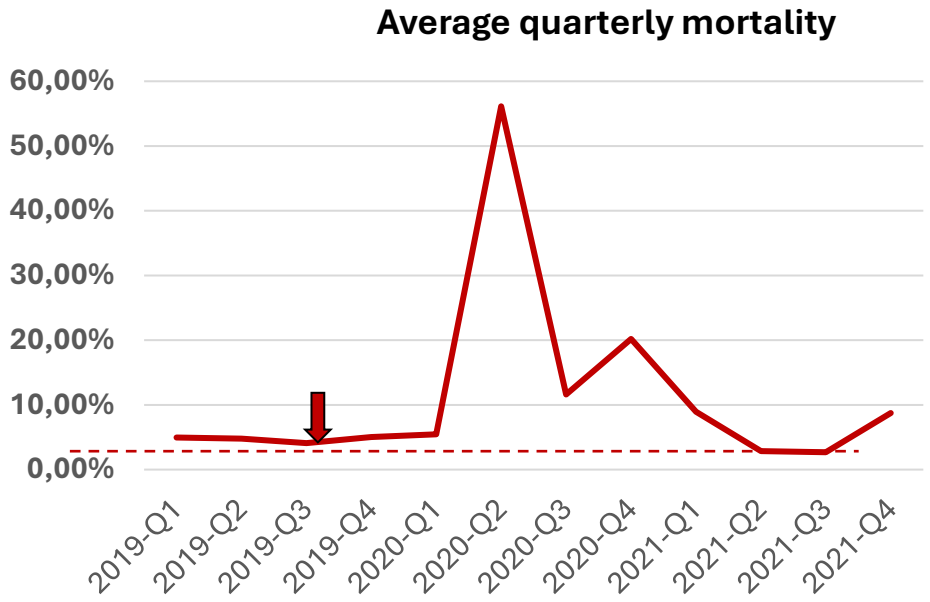
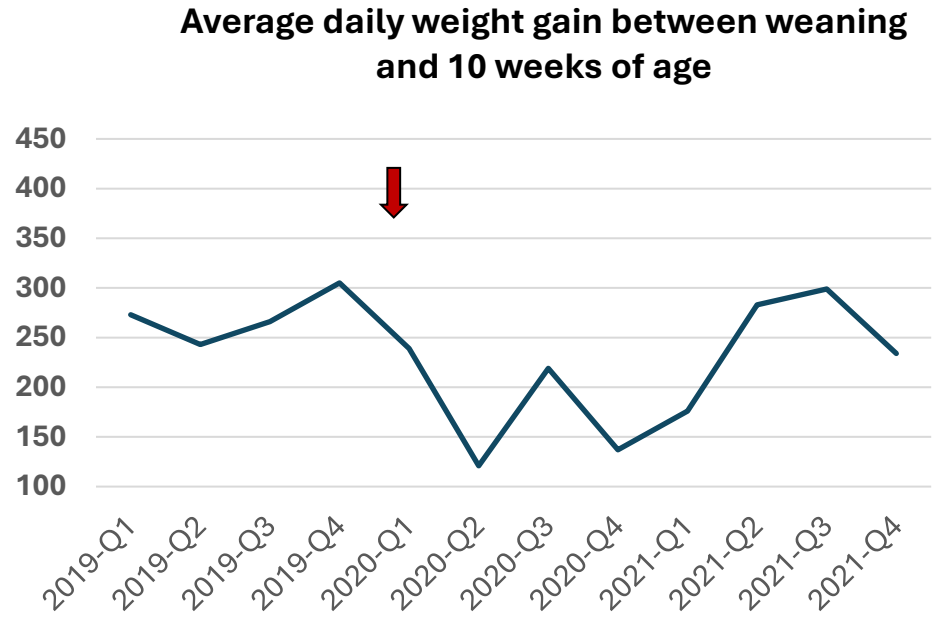
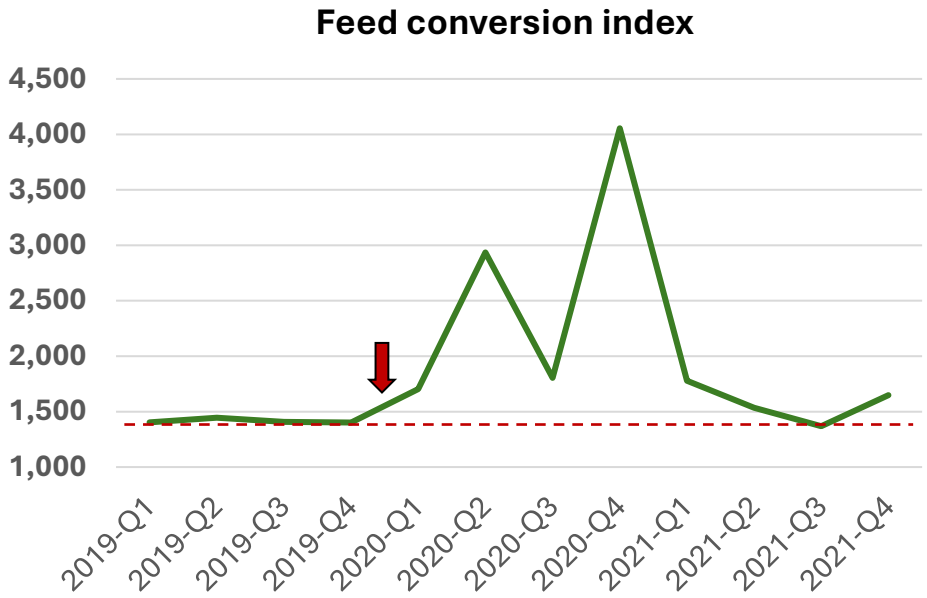
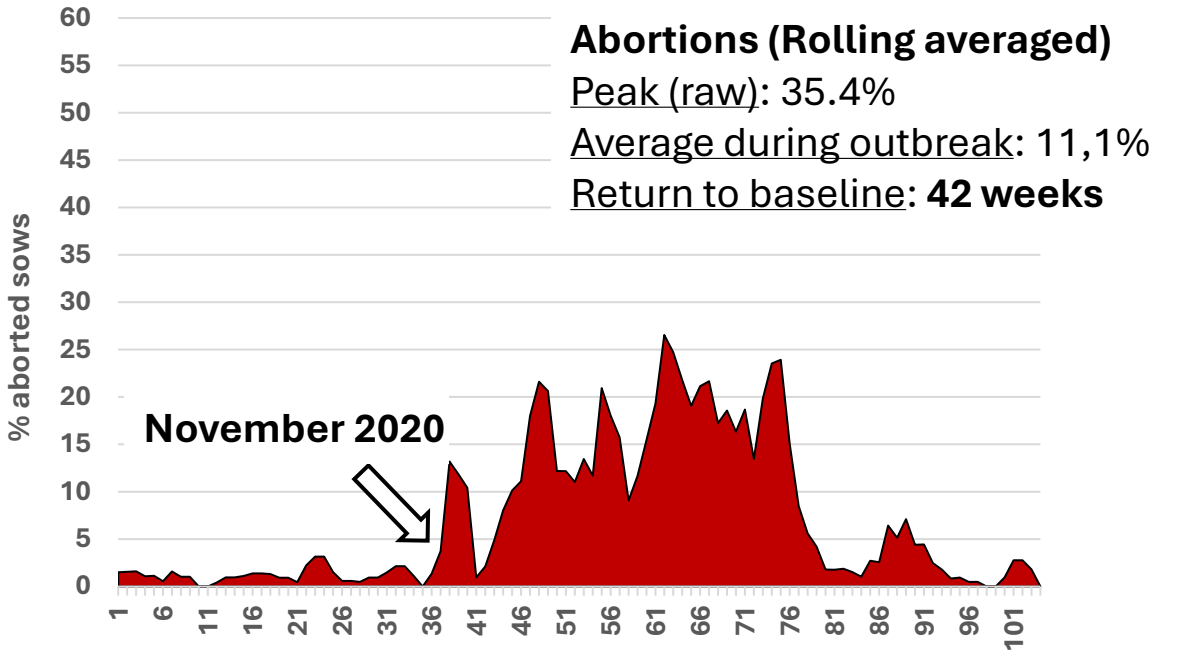
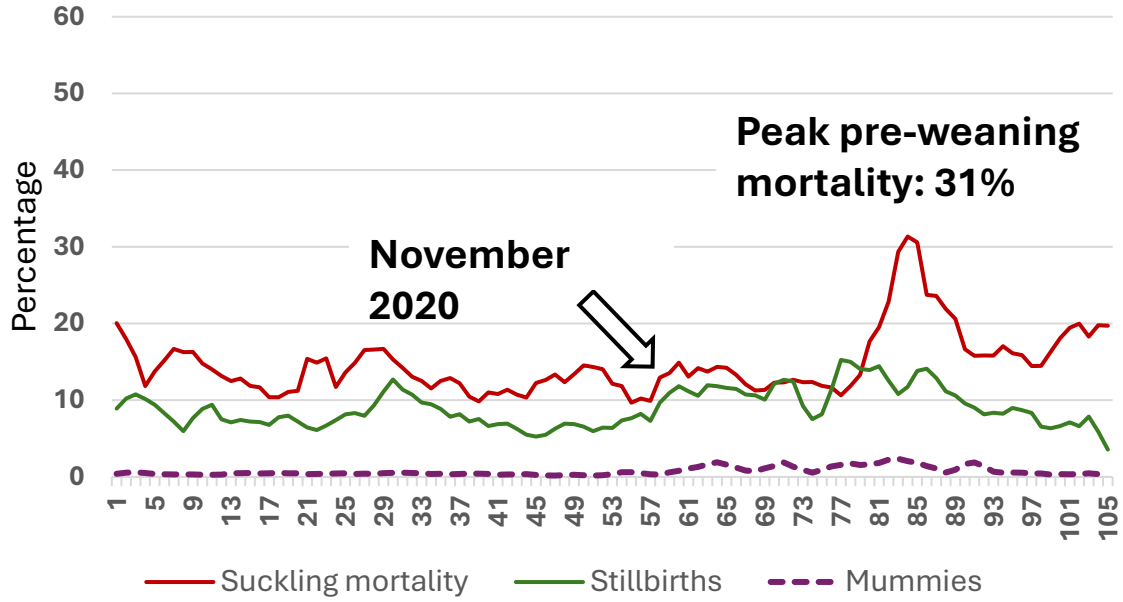


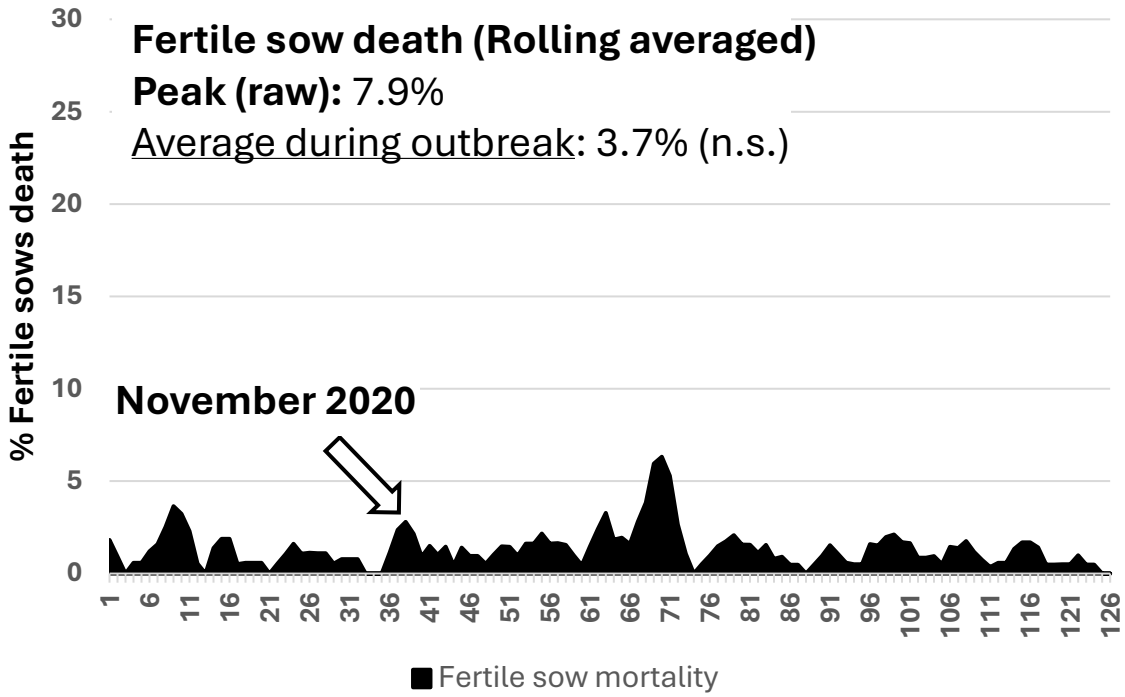


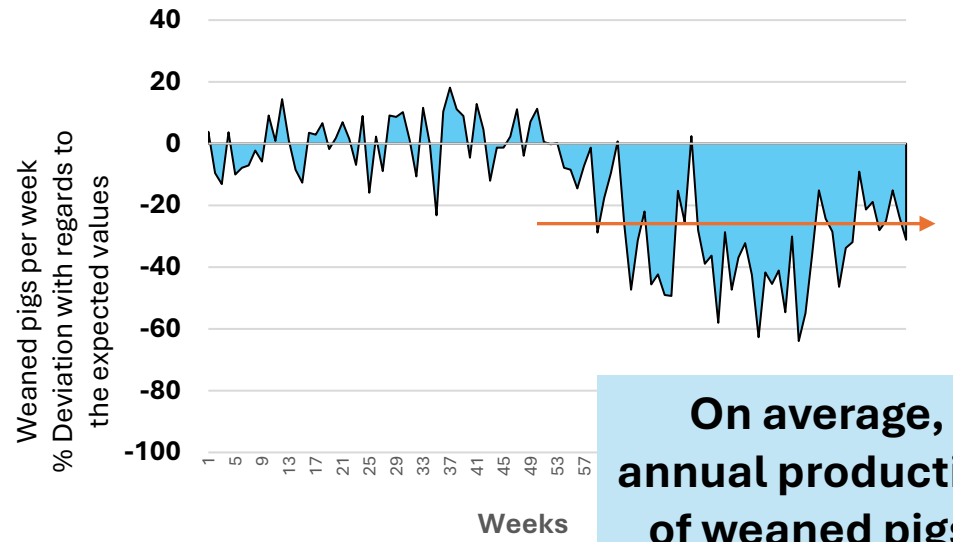


B) Second Wave (Late 2020-Early 2021). Example: Stable vaccinated farm (M7, 1,200 sows)





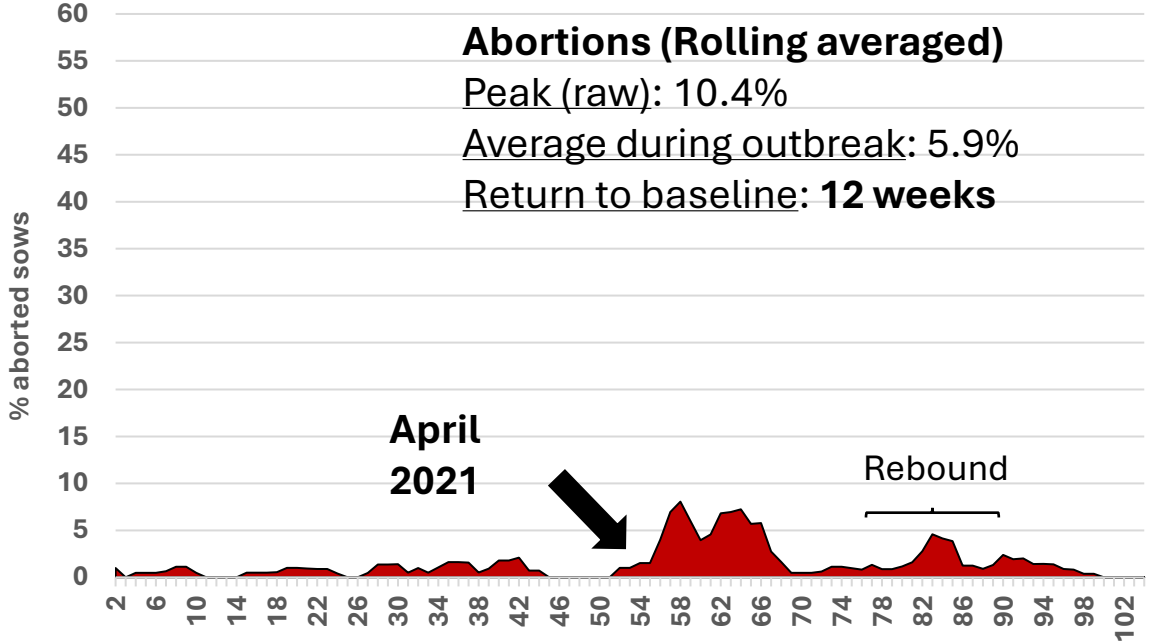


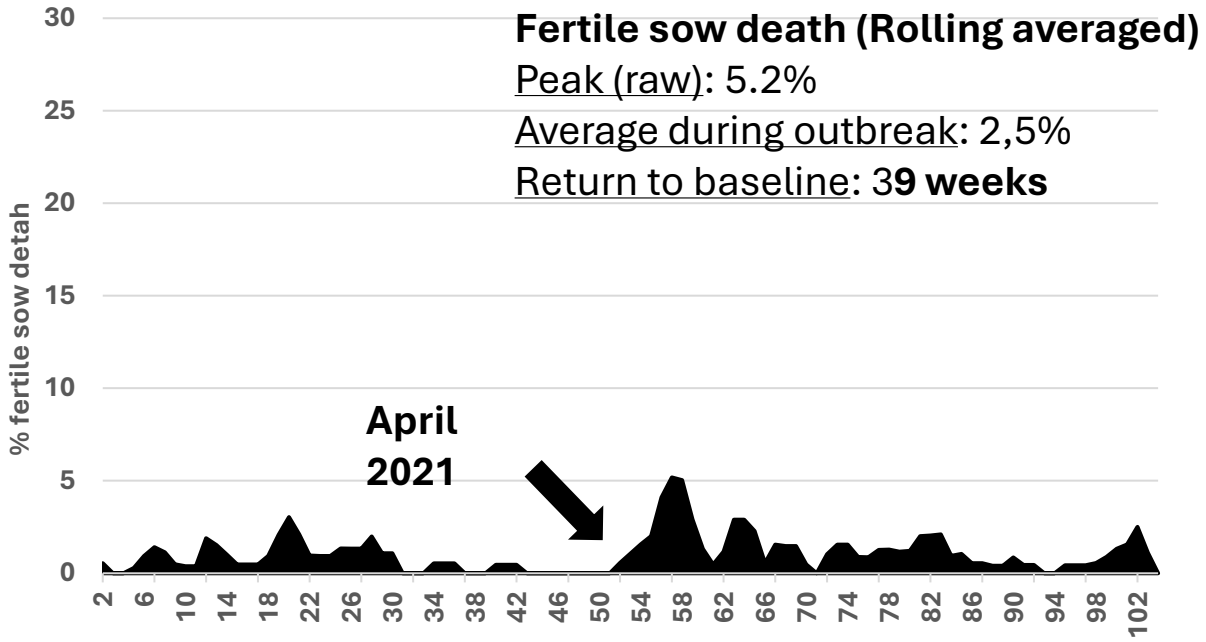


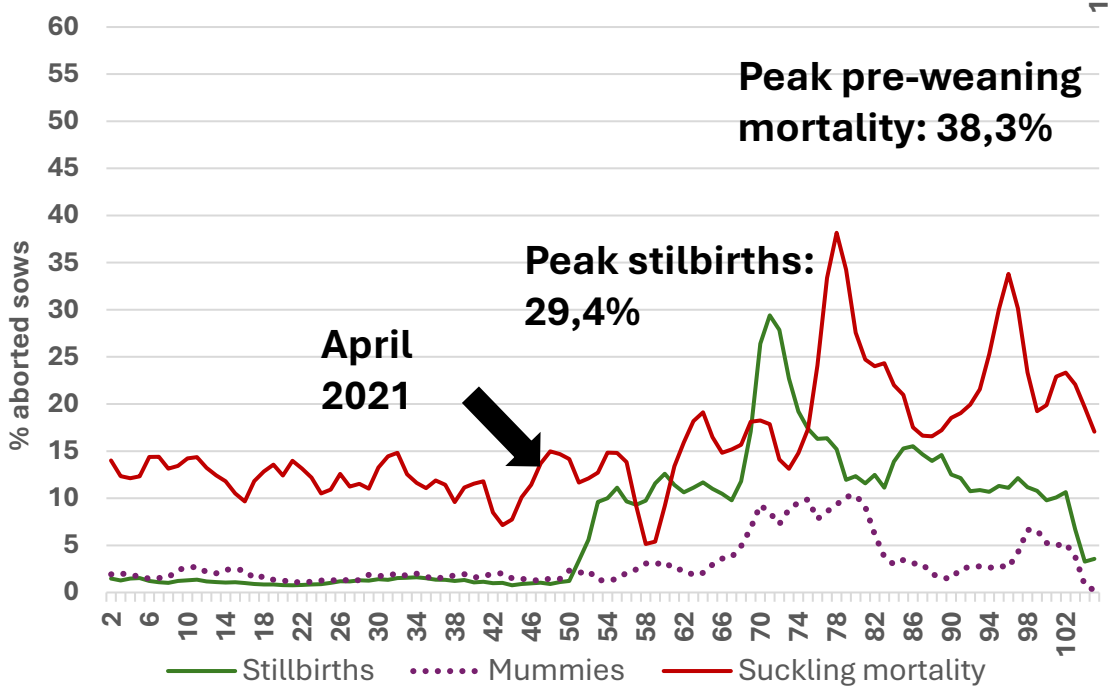
On average, 17% annual production loss of weaned pigs after the outbreak

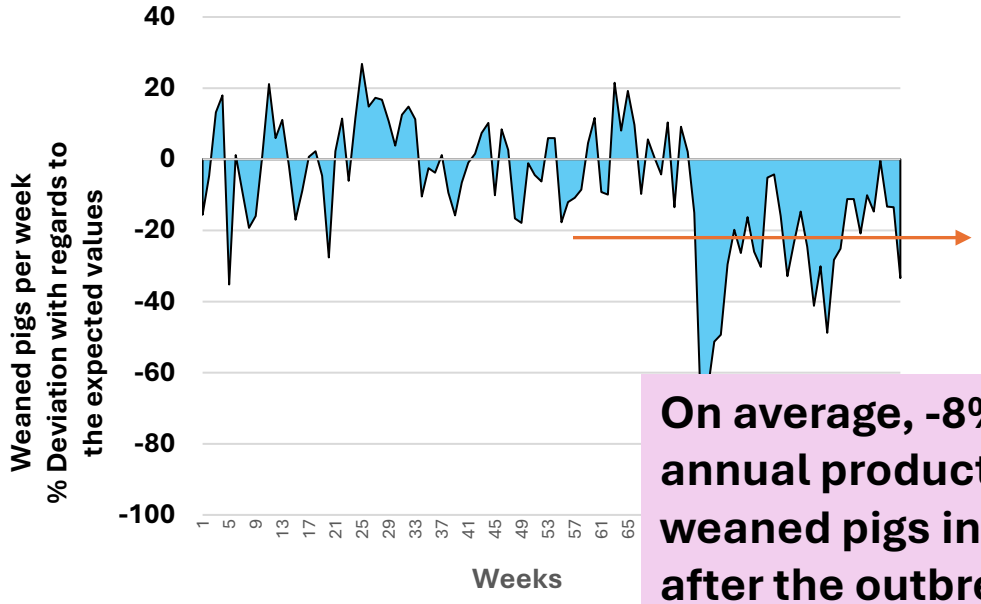
C) Rosalia's Third Wave (spring-summer 2021). Example: Unstable unvaccinated farm

IMPACT









On average, -8% annual production of weaned pigs in 1 year after the outbreak

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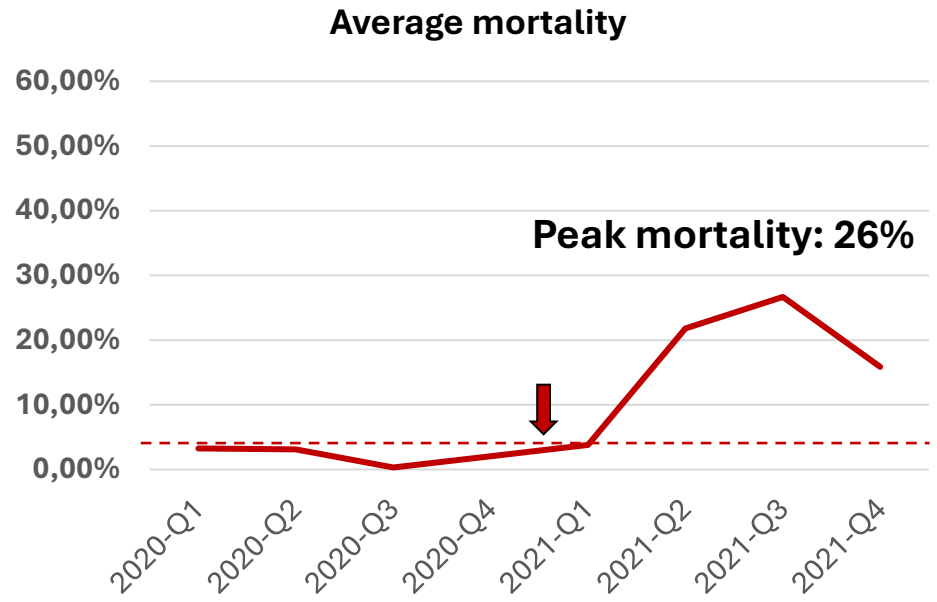

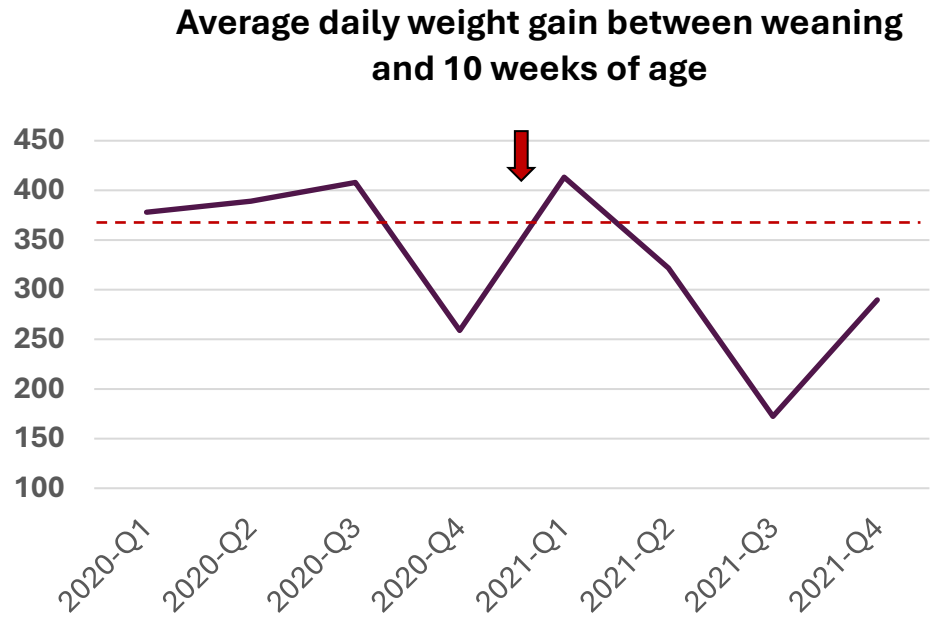

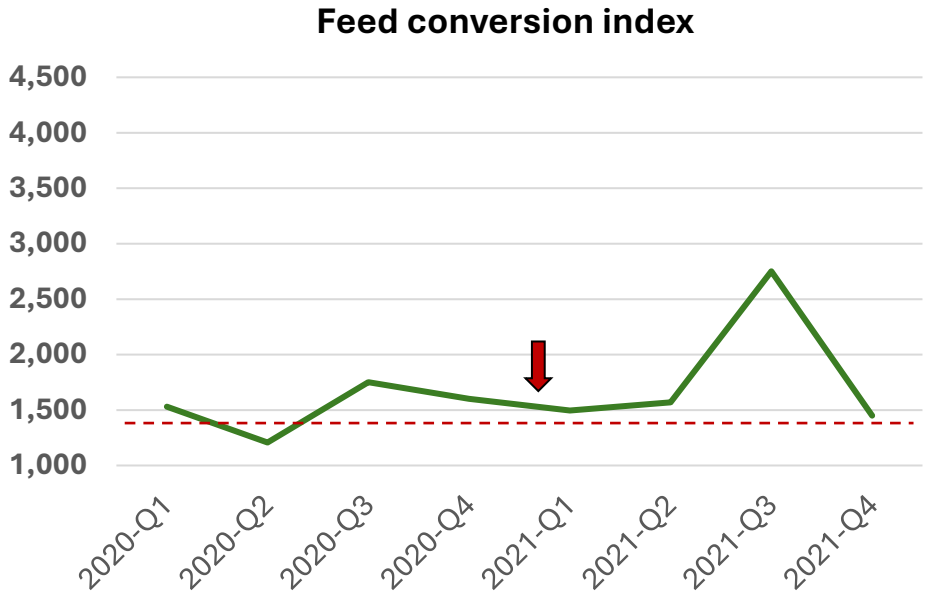

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- Explosive onset
- Extremely high abortion rate
- Relatively fast return to baseline (reprod)
- Nurseries remained affected longer

- Explosive onset
- Very high abortion rate
- Slow return to baseline
- Nurseries affected longer

- Not that explosive onset
- High abortion rate
- Relatively fast return to baseline (reprod.)
- Nurseries affected longer

- Apparently less reproductive impact
- High mortality (>10%) in nurseries

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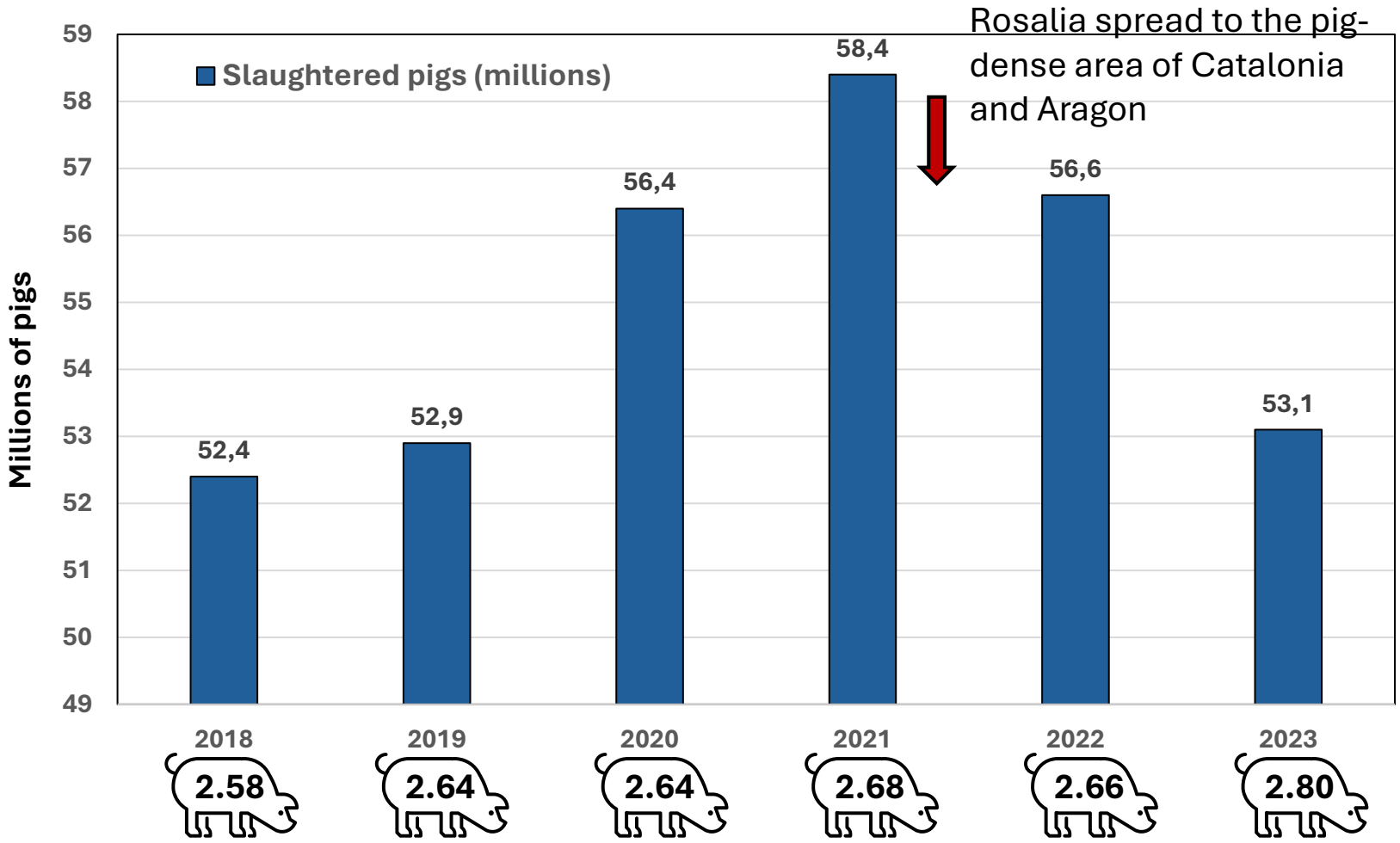
Slaughtered pigs (millions)



With 160,000 sows more than in 2019, the number of slaughtered pigs is similar to that year, this means a deficit of about 3.75 million pigs that are mostly imported from the Netherlands and Germany

6. Attempts to control the impact of the infection in the affected farms

EMERGENCY VACCINATION

Little effectivity
Apparently did not contribute to significantly reduce the duration of the outbreak in sows
Seldom used in piglets

MANAGEMENT CHANGES

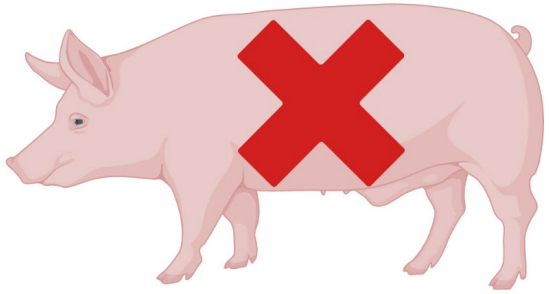
MCREBEL

Slightly effective
Help to alleviate mortality, particularly in early age.
Stop moving animals, the most important action.

CHANGES IN BATCH PERIODICITY

Effective
Switching from 1-week farrowing batches to 3 or 5-week farrowing batches has been the most effective measure up to now to alleviate the outbreaks

DEPOPULATION



Effective (?)
Seldom applied because of the risk of reinfection.
Some farms considered it.
Nursery depop once stable

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7. Vaccination in the Rosalia model

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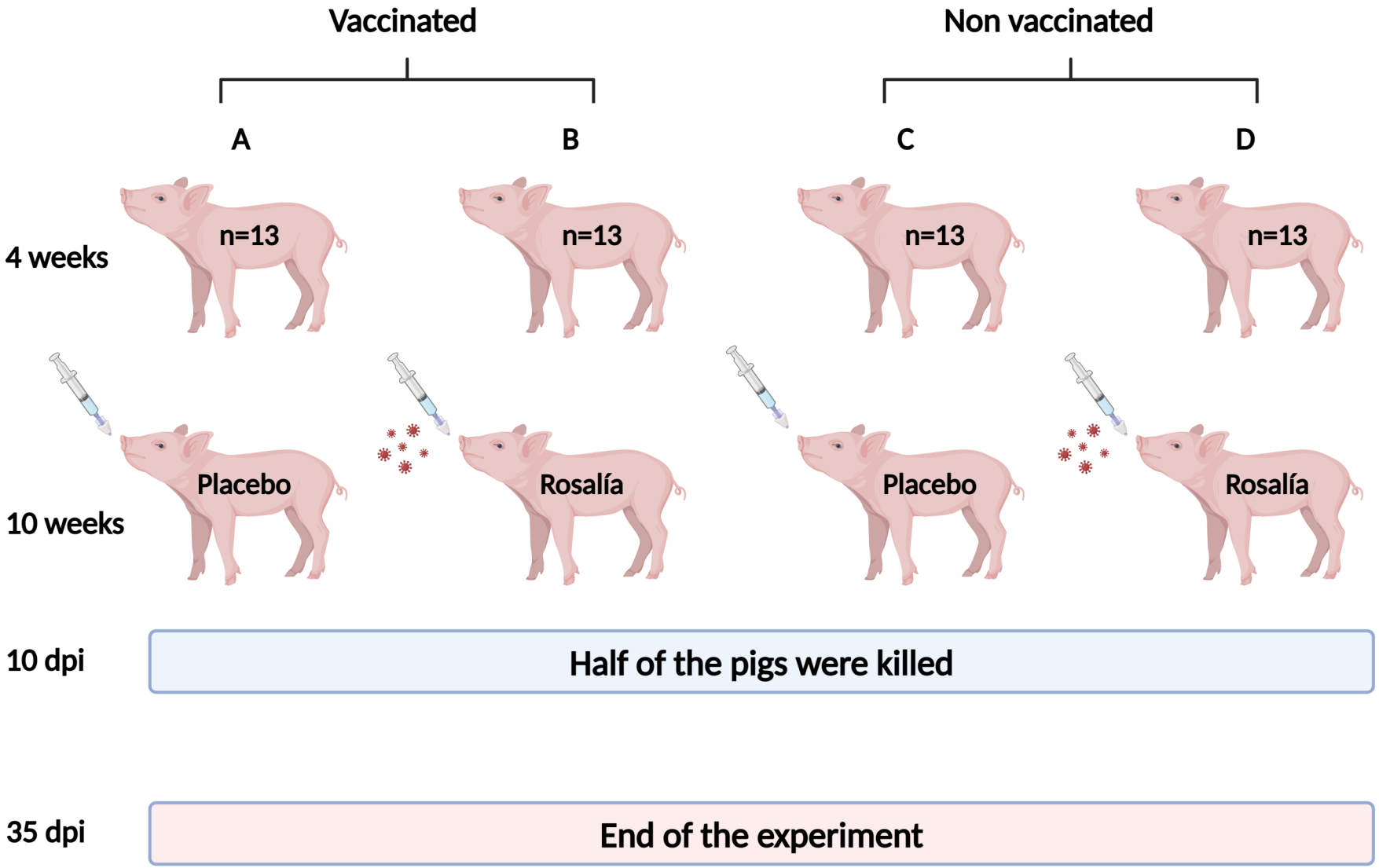
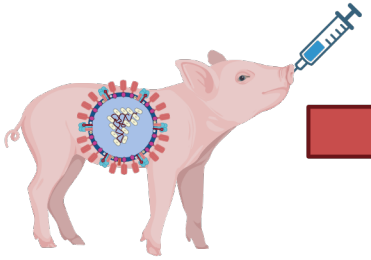
PORCILIS™ PRRS - ID



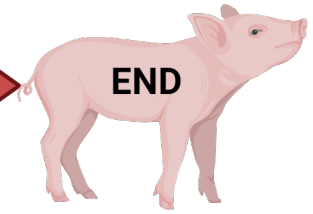
$10^{5.5}$ $TCID_{50}$/ml
1 ml nostril
Strain Rosalia

VACCINATION PHASE

- Antibodies
- IFN-γ secreting cells



CHALLENGE PHASE



- Temperature (-2-14 dpc)
- Clinical signs
- Lung lesions (10 and 35 dpc)
- Gain weight (weekly)
- Viremia and viral sheding
- Lymphopenia
- IFN-γ secreting cells

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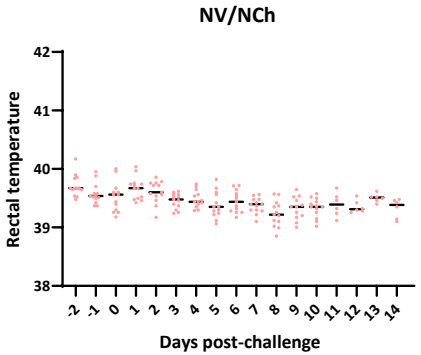
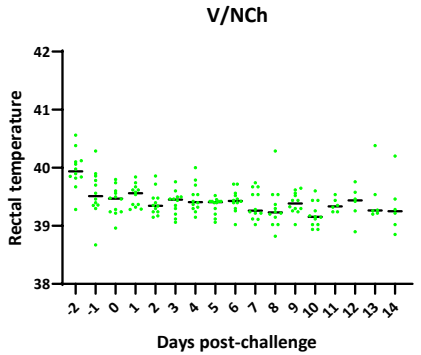
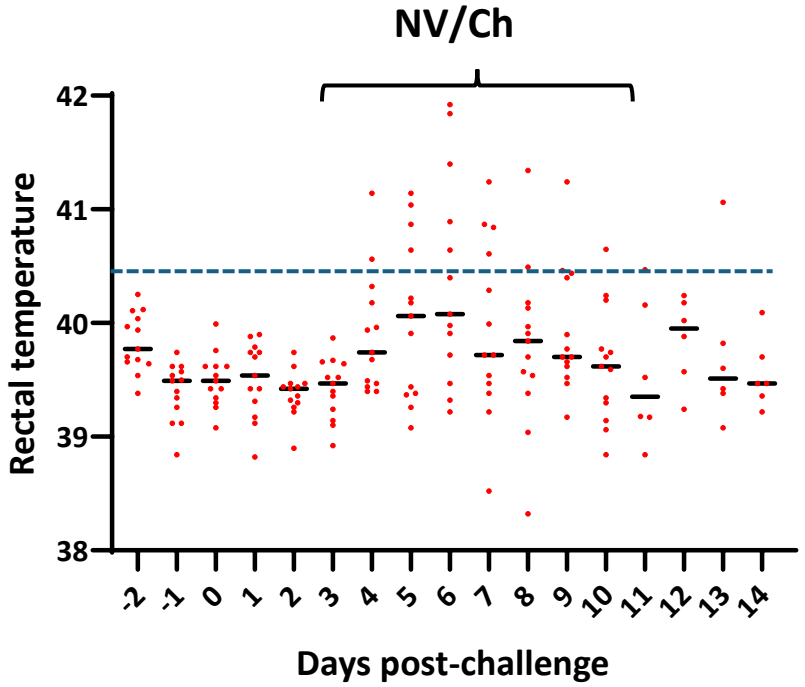
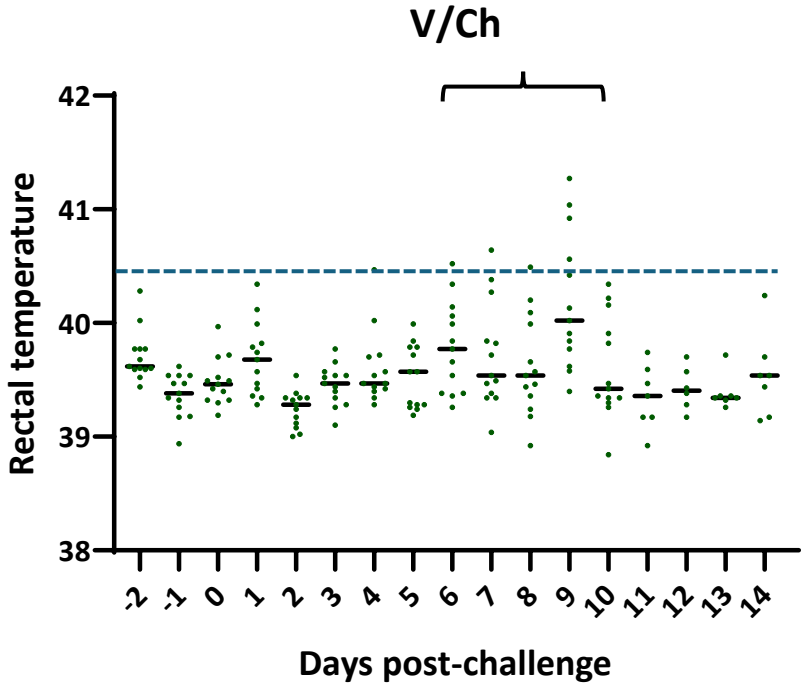
Results (temperature)

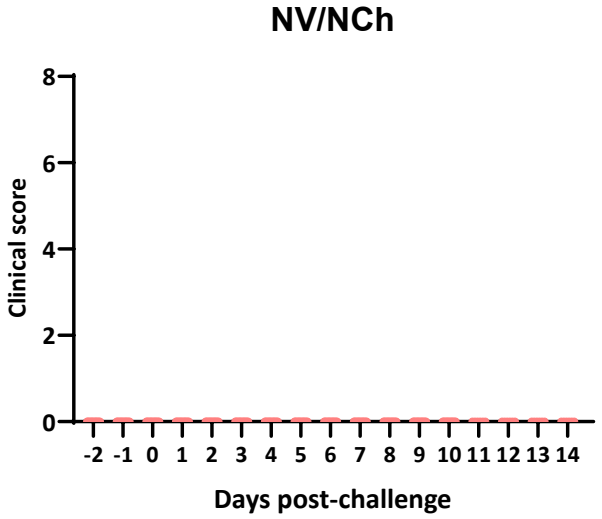


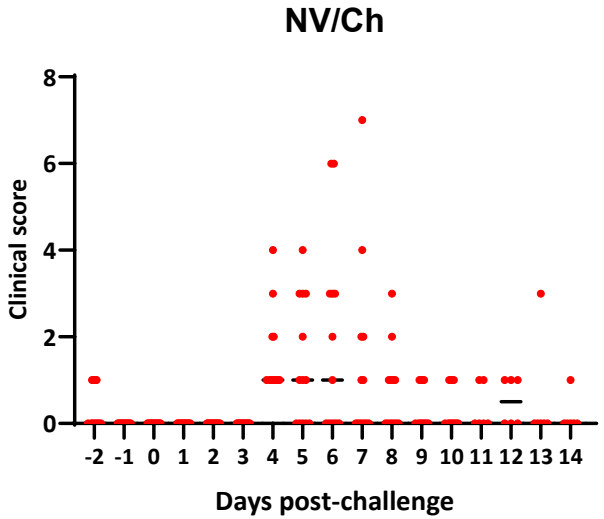




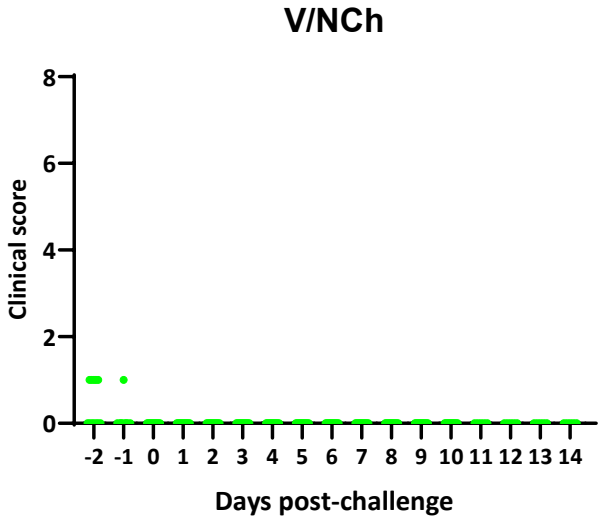


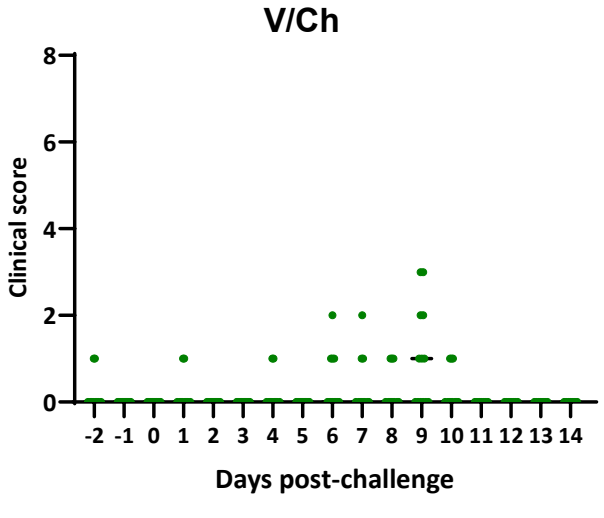
Results (clinical signs)





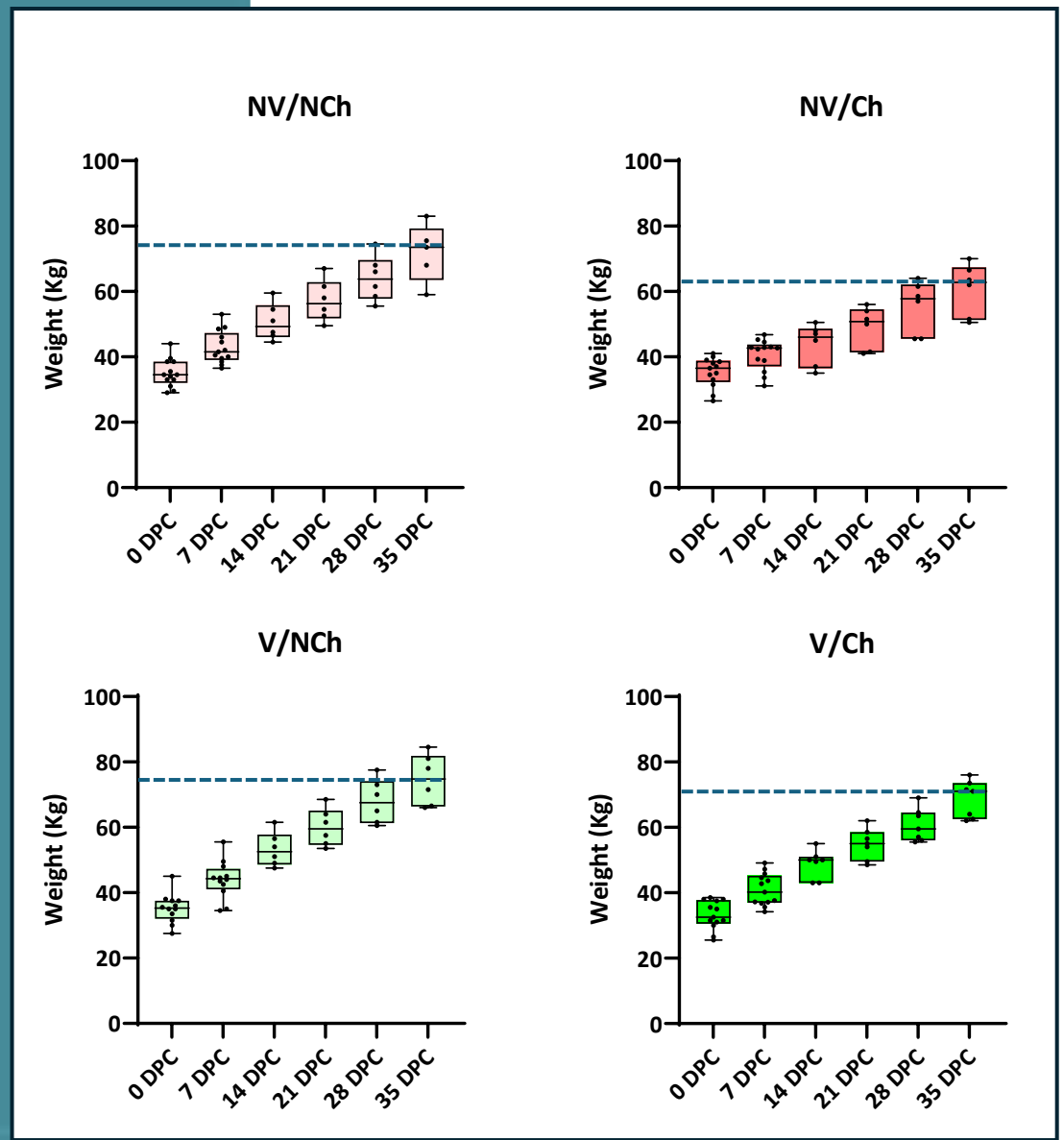
Lethargy
Laboured breath

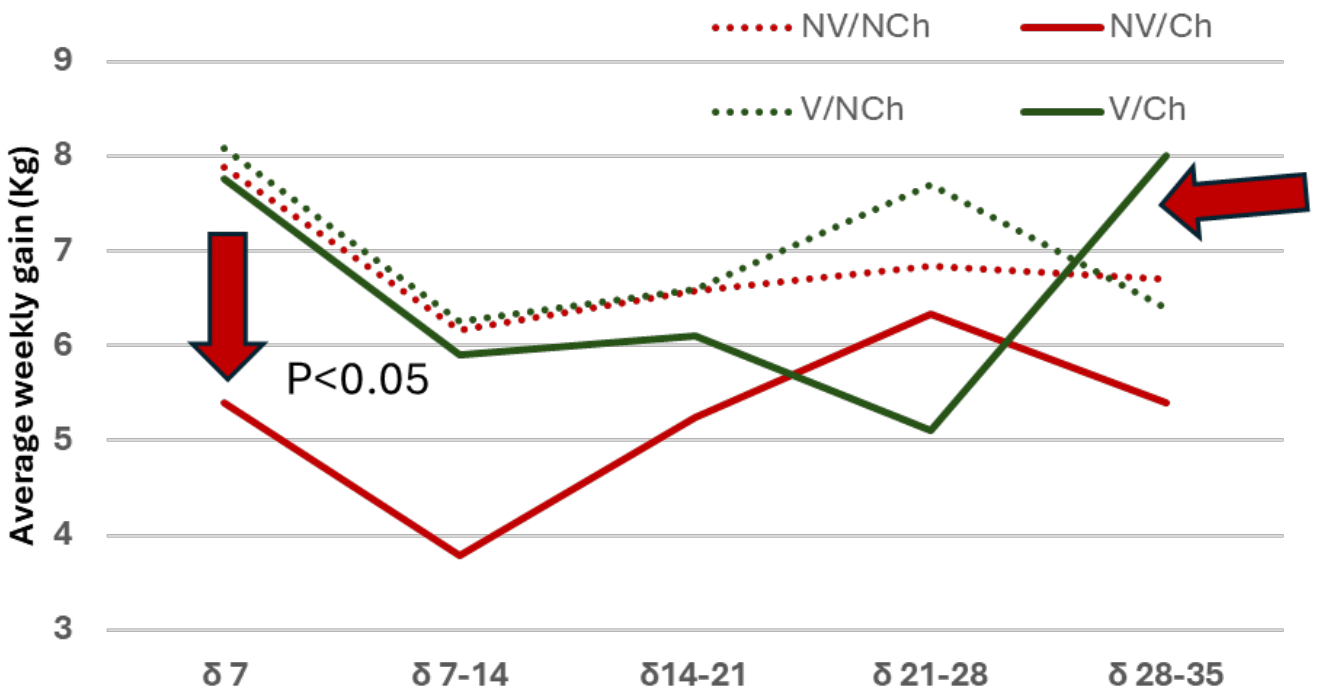




Lethargy

Results (weight gain)





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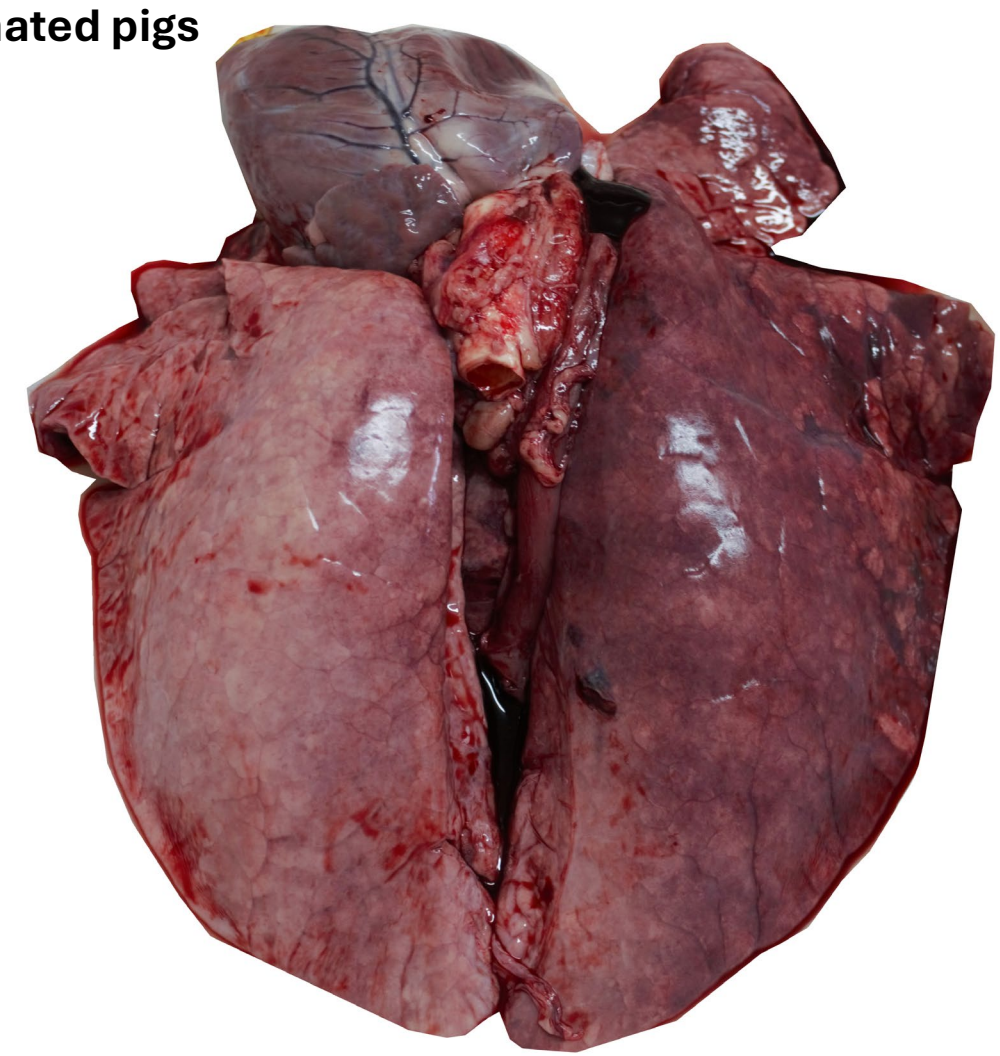
Results (lung lesions 10 DPC)

Moderate to severe Interstitial pneumonia in unvaccinated pigs



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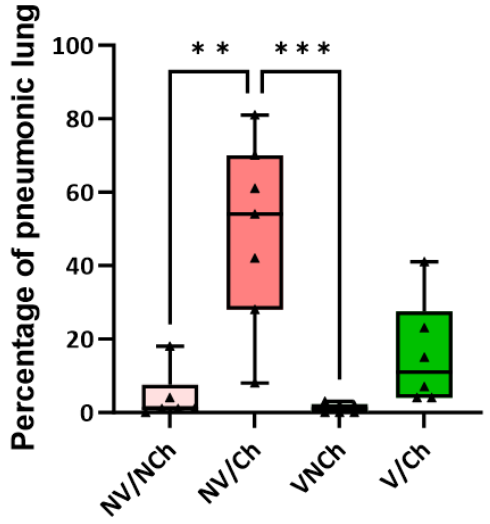
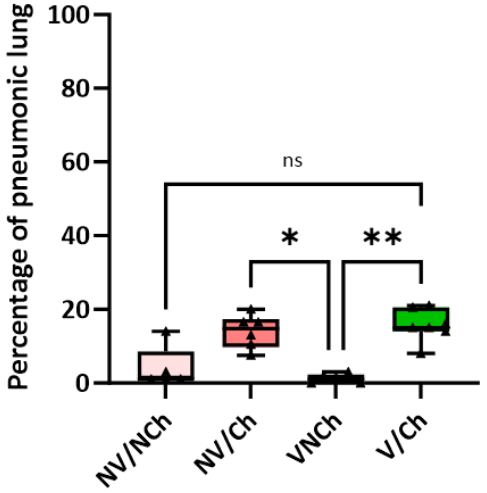
Results (lung lesions)

Macroscopic

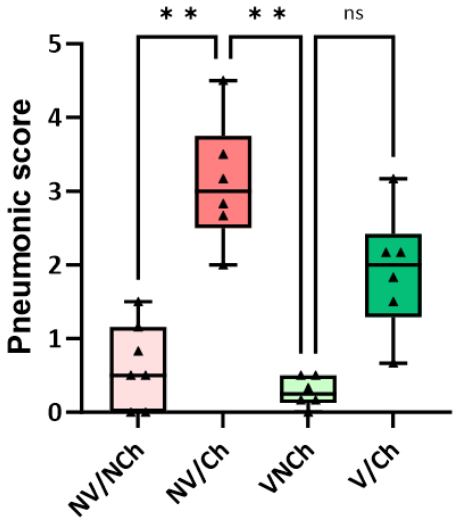
A) 10 days post-challenge

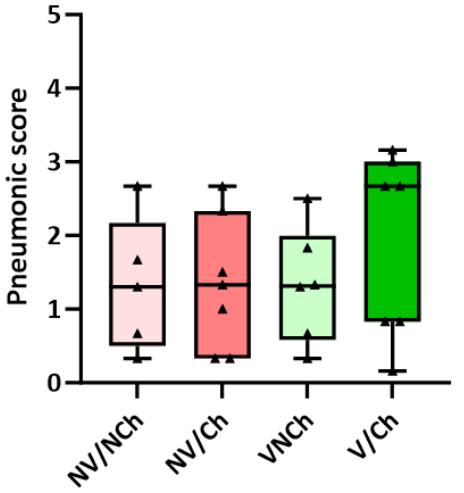


B) 35 days post-challenge



Microscopic





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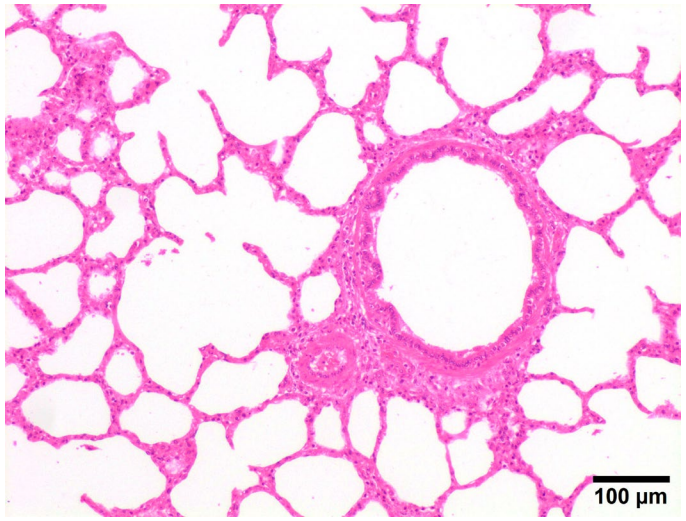
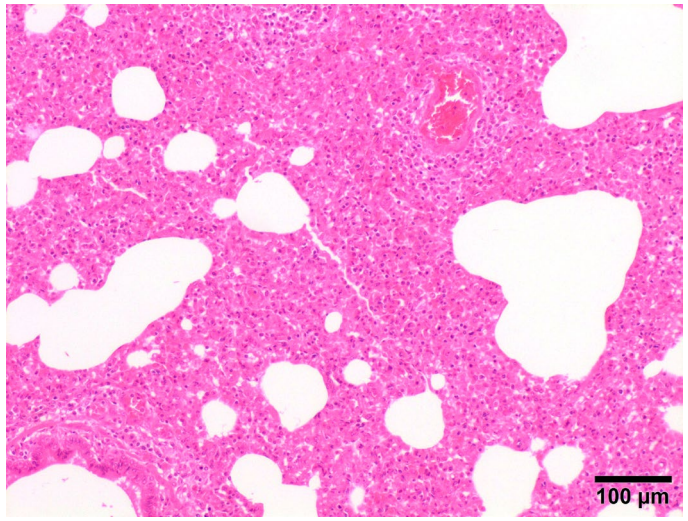
Results (lung lesions 10 DPC)

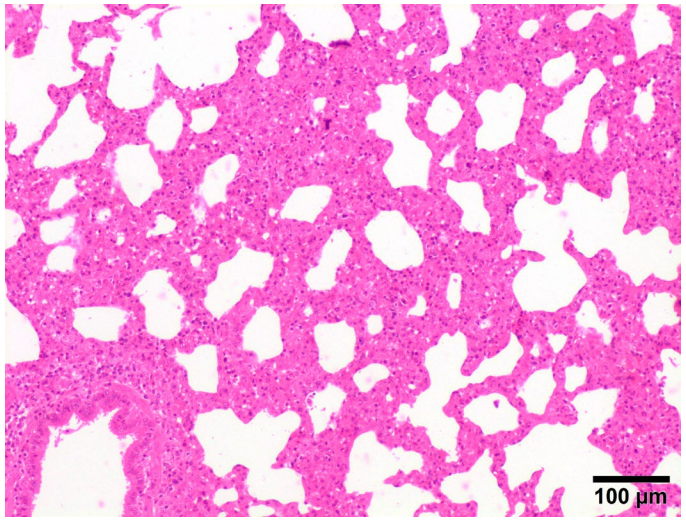
Uninfected control



Unvaccinated/Challenged



Vaccinated/Challenged



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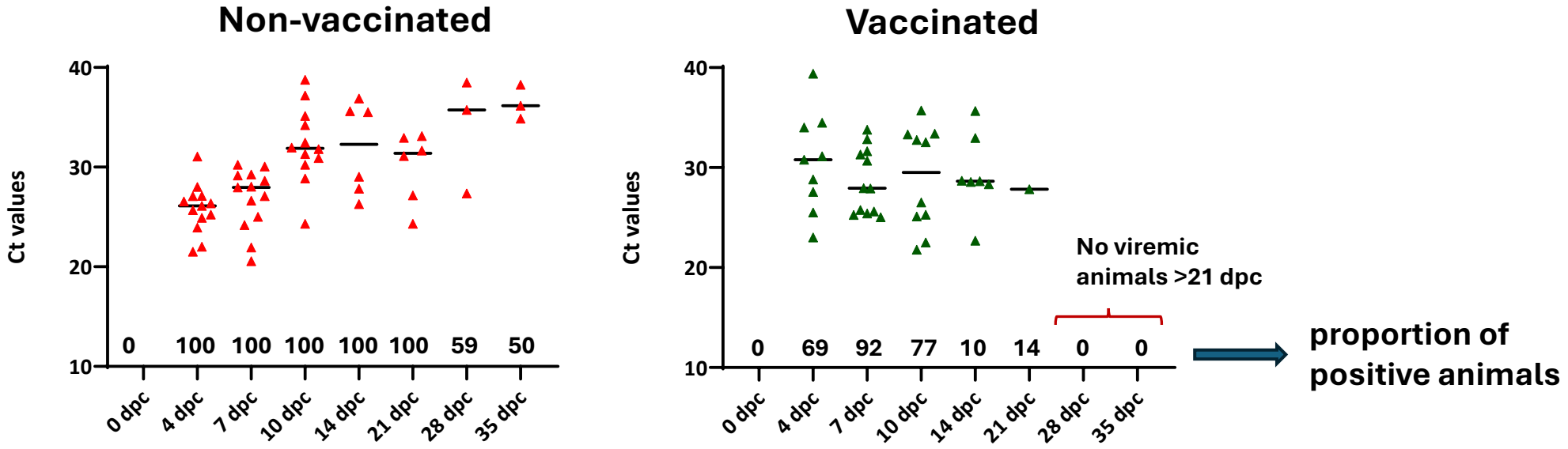
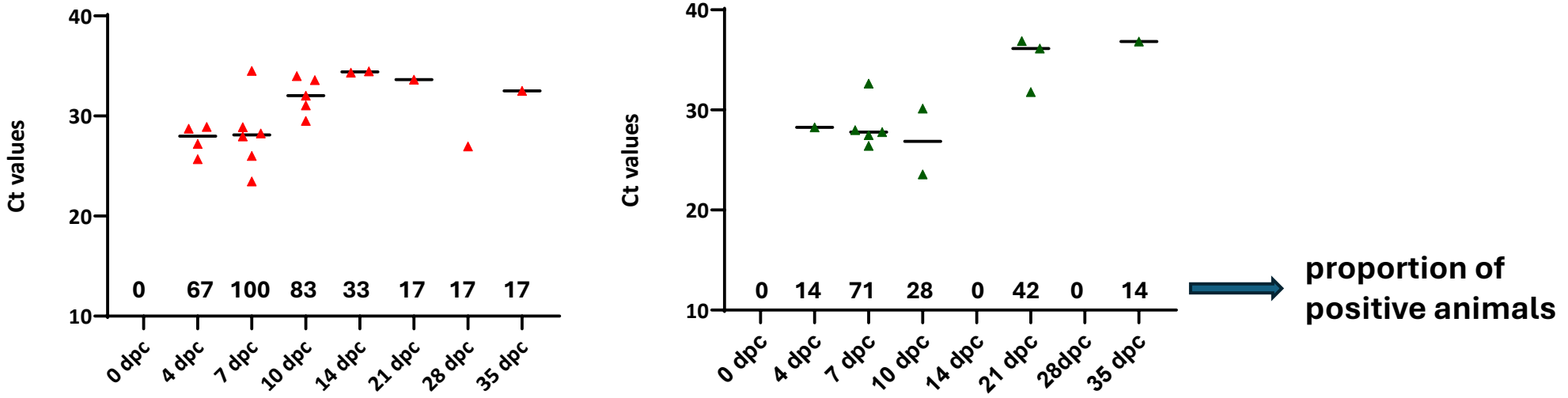
Results (viremia and viral shedding)

A) Viremia



B) Nasal shedding



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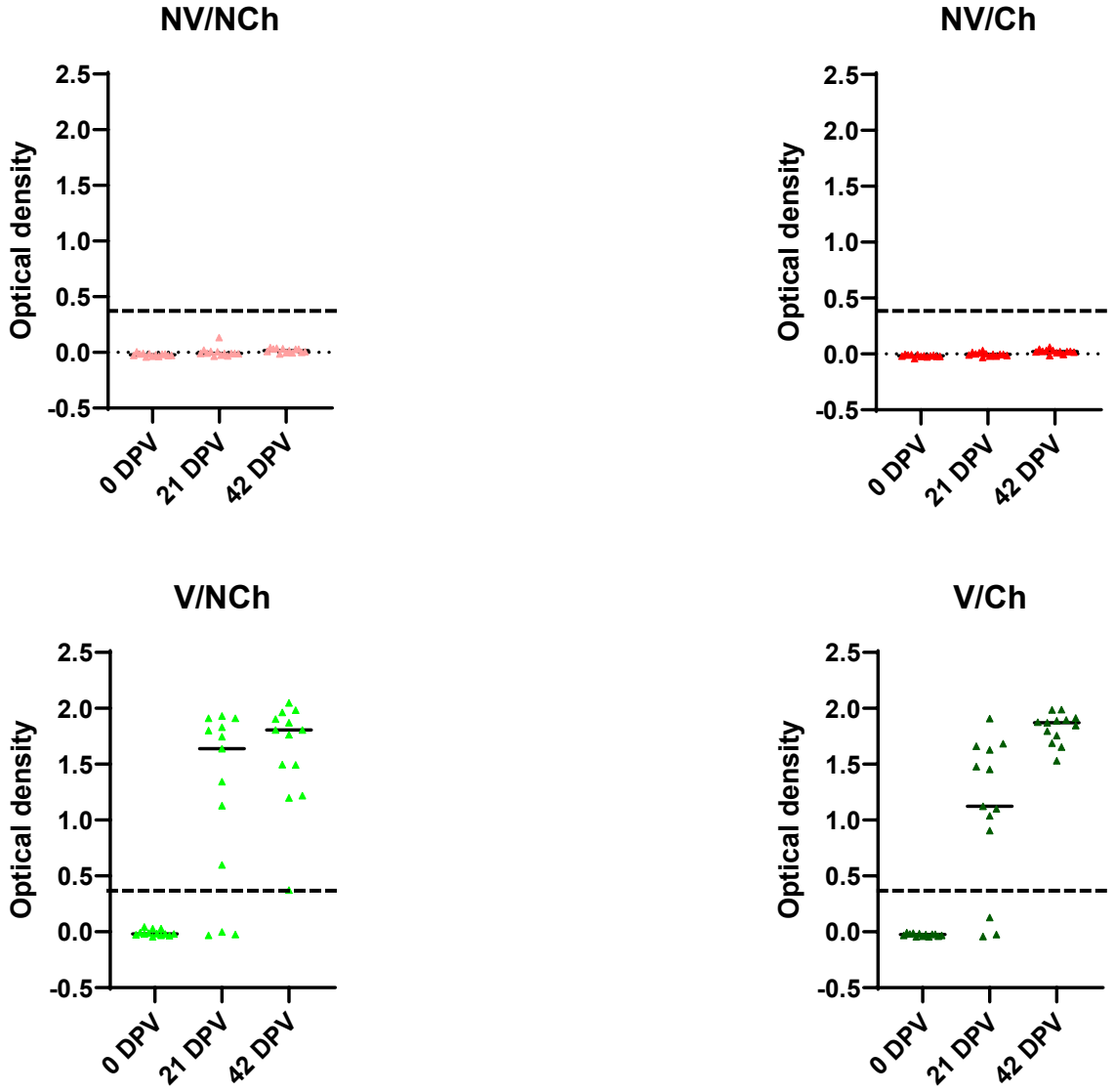
Results (seroconversion after vacination)



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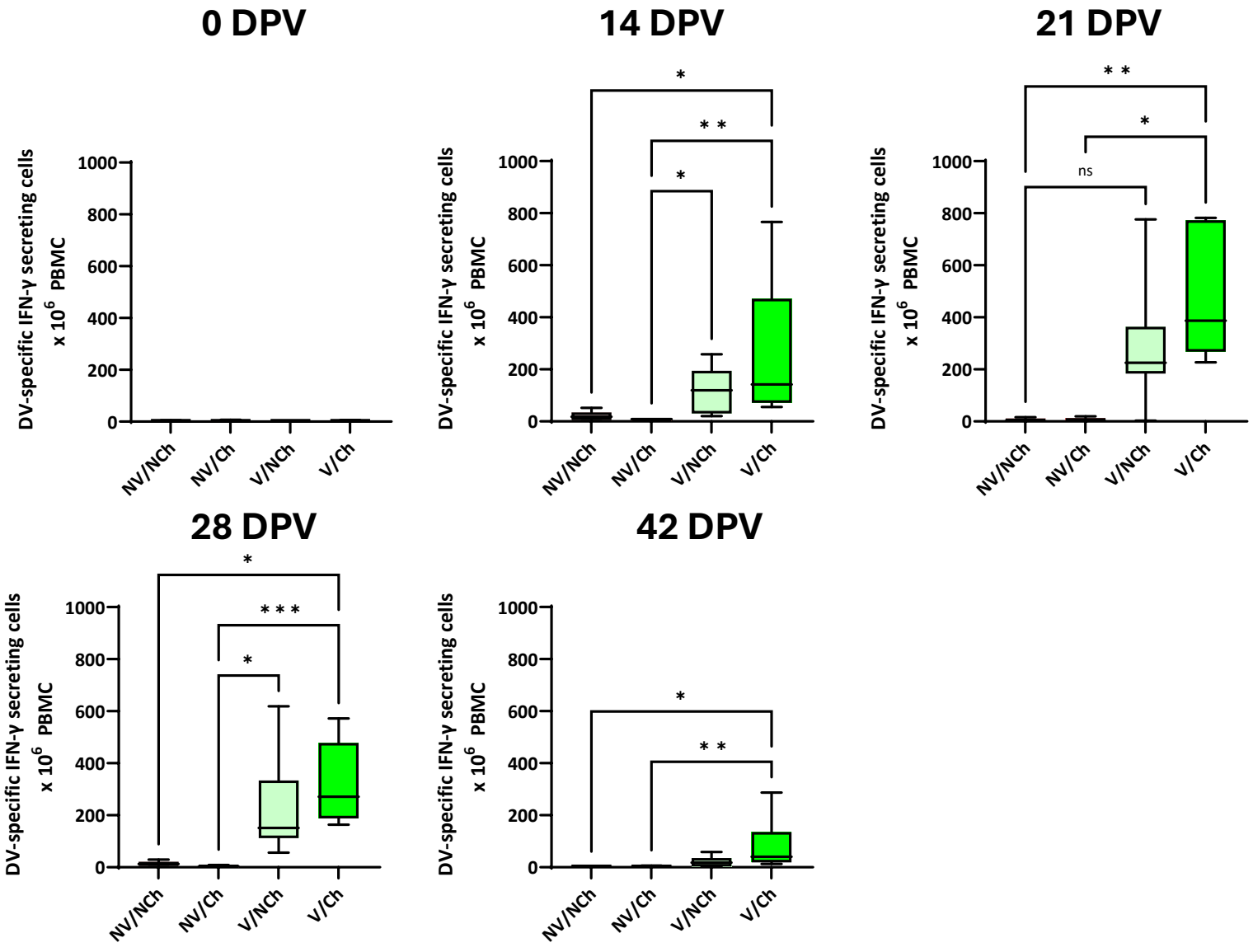
Results (IFN-γ ELISPOT after vaccination)

DV-specific IFN-γ secreting cells



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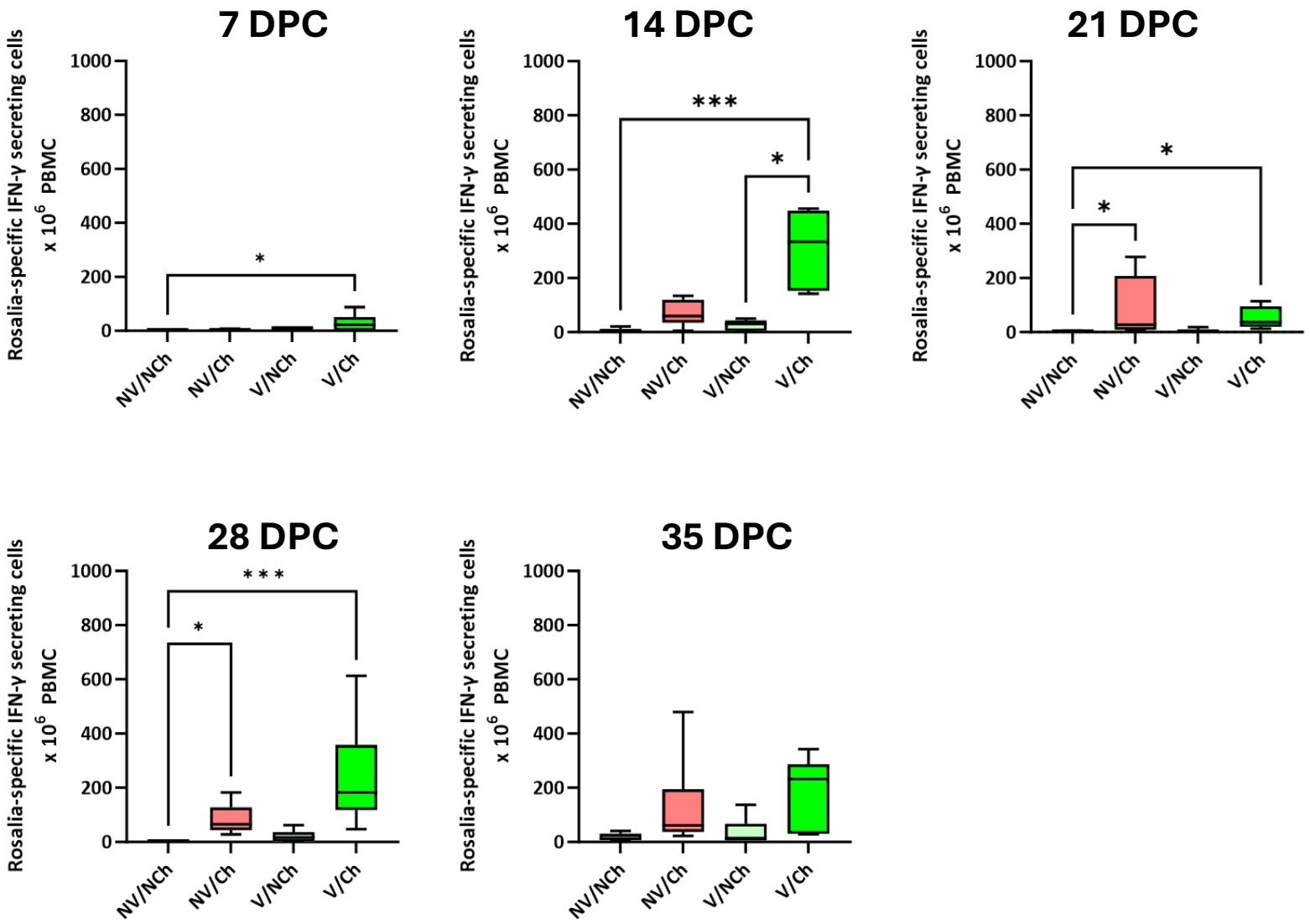
Results (IFN-γ ELISPOT after challenge)

Rosalia-specific IFN-γ secreting cells



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Conclusions

Vaccination proved useful to alleviate the impact of Rosalia's infection in terms of:

1. **Reduction of clinical signs**
2. **Reduction of lung lesions**
3. **Reduction of viremia**
4. **Improvement of weight gain**

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Lessons to be learnt from Rosalia epidemics

1. Investigation of all PRRSV outbreaks of high virulence is mandatory (including sequencing).

2. Constant monitoring and monitoring networks are essential to launch early warnings and trying to limit the spread of new PRRSV strains.

3. By now, emergence of highly virulent strains cannot be predicted but sequencing can help to gather information that will help to increase our capability for prediction.

4. improving biosecurity of pig farms may reduce the chances for highly virulent PRRSV to spread.

5. Vaccination helps alleviate the impact of the infection in pigs, particularly with regards to the clinical and zootechnical parameters (clinical signs weight).

6. Vaccination alone is not enough; improved management of the herd may help to reduce the impact of the infection on the farm.