

# Porcine Epidemic Diarrhea: assessment of the risk of introduction and spread in France

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# Introduction

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- In France only sporadic cases have been described until the late 80's
- Follow-up of the PED epidemics in the US and Canada from the beginning (international surveillance)
- Feb, 22<sup>nd</sup> 2014: report to the Ministry of Agriculture of the striking epidemics ⇒ potential impact in case of introduction?
- Apr, 8<sup>th</sup> 2014: formal request from the Ministry of Agriculture to Anses:
  - ⇒ assessment of the risk of introduction and measures intended to reduce this risk
  - ⇒ Risk of disease spread and measures intended to reduce this risk
- May, 12<sup>th</sup> 2014: PED is listed in the 1<sup>st</sup> category of animal health hazard
  - ⇒ notification is mandatory

# Anses opinion on risk ranking / PEDV introduction

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- **Emergency Collective Expert Assessment Group**
- **Carried out in accordance with the French Standard NF X 50-110 “Quality in Expertise Activities”**
- **Working group: Didier Gaudré, Béatrice Grasland, Maryline Kouba, Arlette Laval, Nicolas Rose, Etienne Thiry, under the coordination of Charlotte Dunoyer and Caroline Boudergue**
- **Presented at the Anses Animal health expert committee**

# Anses opinion on risk ranking / PEDV introduction

Source	likelihood of introduction
Swill	0
Manure	0
Hydrolysed proteins	1
Animal fats	1
Pork	1
Collagen	1
Organic fertilisers	1-2
Gelatine	2-3
Humans	3
Equipment, vehicles	5
Semen	5
Embryos	5
Blood products (plasma, red blood cells)	6
Live pigs	6-7

- **Qualitative assessment**
- **Import from an infected country**
- **Likelihood of excretion ( $L_{\text{Excretion}}$ )**
- **Data on import (I: 0/1)**
- **Likelihood of exposure of French pigs ( $L_{\text{exposure}}$ )**

$$L_{\text{introduction}} = L_{\text{excretion}} \times I \times L_{\text{exposure}}$$

Ordinal scale	Description
0	Zero (Z)
1	Near-zero (NZ)
2	Minimal (M)
3	Extremely low (EL)
4	Very low (VL)
5	Low (L)
6	Not high (NH)
7	Fairly high (FH)
8	High (H)
9	Very high (VH)

# Anses opinion on blood products incorporated into pig feed

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- Heat treating the products at a temperature of over 71° C for at least ten minutes; all other time-temperature combinations need to be validated based on relevant experimental tests or new bibliographic data;
- Storing the heat treated products in a dry environment for at least seven days at a temperature of 20° C; this storage is not an alternative to heat treatment. Temperature and hygrometry parameters must be monitored;
- Complying with hygiene measures in order to keep the treated products from becoming re-contaminated by contaminated products through cross contamination.

# Risk of PED spread and measures to reduce this risk

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- ⇒ **Simulating a PEDv epidemics in a densely pig populated area**
- **Spatio-temporal stochastic individual-based model**
- **Parameterization: data extraction from a national database:**
  - *Geographical location, farm type and size*
  - *6 different herd types : FtoF, Farr., Fatten., Wean., WeantoF, FtoWean*
  - *Animal movements between herds*
  - *Frequency of contacts with vehicles and other mechanical carriers*
- **Use of the North American Animal Disease Spread Model (NAADSM 4.0.10) ([Harvey et al., 2007](#)) (Colorado State University / Guelph University)**

# Contact parameterization

- Analysis of animal movements between herds: Direct contacts

- Piglets 8 kg

- Piglets 30 kg

- Breeding sows

- Frequency of movements by herd category ( $i$ )  $F_{ij}$

- Frequency of herd types doing specific movements ( $j$ )  $\varphi_j$

⇒ Contact matrix between herd types  $C_i = \sum_j F_{ij} \varphi_j$

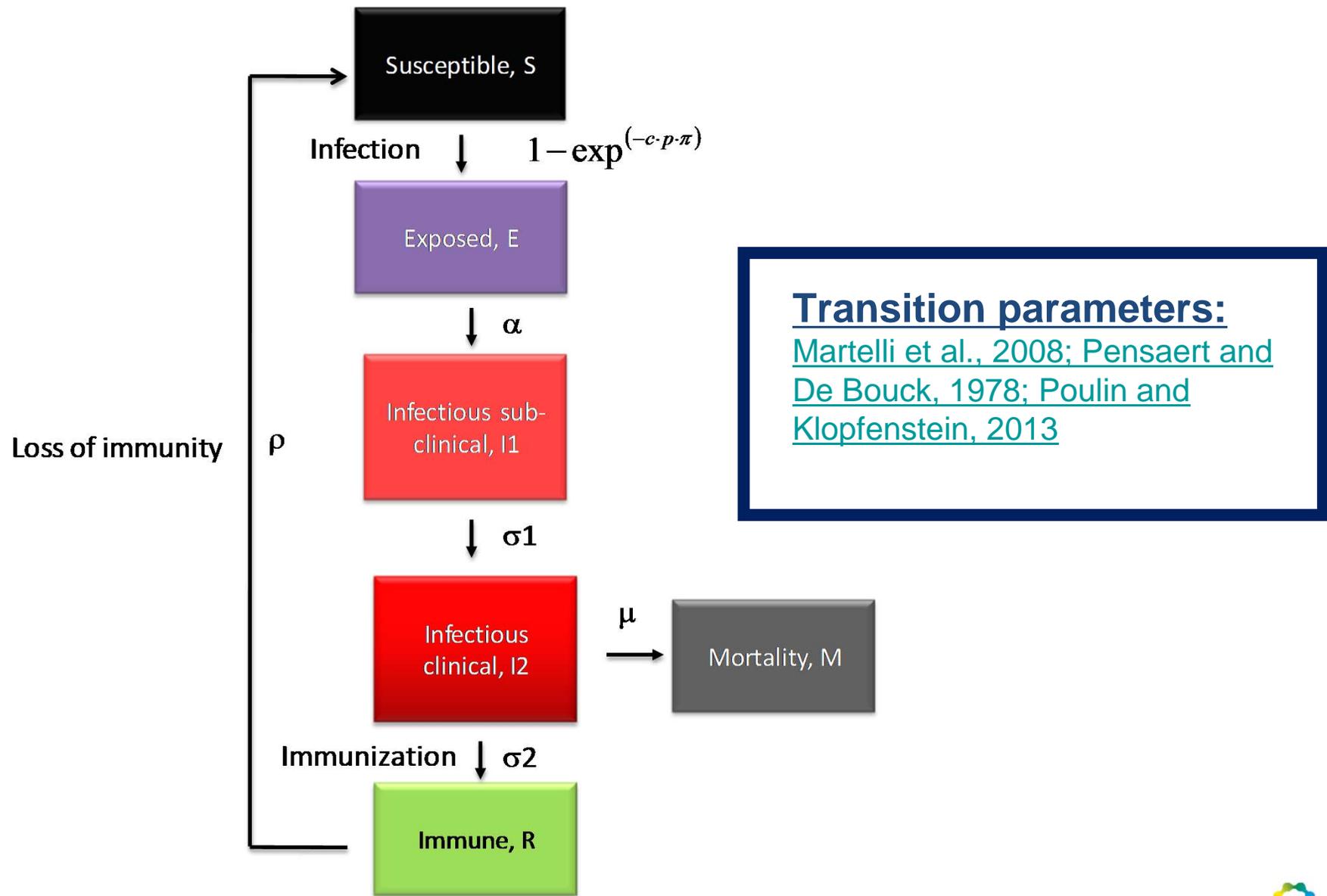
- Indirect contacts ⇒ vehicles: slaughterhouse, feed, vet / technicians, rendering, manure, visitors

⇒ Frequency by herd type (Rose et Madec, Vet. Res. 2002)

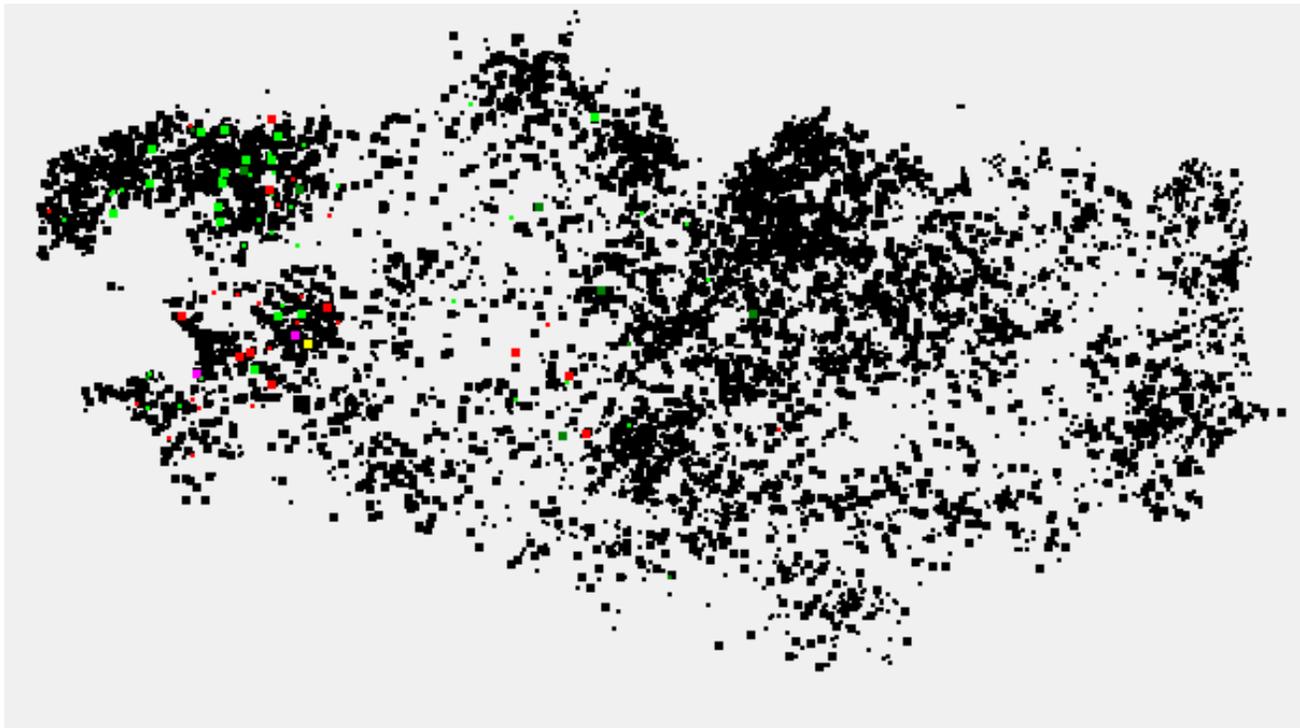
- 100 simulations / scenario / 550 days

- Epidemic curve, cumulated number of affected units

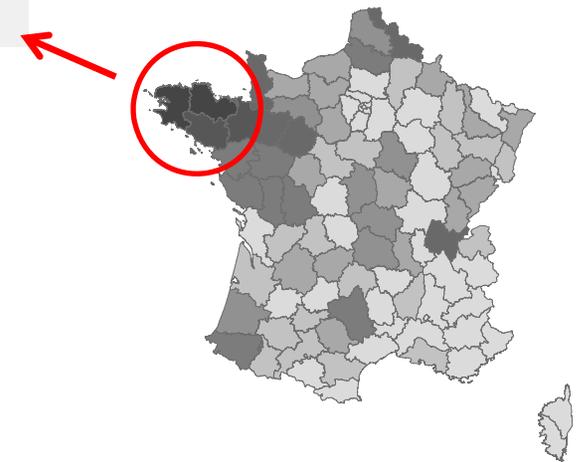
# Herd health states: conceptual model



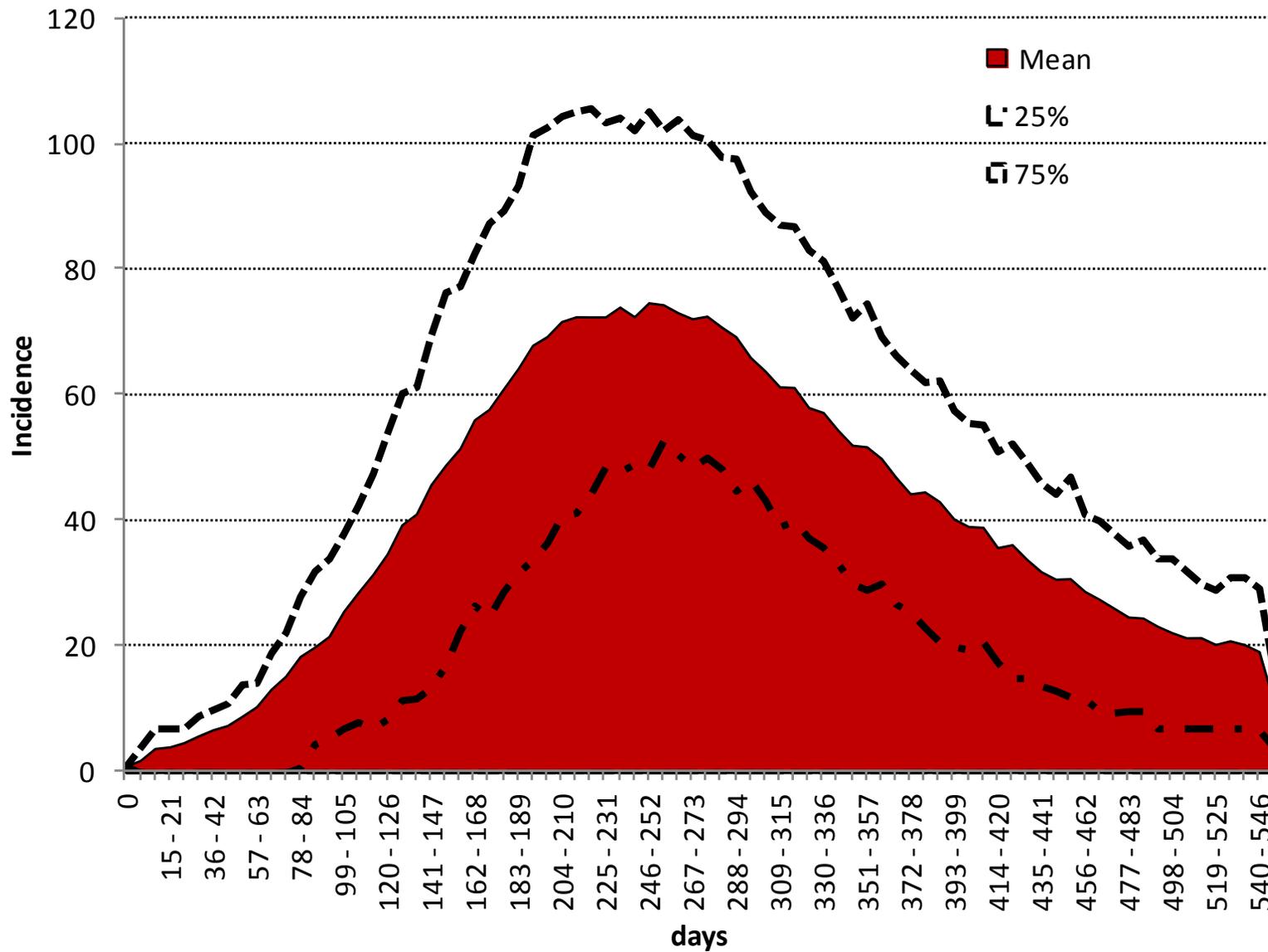
# Simulation of the epidemics in Brittany



**Brittany: almost 60% of the national pig production**

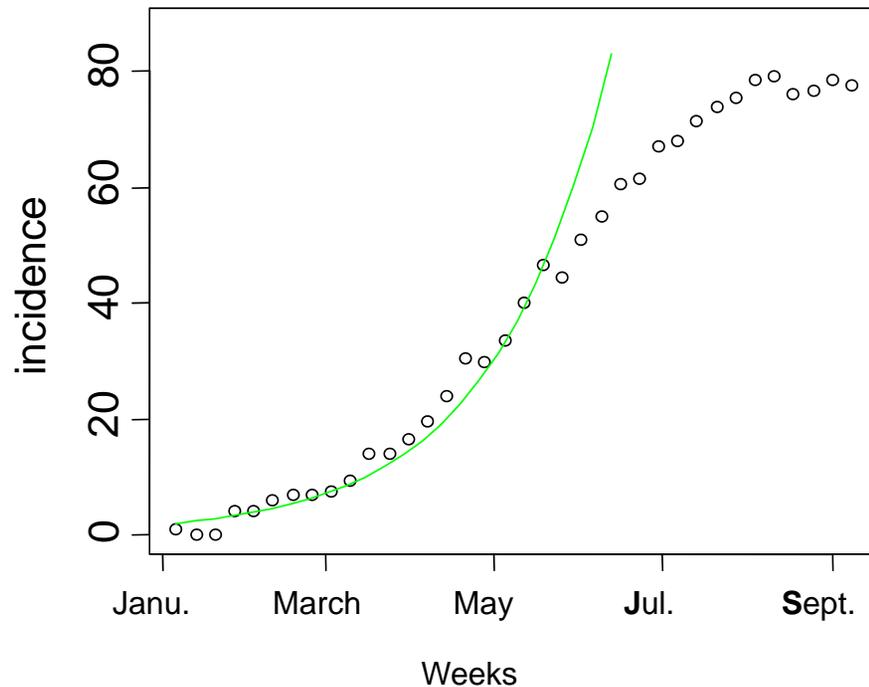


# Simulated epidemics



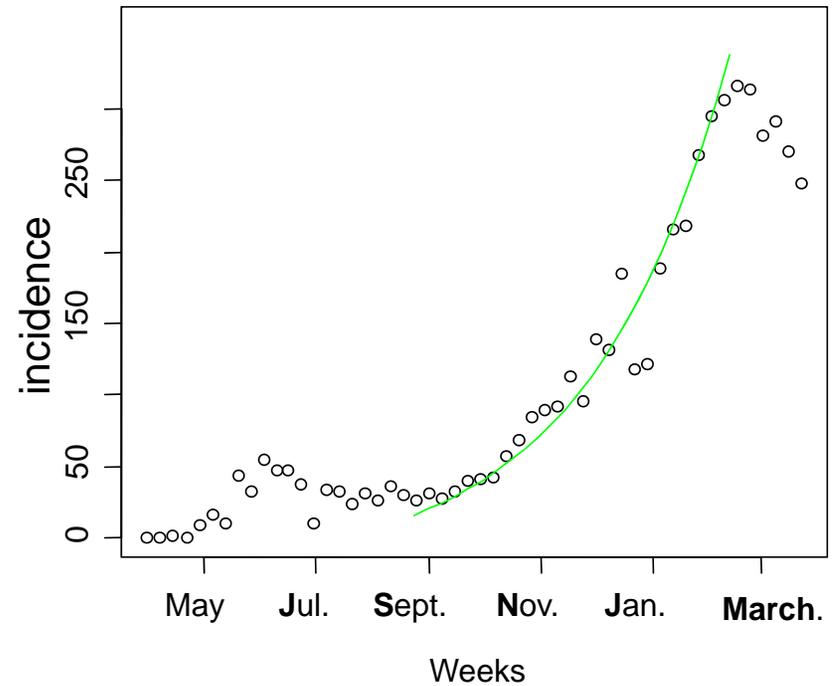
# Comparison of the simulated epidemics with US observed data

## Simulated epidemics in Brittany, FR



$$R0 = 3.4 [3.0; 3.9]$$

## Observed data in the US

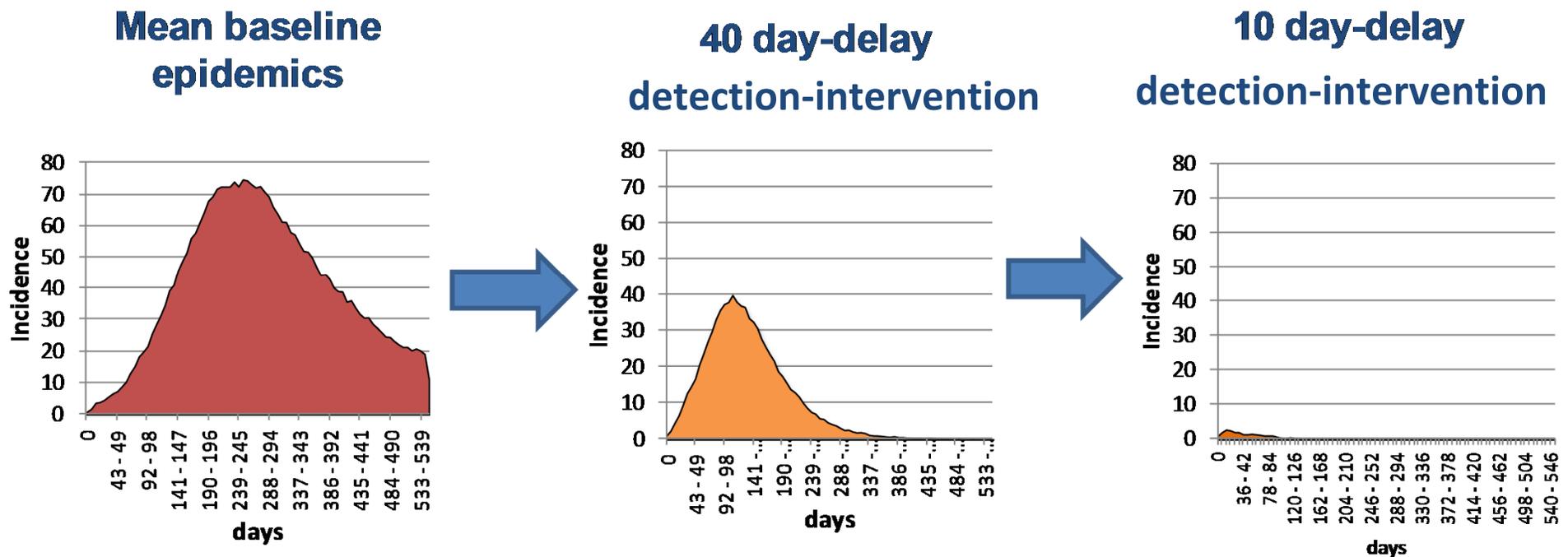


$$R0 = 2.4 [2.3 ; 2.5]$$

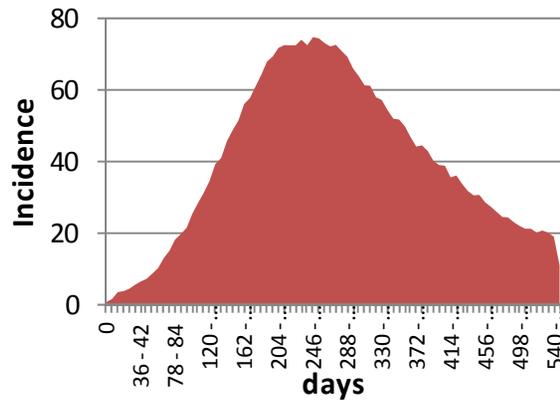
- ⇒ small area, densely populated
- ⇒ faster increase
- ⇒ lower peak incidence compared to US (80 versus 300)

# Impact of pig movement restriction

- ⇒ Definition of a restriction area (2 km radius) once the case notified
- ⇒ Movements from the zone to outside are banned



# Impact of stamping out



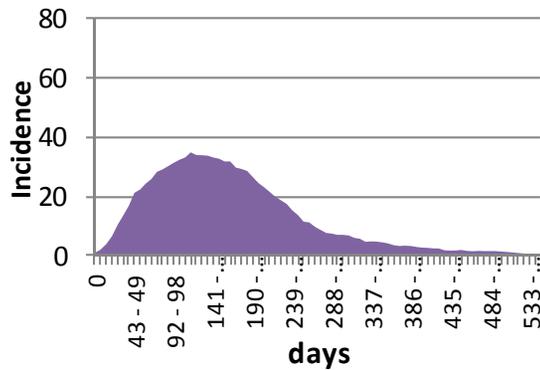
⇒ Elimination of each infected herd once disease notification



**Stamping out**

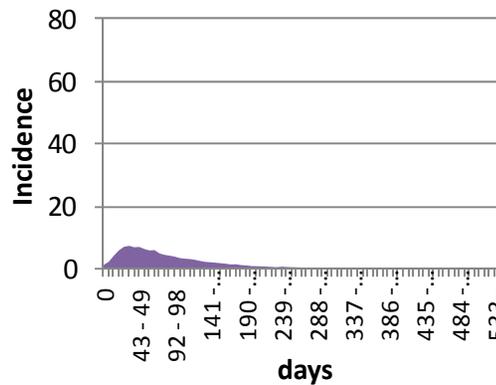
**40 day-delay**

**detection-intervention**



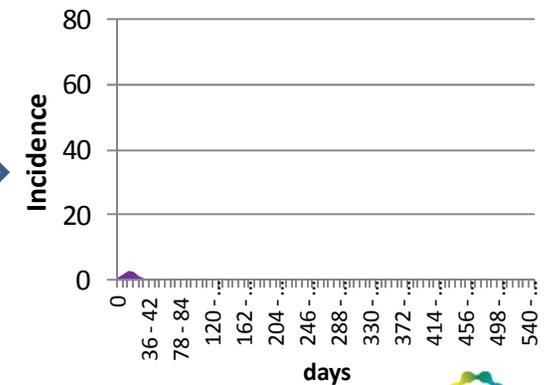
**20 day-delay**

**detection-intervention**



**10 day-delay**

**detection-intervention**



# Conclusion on the risk of spread and control measures

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- Rapid spread with a likely high impact in absence of population immunity
- Animal movement restriction would have a partial effect
- Early slaughter of 1<sup>st</sup> outbreaks would be the most effective
- Increase of biosecurity has to be promoted
- In 'real-life' these measures should be combined for maximum efficacy
- Importance of rapidity for the intervention chain (detection-notification-intervention)

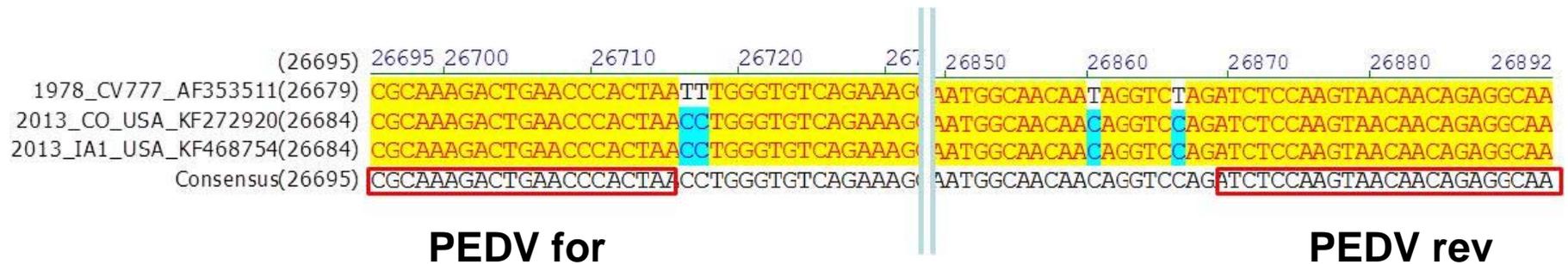
# Diagnostic methods developed in Anses

- Pan-coronavirus RT-qPCR : adapted from Moes et al, 2005 (BMC Infectious Diseases 5:6)

⇒ lack of sensitivity but detection of alpha- and gamma-coV

- PEDV RT-qPCR : adapted from Kim et al, 2007 (J Virol Methods 146:172-177)

⇒ primers in the N gene region ⇒ highly sensitive and specific



- IPMA for virus titration
- ELISA (under development: S1 region amplified and cloned in the baculovirus transfer vector and sequenced) ⇒ production of the S1 prot.
- Participation to the COVETLAB initiative on PEDv diagnostic

# Biological material

- **Bioassay in SPF piglets to amplify CV777 strain**
  - ↘ Average daily weight gain
  - PED intestinal lesions (thin wall, aqueous and yellow content)
  - virus titration
  - production of positive serum
- **1<sup>st</sup> 'Seroprevalence' data (non representative)**
  - 30 herds, 10 serums (sows) /herd, 2014 ⇒ 300 serums
  - PED swine check ELISA kit (Biovet, Canada)
  - Correction for herd clustering and Se/Sp
  - **3.60% [95%CI 1.55 - 6.47] sow level**
  - [Positive predictive value of the test 55%]



# General conclusion

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- Confirmed risk of PED being introduced in France
  - Risk  $\geq 5/9$  for **Live pigs, blood products, semen**
  - Minimum production conditions should be required for blood products incorporated into pig feed
  - The foreseeable impact for the sector in case of introduction is expected to be high
- ⇒ **PED has been regulated as an emerging disease**
  - ⇒ **implementation of a surveillance system**
  - ⇒ **enforcement of biosecurity measures at the EU borders**
  - ⇒ **awareness of all stakeholders**



**Thank you for your attention**

