Monitoring and surveillance systems for sow herds

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Agenda

- How to design a surveillance program?
- How to surveil for PRRSV?
- How to surveil for IAV?
- Conclusions

How to design a surveillance program?

Key inputs include:

- Define the purpose of surveillance
- Identify the epidemiological unit and sampling unit
- Choose the specimen(s) to be collected and assay(s) to be used
- Decide where, how many, and how often to sample

How to design a surveillance program?

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How to design a surveillance program?

Key inputs include:

- Define the purpose of surveillance
  - Document freedom of disease
  - Track spatiotemporal distribution of pathogen within population
  - Monitor population's response to vaccination
  - Assess the impact
    - Management decisions on population health
    - Infrastructure change on population health
  - Quantify the effect of pathogen on pig health and productivity

Evaluation of PRRSV stability at birth using tongue tips of stillborns

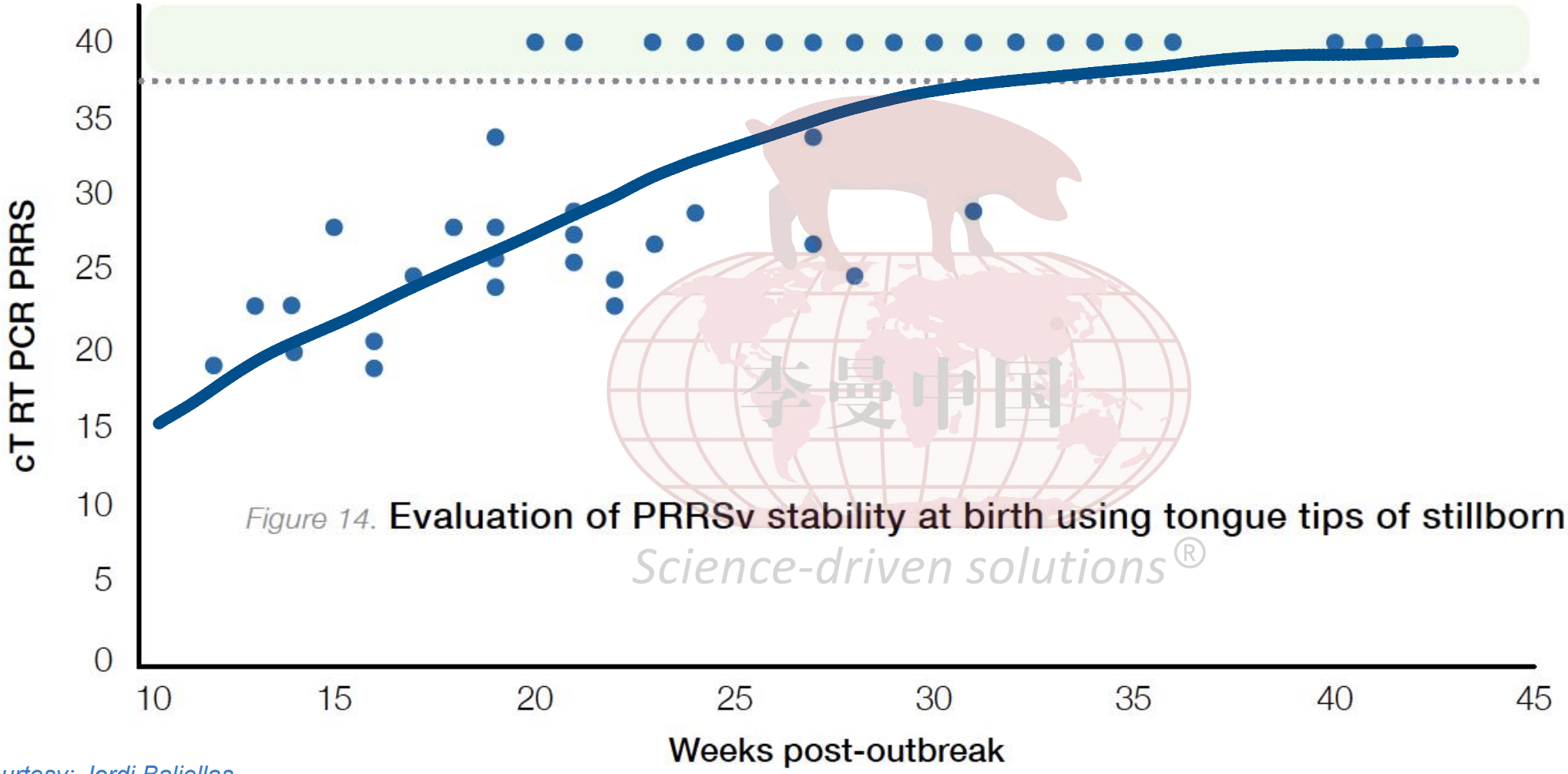
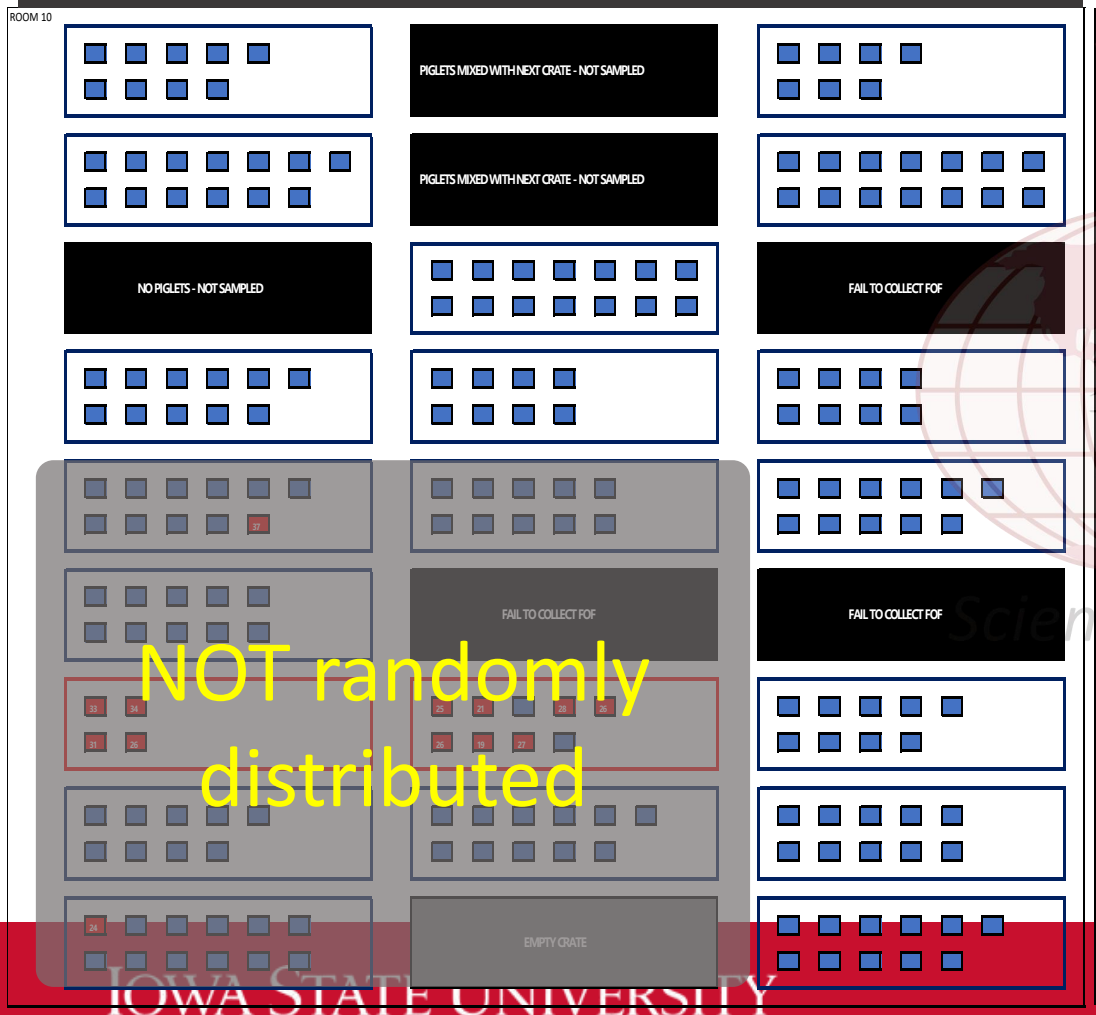


Figure 14. **Evaluation of PRRSv stability at birth using tongue tips of stillborn piglets.**

Courtesy: Jordi Baliellas

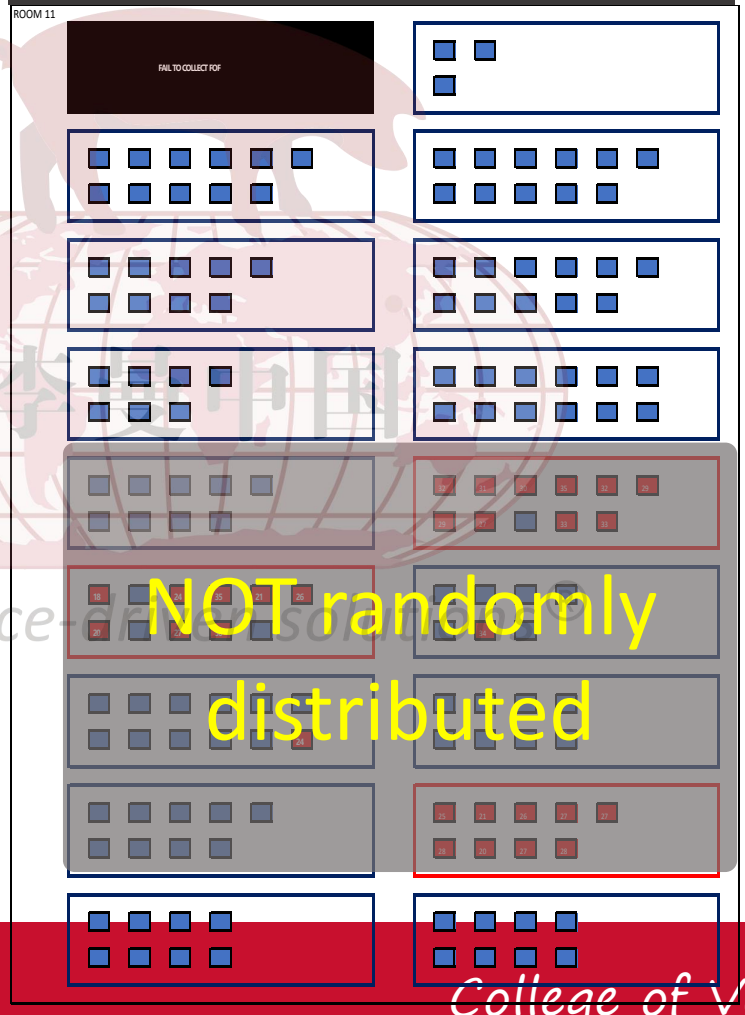
Room A

Piglet prevalence: 6.3%
Litter prevalence: 19.0%
FOF-positive litters = 9.5%



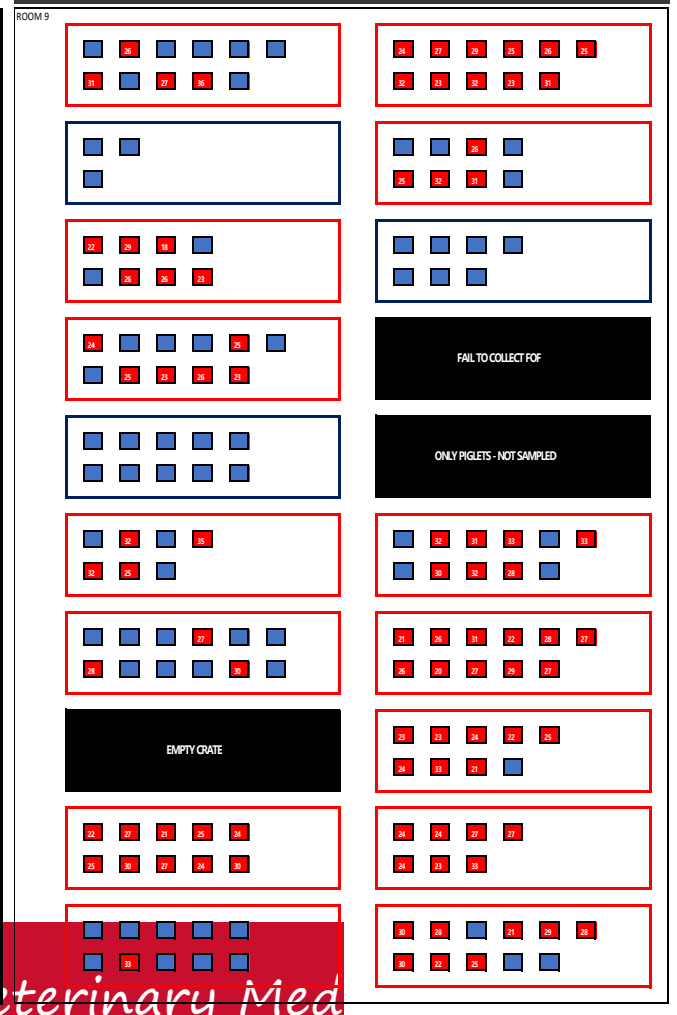
Room B

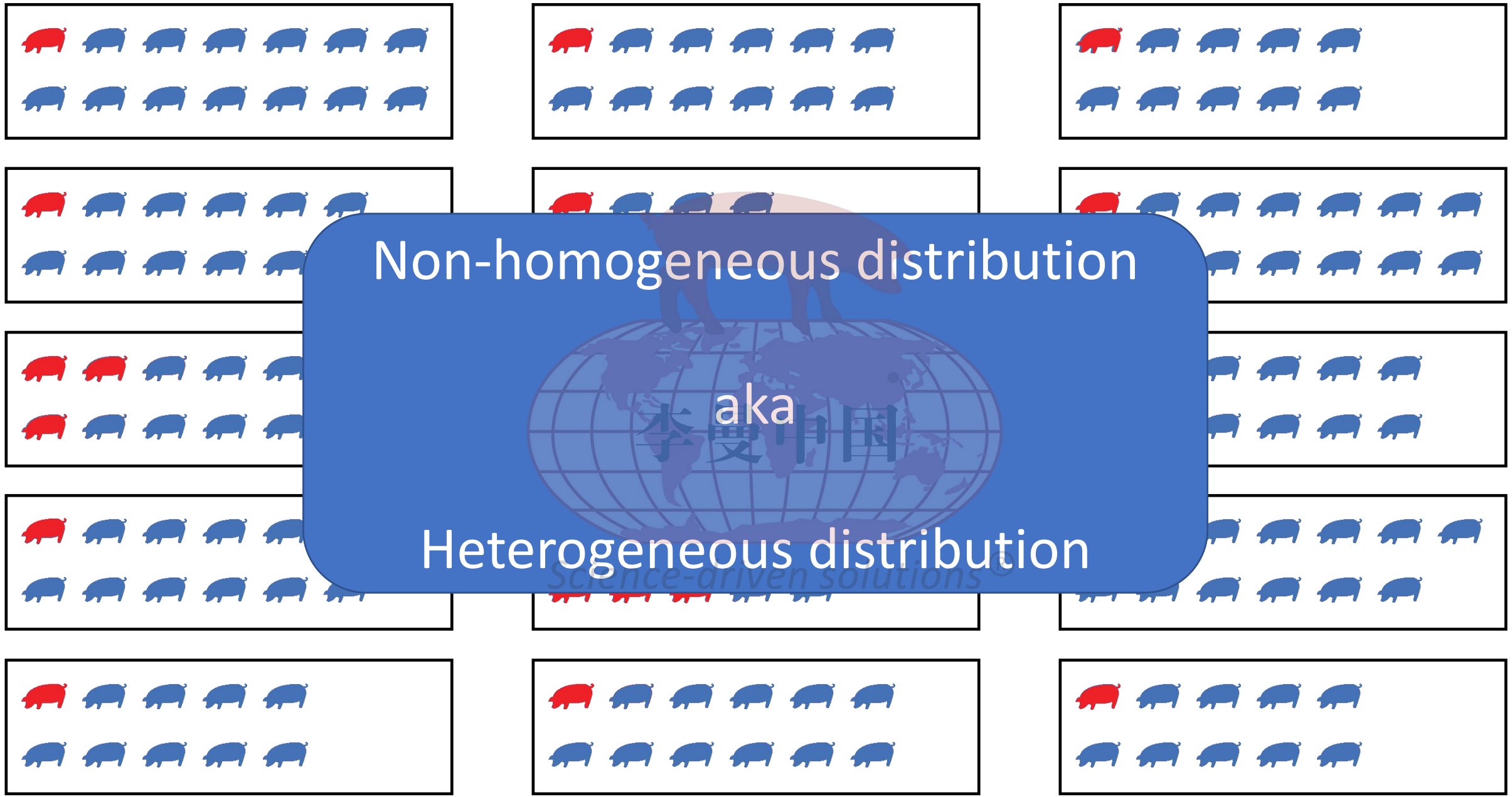
Piglet Prev: 19.0%
Litter Prev: 29.4%
FOF Pos = 17.6%



Room C

Piglet Prev: 57.3%
Litter Prev: 82.4%
FOF Pos = 82.4%

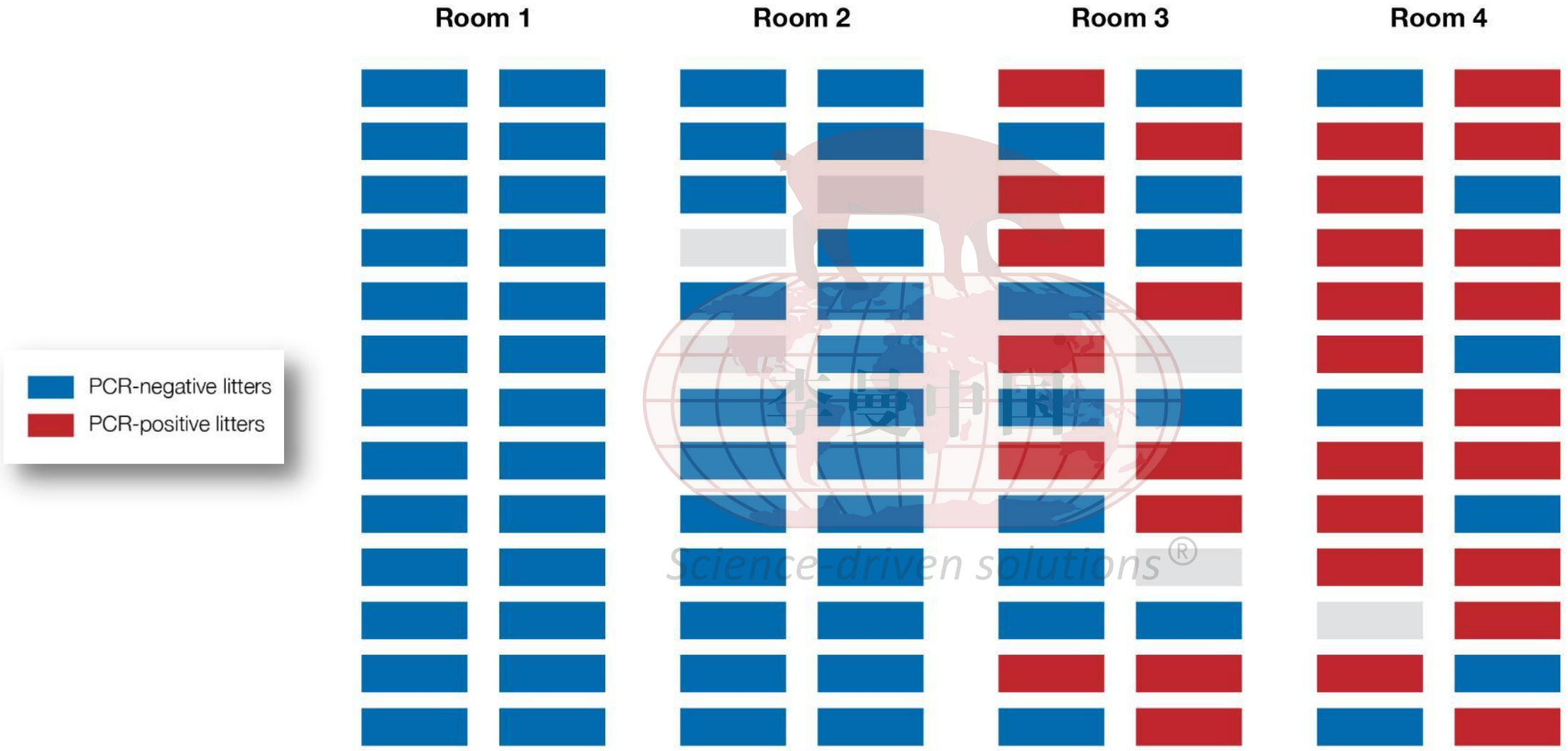



Non-homogeneous distribution
aka
Heterogeneous distribution

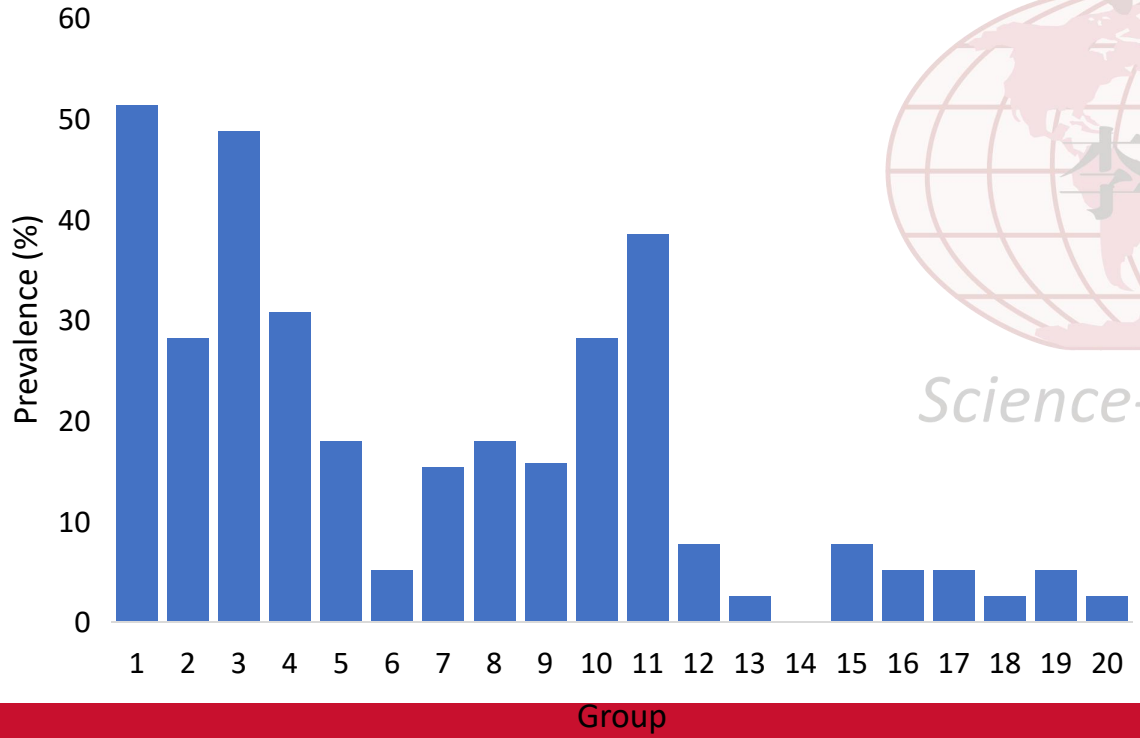
Farm	Room	Positive piglets	Population homogeneity analysis				P-value	Clustering analysis	
			Expected + litters		Observed + litters			Clustered (Y/N)	Probability
			n	Avg. No. of + piglets/litter	n	Avg. No. of + piglets in + litters			
A	1	90	17	0.57	14	0.66	< 0.01	N	0.684
	2	13	20	0.06	4	0.36	< 0.01	Y	0
	3	29	17	0.19	5	0.58	< 0.01	Y	0
	4	2	5	0.04	1	0.20	> 0.05	N	0.185
C	1	8	7	0.13	1	1.00	< 0.01	Y	0
							< 0.01	Y	0.001
							< 0.01	Y	0
							< 0.05	N	0.219
							< 0.01	Y	0.001
							< 0.01	Y	0
J	1	117	20	0.55	17	0.65	< 0.01	Y	0
	2	58	21	0.36	16	0.46	< 0.01	Y	0.03
K	1	14	7	0.21	4	0.42	< 0.01	Y	0
	2	10	19	0.05	3	0.37	< 0.01	N	0.315
	3	7	4	0.18	2	0.64	< 0.01	Y	0.024
	4	36	17	0.21	13	0.28	< 0.01	N	0.329

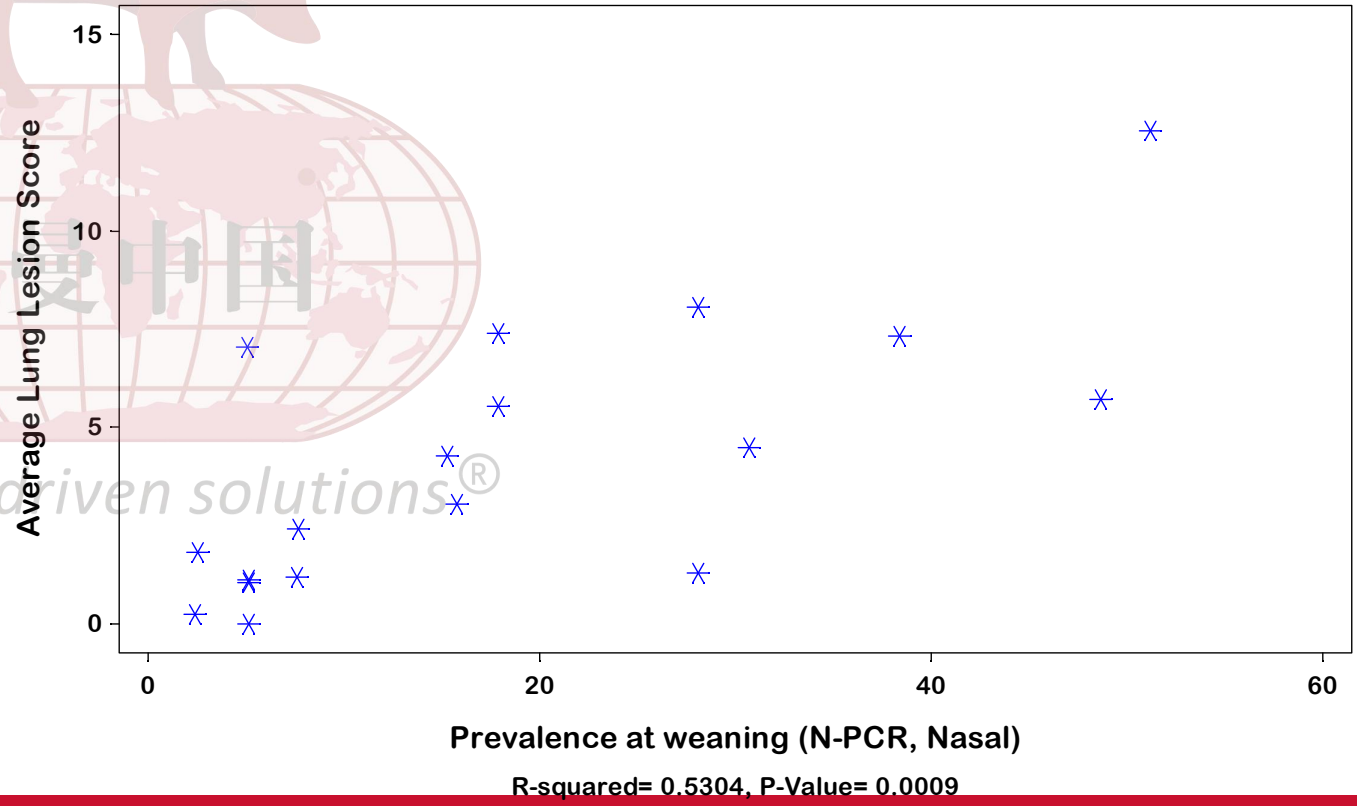
PRRSV distribution is clustered and not homogeneous

FOF results of 4 weaning-age farrowing rooms: same farm, same day



Impact of vertical transmission on severity of disease in finishers





Source: Fano et al., 2007

How to design a surveillance program?

Key inputs include:

- Define the purpose of surveillance
- Identify the epidemiological unit and sampling unit
- Choose the specimen(s) to be collected and assay(s) to be used
- Decide where, how many, and how often to sample

How to design a surveillance program?

Key inputs include:

- Identify the epidemiological unit and sampling unit
  - Epidemiological unit = group of animals with approximately the same likelihood of exposure to pathogens.
    - Same air space, pen, barn, room
  - Sampling unit is the level at which samples are collected
    - Individual pig (serum)
    - Pen (pen-based oral fluid)
    - Barn (air sample)
  - Discrete samples are needed for surveillance (individual or aggregate)
    - Known what sample, how it was collected, where, and when

How to design a surveillance program?

Key inputs include:

- Identify the epidemiological unit and sampling unit
  - Epidemiological unit = group of animals with approximately the same

Pooled samples are a combination of two (or more) discrete samples.

Benefits:

1) Cost savings
2) Increase in sample size

Potential issues:

1) Dilution of the target below limit of detection (false negative)
2) Pooling samples with different identities (locations, time, etc) → difficult to interpret

How to design a surveillance program?

Key inputs include:

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- Decide where, how many, and how often to sample

How to design a surveillance program?

- Choose the specimen(s) to be collected and assay(s) to be used

Specimens

- Serum
- Swabs
  - Nasal
  - tracheal,
  - Oropharyngeal
  - Rectal
  - Vaginal
  - Blood
- Tonsil scraping
- Oral fluid
- Family oral fluid
- Colostrum
- Milk
- Placental umbilical cord serum
- Tongue fluids
- Fetal thoracic fluid
- Tissues (lung, heart, etc.)
- Processing fluids
- Wipes
  - Nasal
  - Udder

Assays

- Antibody
  - ELISA, CF, HI, VN
- Nucleic acid
  - PCR
- Viable agent
  - Culture, VI

How to design a surveillance program?

- Choose the specimen(s) to be collected and assay(s) to be used

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Assays

- Antibody
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- Nucleic acid
  - PCR

<u>Considerations on</u>

- Diagnostic sensitivity
- Diagnostic specificity
- Disease transition stages

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How to surveil for PRRSV?

Professor Daniel C. L. Linhares
Iowa State University - College of Veterinary Medicine
Works with ISU Field Epi, a team of 23 post-DVM graduate students on "development and evaluation of strategies to improve health and productivity of swine populations under field conditions"

Boehringer Ingelheim

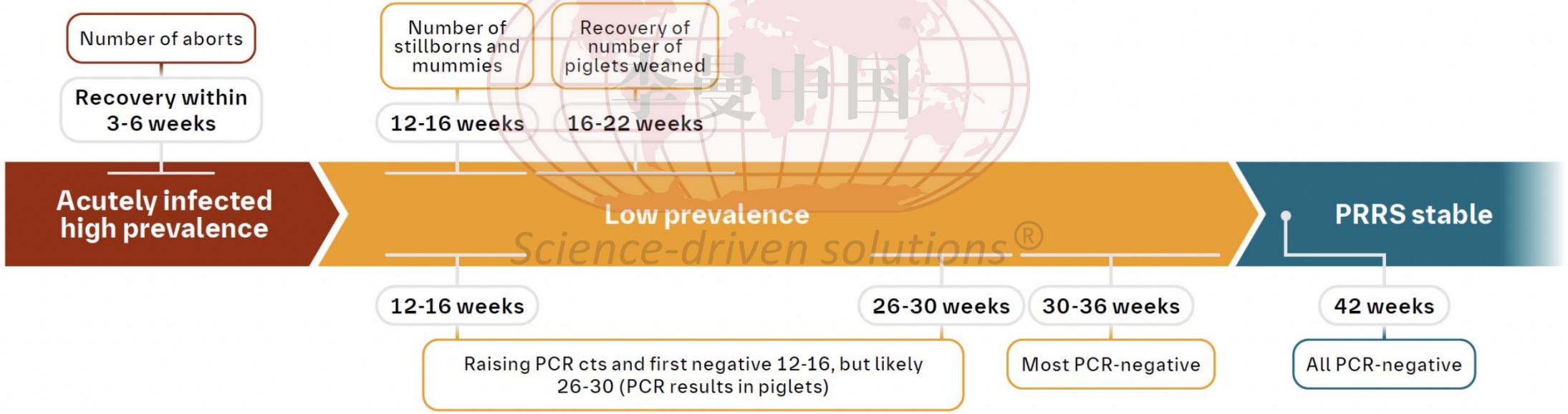
Understanding the practical value

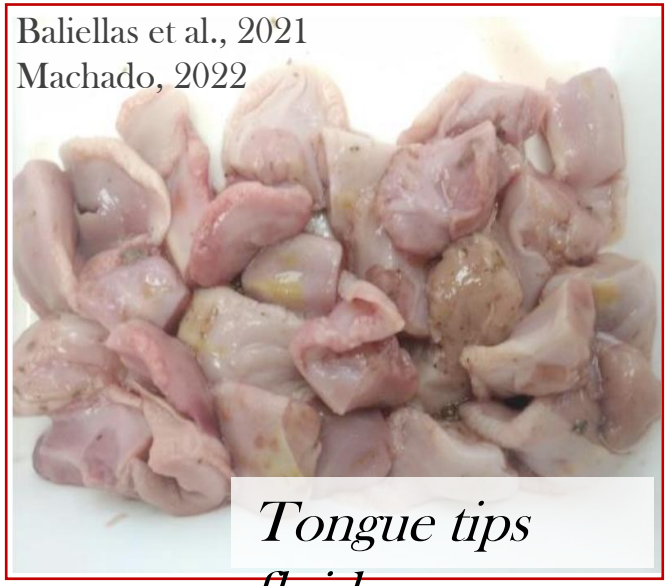
Clever & Convenient PRRSv Monitoring

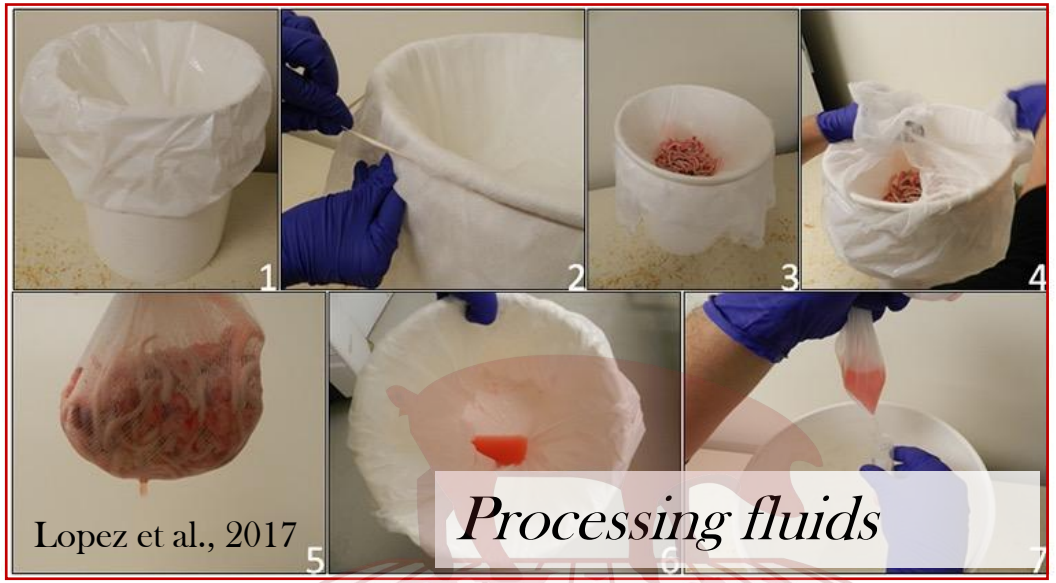
Sampling guidelines: For herds aiming for PRRSv stability

Am I on the right track?

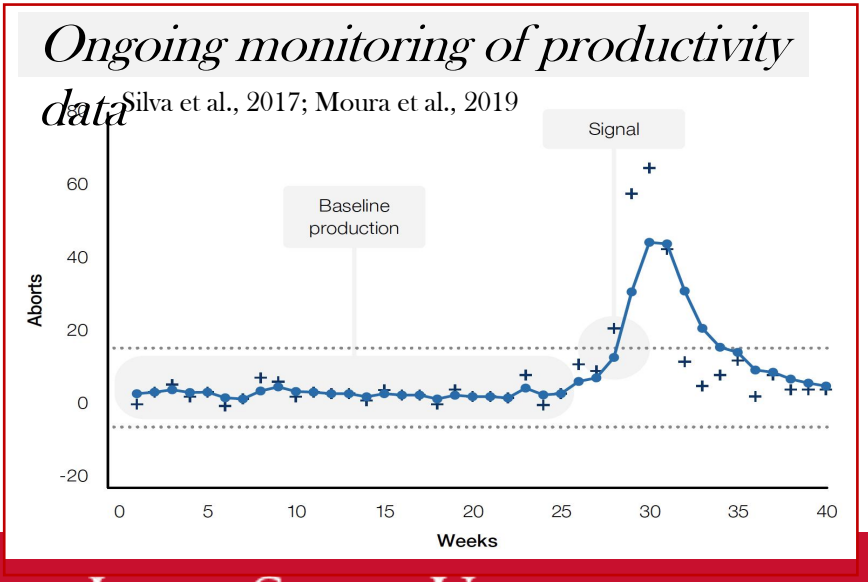
Check the recovery timelines after PRRS outbreak to verify that your control program is effective.

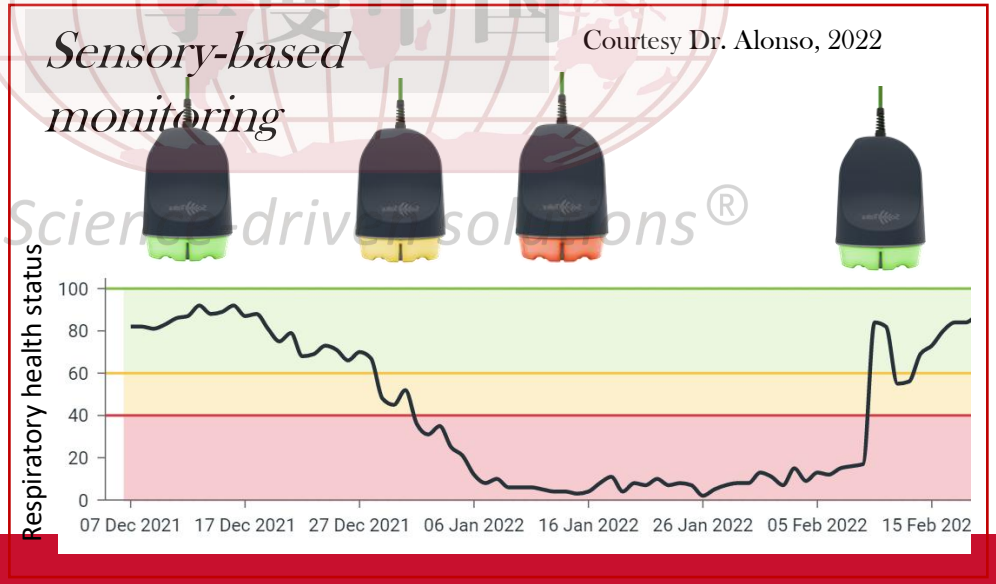




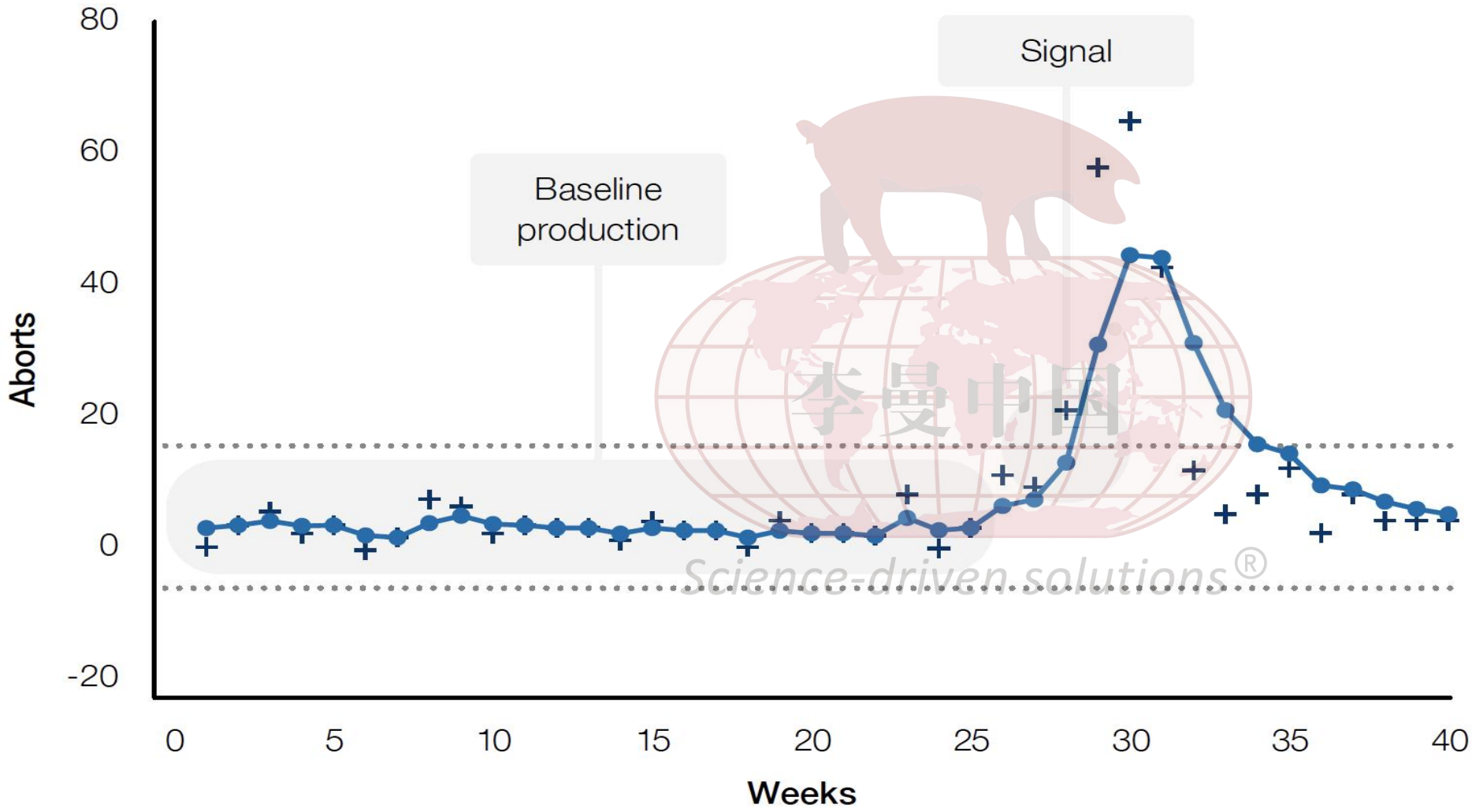


Population-based monitoring and surveillance systems





Early detection:



Ongoing monitoring of productivity data

Silva et al., 2017
Moura et al., 2019

www.fieldepi.org

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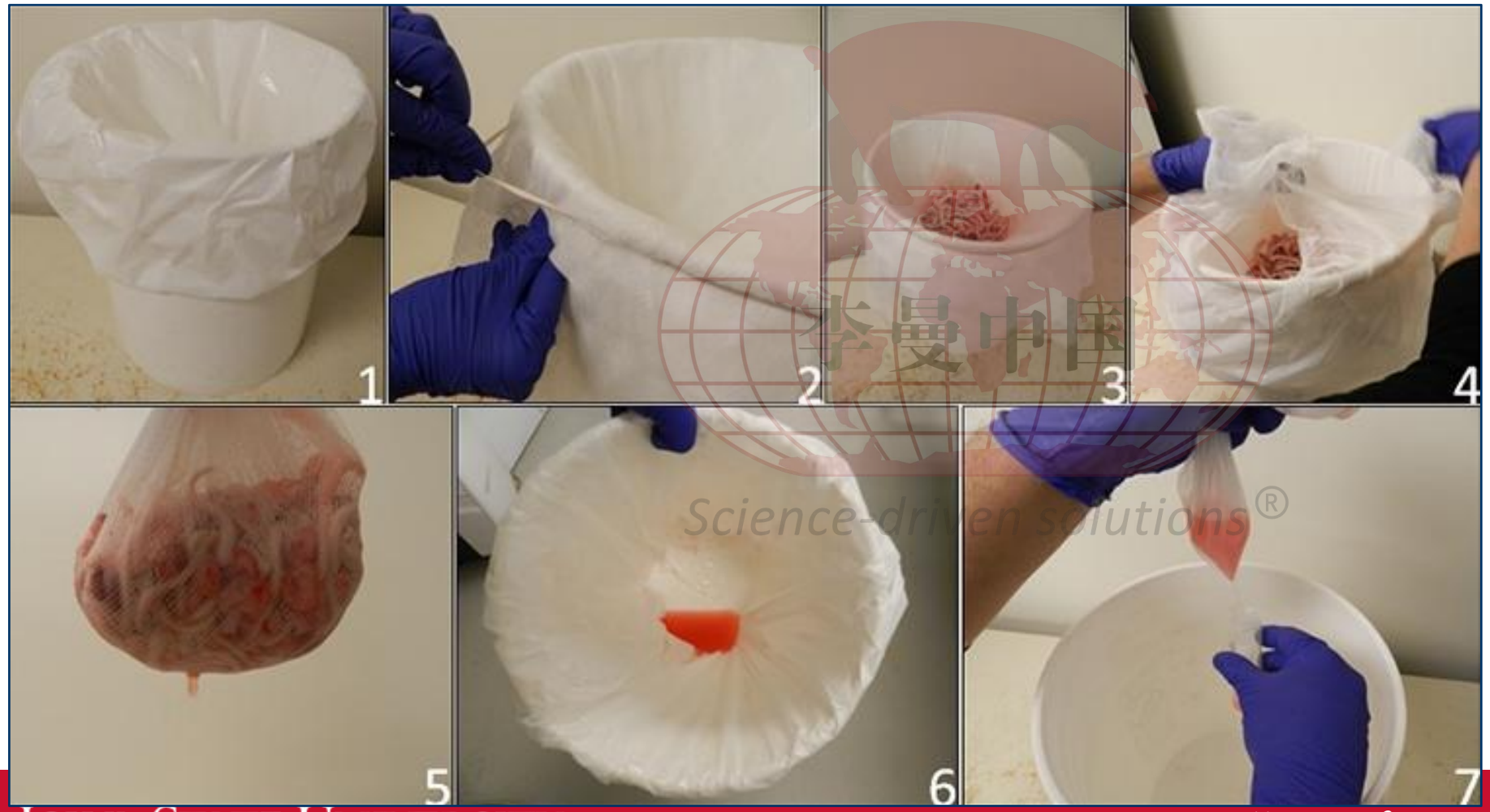
Population-based monitoring and surveillance systems

Tongue tips fluids from dead pigs

Baliellas et al., 2021
Machado et al., 2022, 2023

Population-based monitoring and surveillance systems



Processing fluids

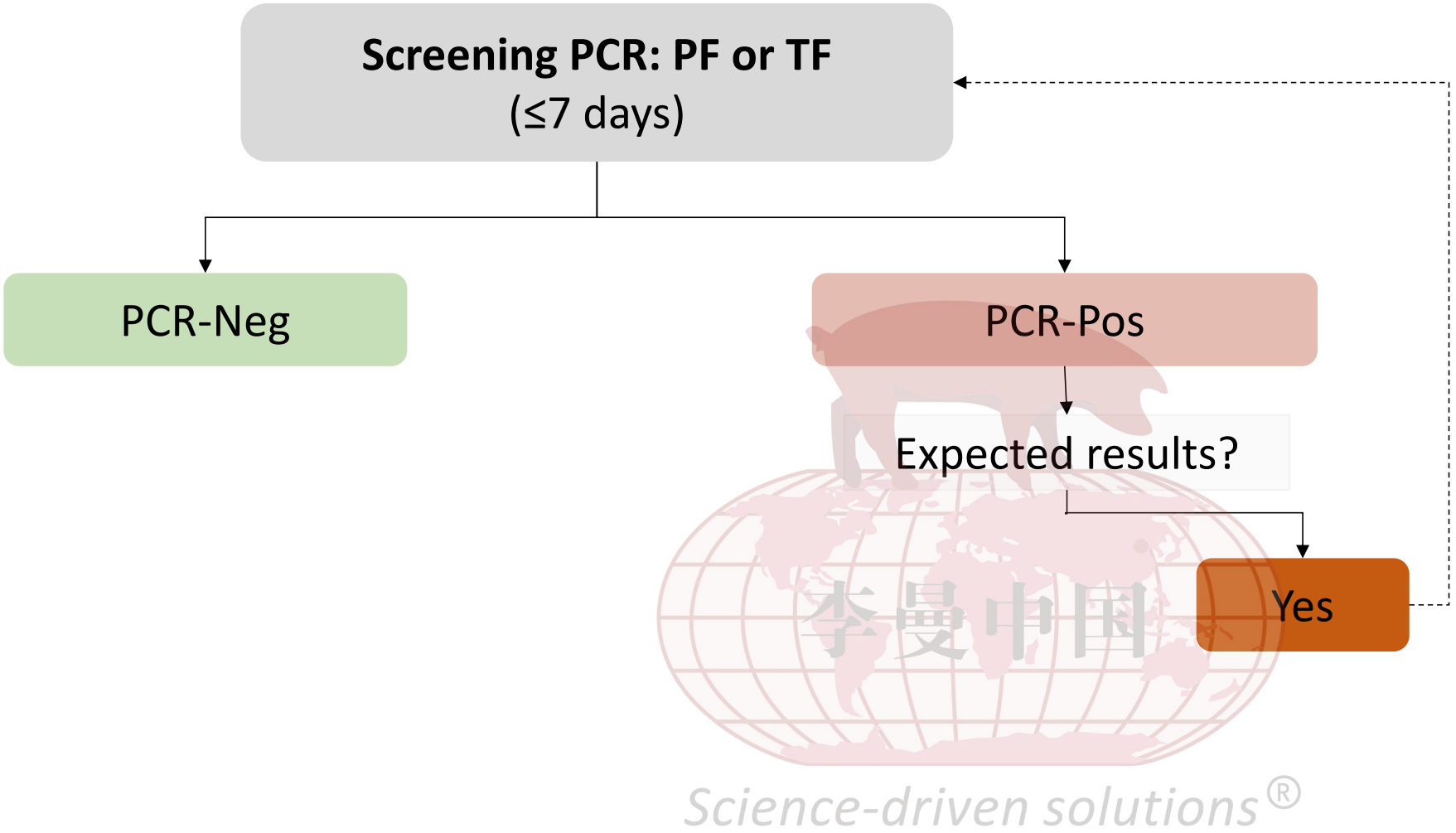
Lopez *et al.*, 2017
Vilalta *et al.*, 2018

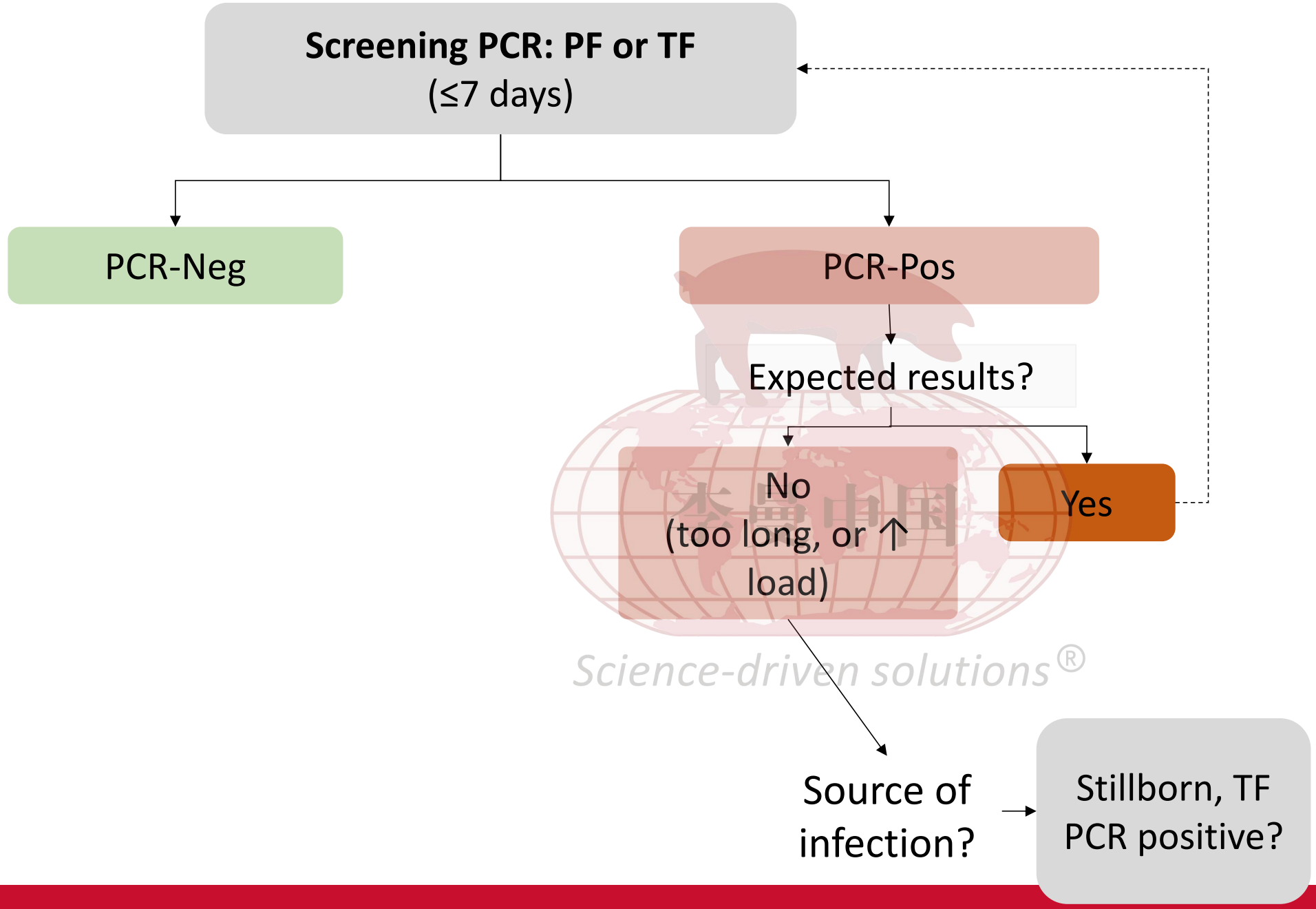
Population-based monitoring and surveillance systems

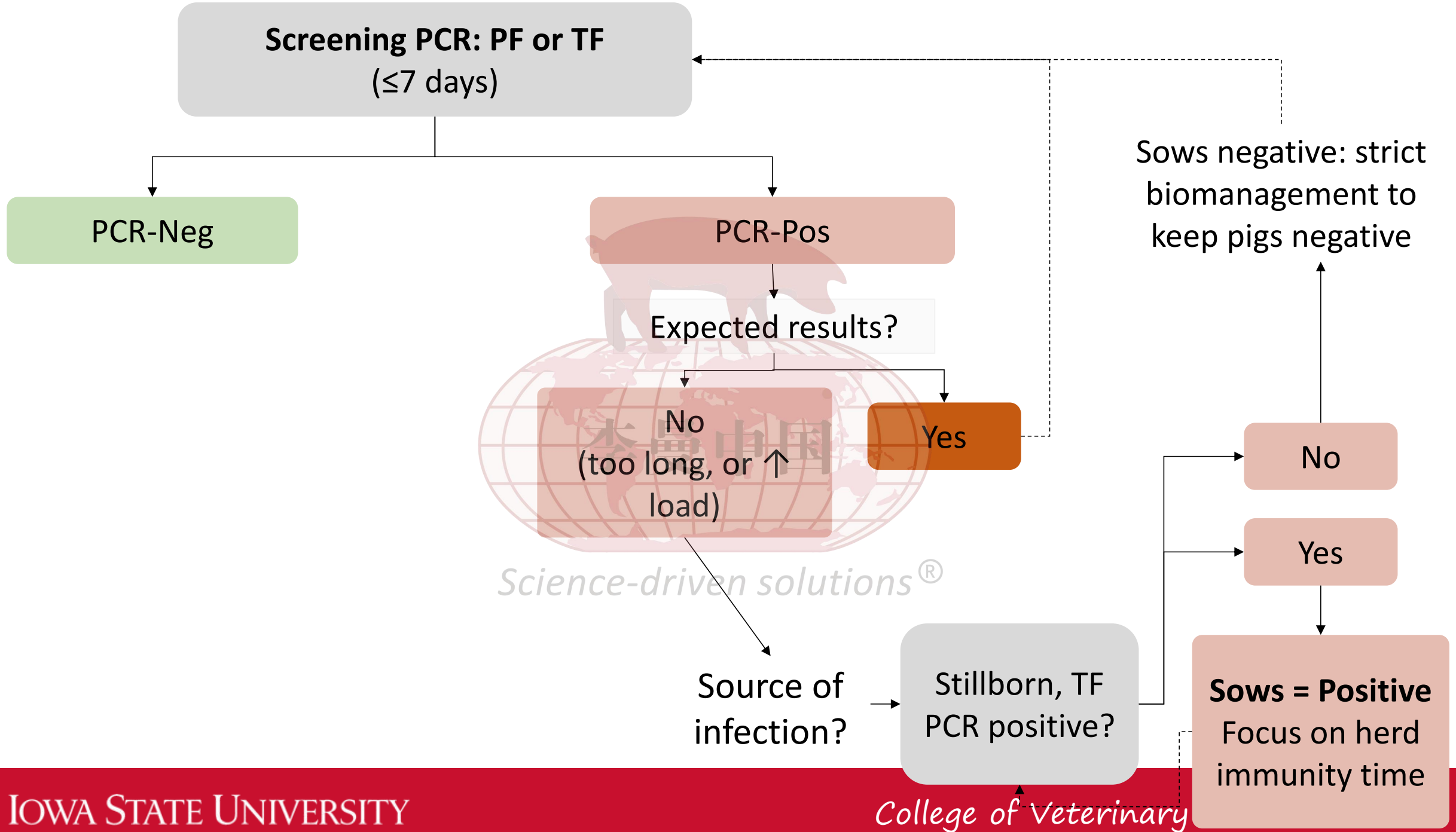
Family oral fluids

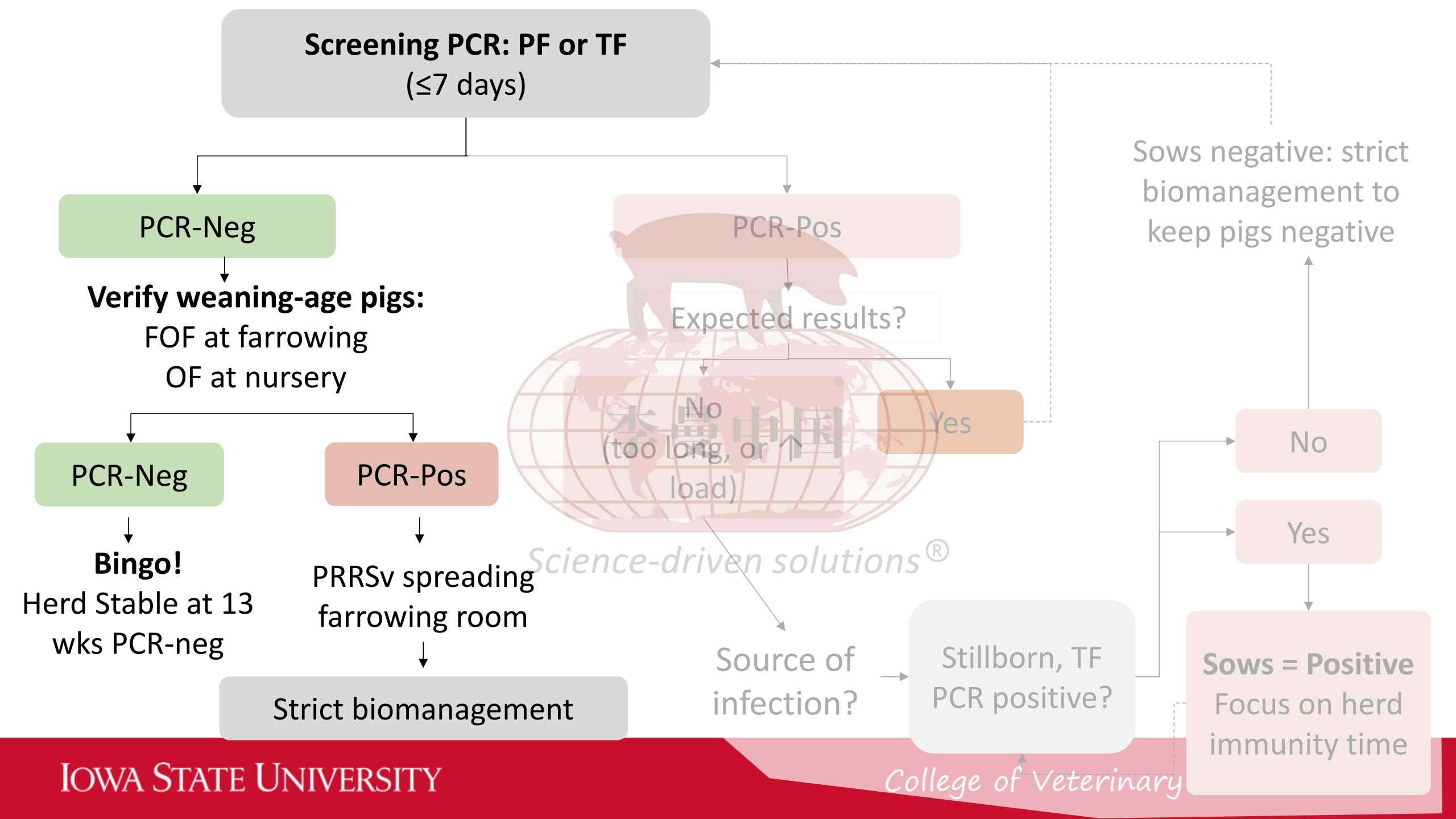
Almeida *et al.*, 2018
- methods and results over time

Osemeke *et al.*, 2023
- pooling considerations on probability of PRRSV detecction






Screening PCR: PF or TF
(≤7 days)
PCR-Neg
PCR-Pos
Expected results?
No
(too long, or ↑ load)
Yes
Source of infection?
Stillborn, TF PCR positive?
Sows negative: strict biomanagement to keep pigs negative
No
Yes
Sows = Positive
Focus on herd immunity time
Science-driven solutions®


Screening PCR: PF or TF
(≤7 days)
PCR-Neg
Verify weaning-age pigs:
FOF at farrowing
OF at nursery
PCR-Neg
PCR-Pos
Bingo!
Herd Stable at 13 wks PCR-neg
PRRSv spreading farrowing room
Strict biomanagement
PCR-Pos
Expected results?
No
(too long, or ↑ load)
Yes
Source of infection?
Stillborn, TF PCR positive?
Sows negative: strict biomanagement to keep pigs negative
No
Yes
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Focus on herd immunity time
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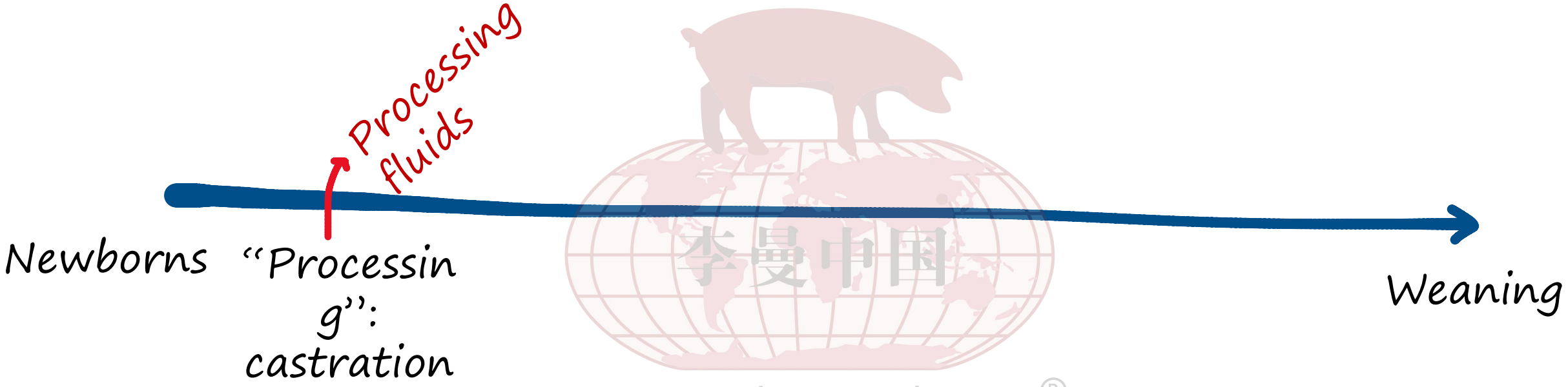
College of Veterinary

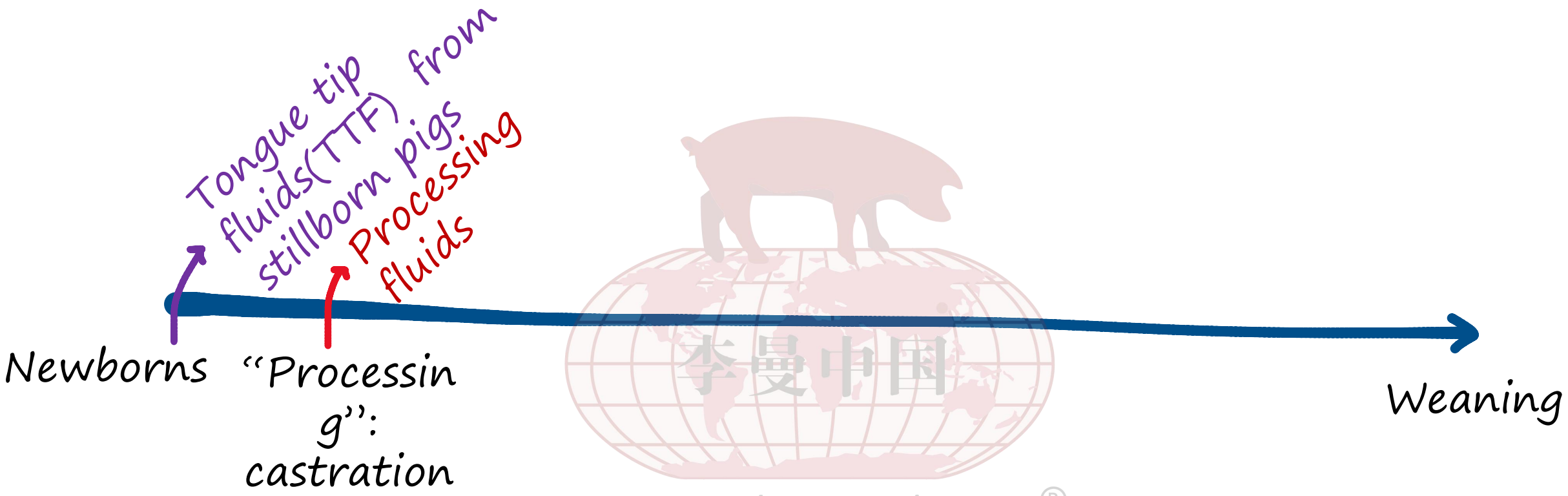
Weekly PRRSV status for breeding herds:
beyond positive/negative

Health status of farms (and batches)	PRRS-assoc clinical signs (eg. aborts, mortality, weak born pigs)	Shedding (PCR)	Prior exposure (ELISA)
Positive (acute)	positive	positive	positive
Positive (low prevalence)	Neg. sow herd	Prevalence <10%	positive
	Pos. downstream		
Positive stable	negative	no evidence	positive
Provisional negative	negative	negative	positive
Naïve	negative	negative	negative

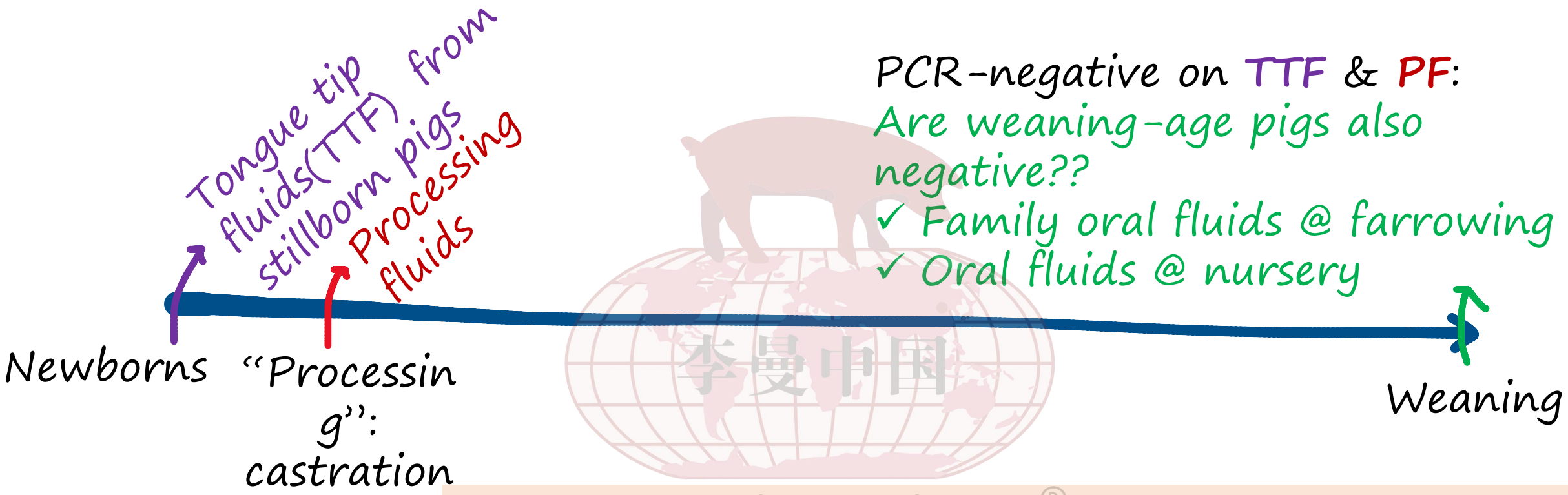
Source: Adapted from Holtkamp *et al.*, JSHAP 2021

PF PCR-positive: keep monitoring while immunity builds up.
PF PCR-positive for too long: vertical versus lateral infection?





TTF PCR-positive: virus likely from the sow herd.
TTF PCR-negative & PF PCR-positive: focus on bio-containment



PCR-negative on TTF & PF:
Are weaning-age pigs also negative??
✓ Family oral fluids @ farrowing
✓ Oral fluids @ nursery

The caveat: if PRRSV is present, it will be at low prevalence.
Intense sampling is required!

How to surveil for IAV?

Which sample type to use?

Udder wipes

2019 by Dr. Garrido-Mantilla
Virus: IAV

Nasal wipes

2015 by Dr. Nolting
Virus: IAV

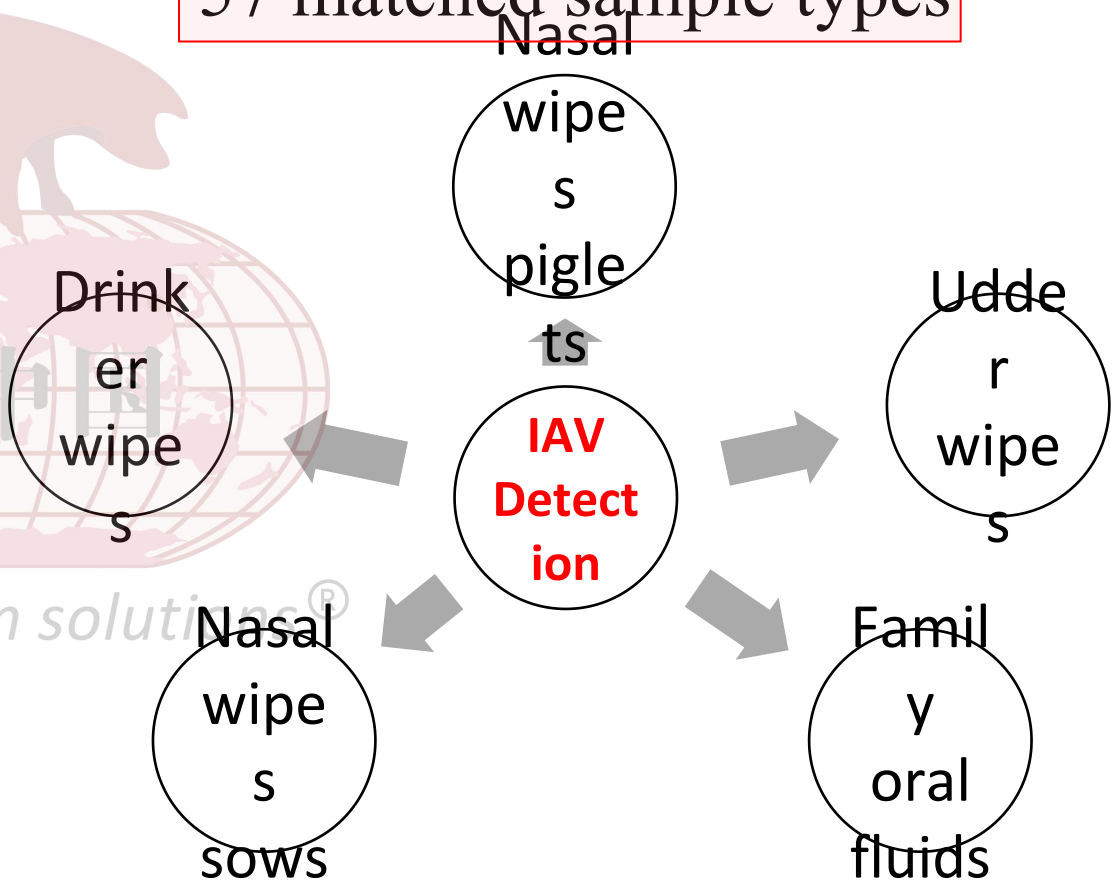
Family oral fluids

2021 by Dr. Almeida
Virus: PRRSV

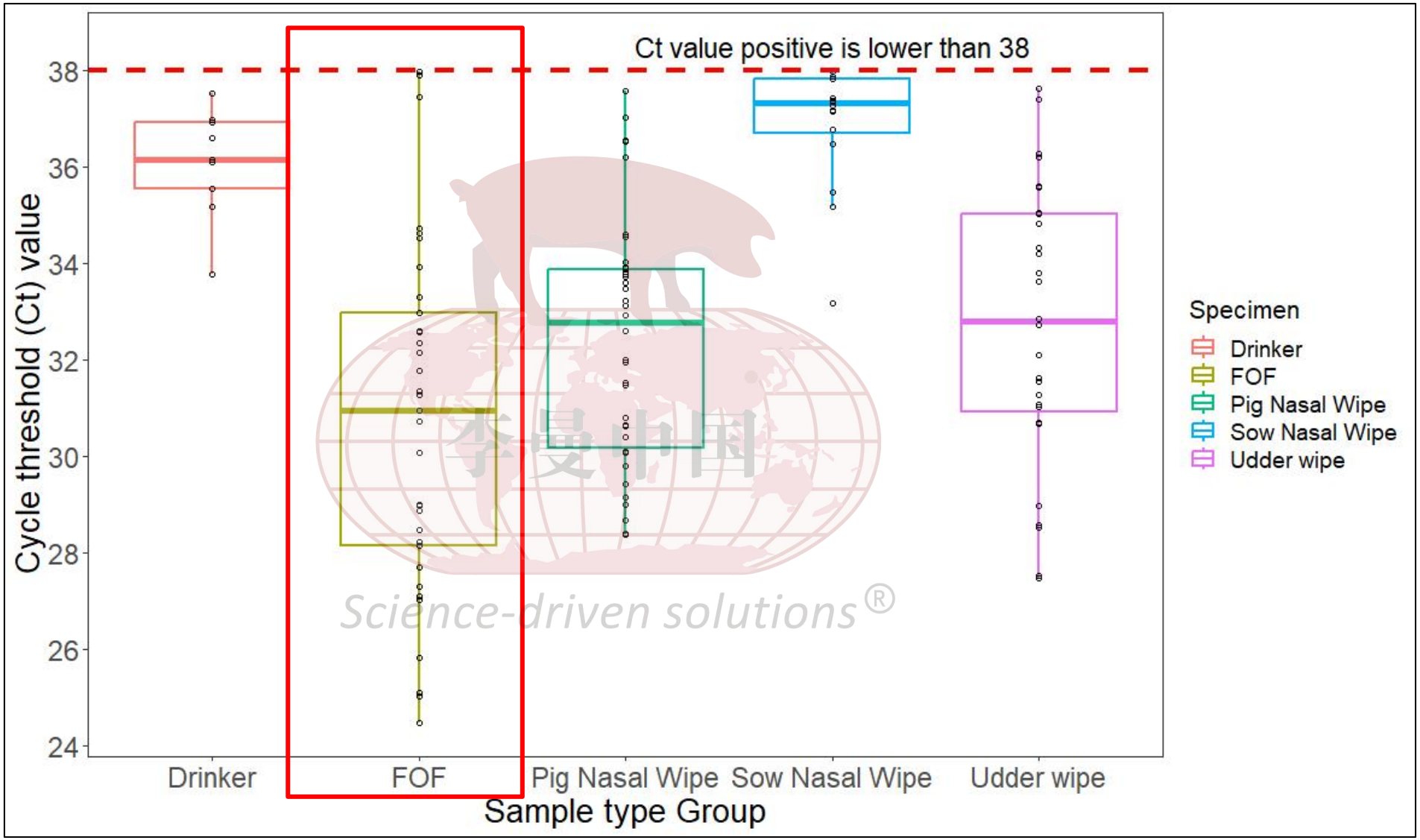
Dr. Daniel Moraes

Compare different sample types on the probability of IAV RNA detection in swine breeding herds

57 matched sample types

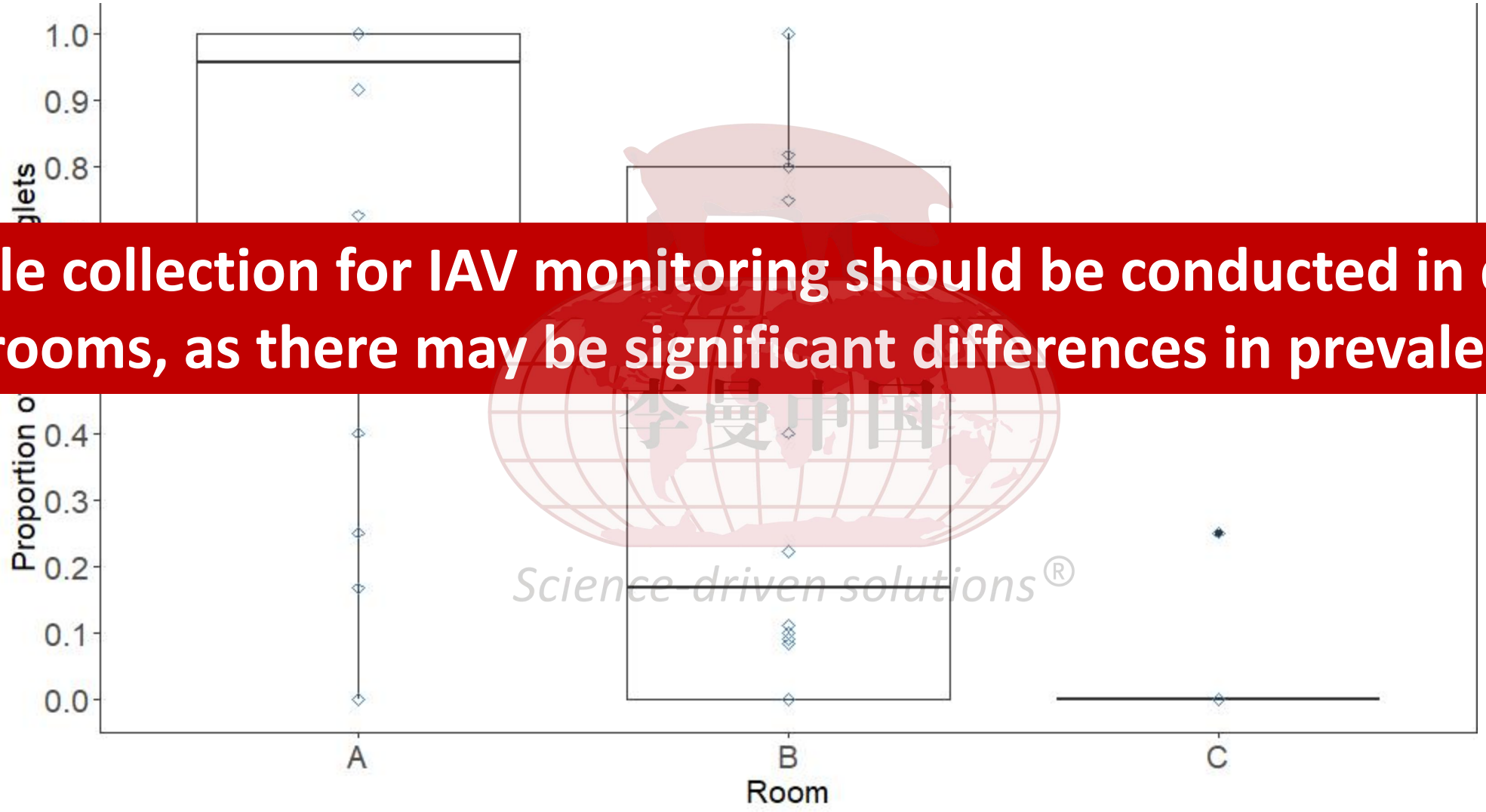


RT-rtPCR detection by sample types



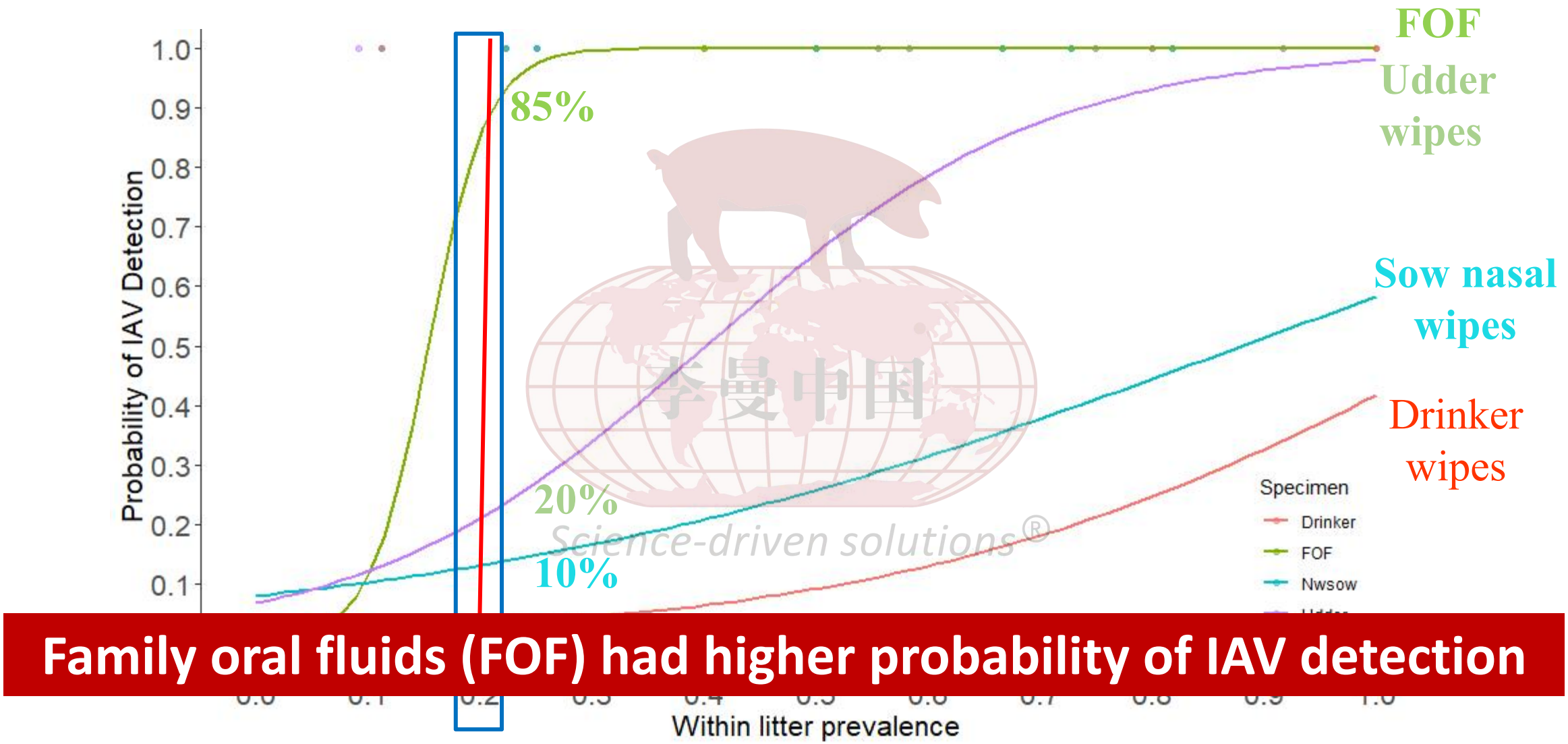
FOF had comparable or lower PCR Ct values against other sample types

Difference in IAV detection by room based on pig nasal wipes



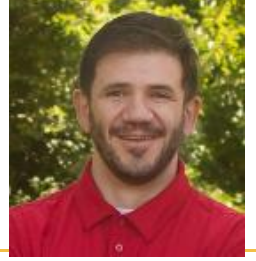
Sample collection for IAV monitoring should be conducted in different rooms, as there may be significant differences in prevalence

Probability of IAV by sample types within litter prevalence

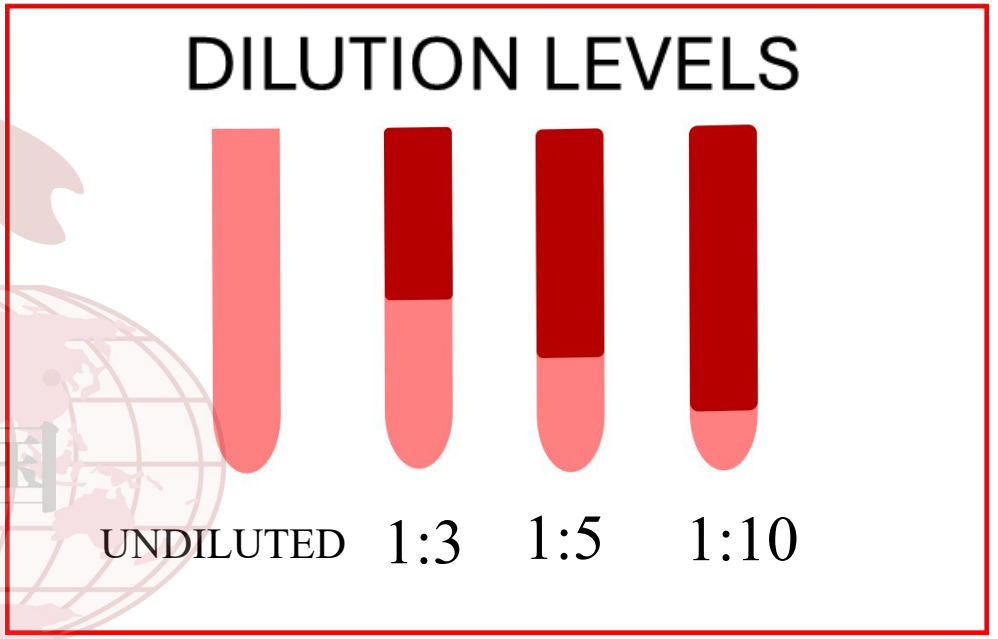


Family oral fluids (FOF) had higher probability of IAV detection

Dr. Daniel Moraes



Compare the probability of IAV RNA detection at different levels of pooling (undiluted, 1:3, 1:5, 1:10) for different sample types

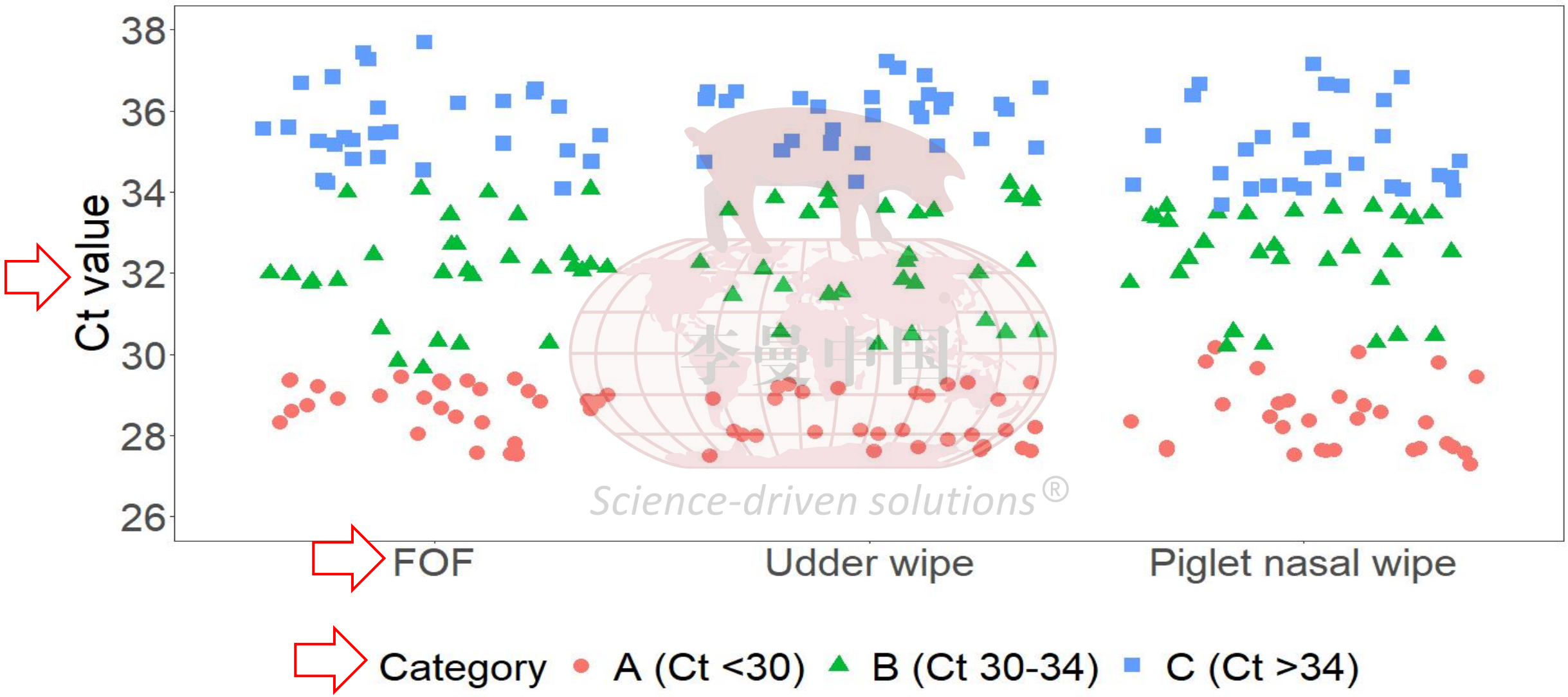


- FOF
- Udder Wipes (UW)
- Nasal Wipes (NW)

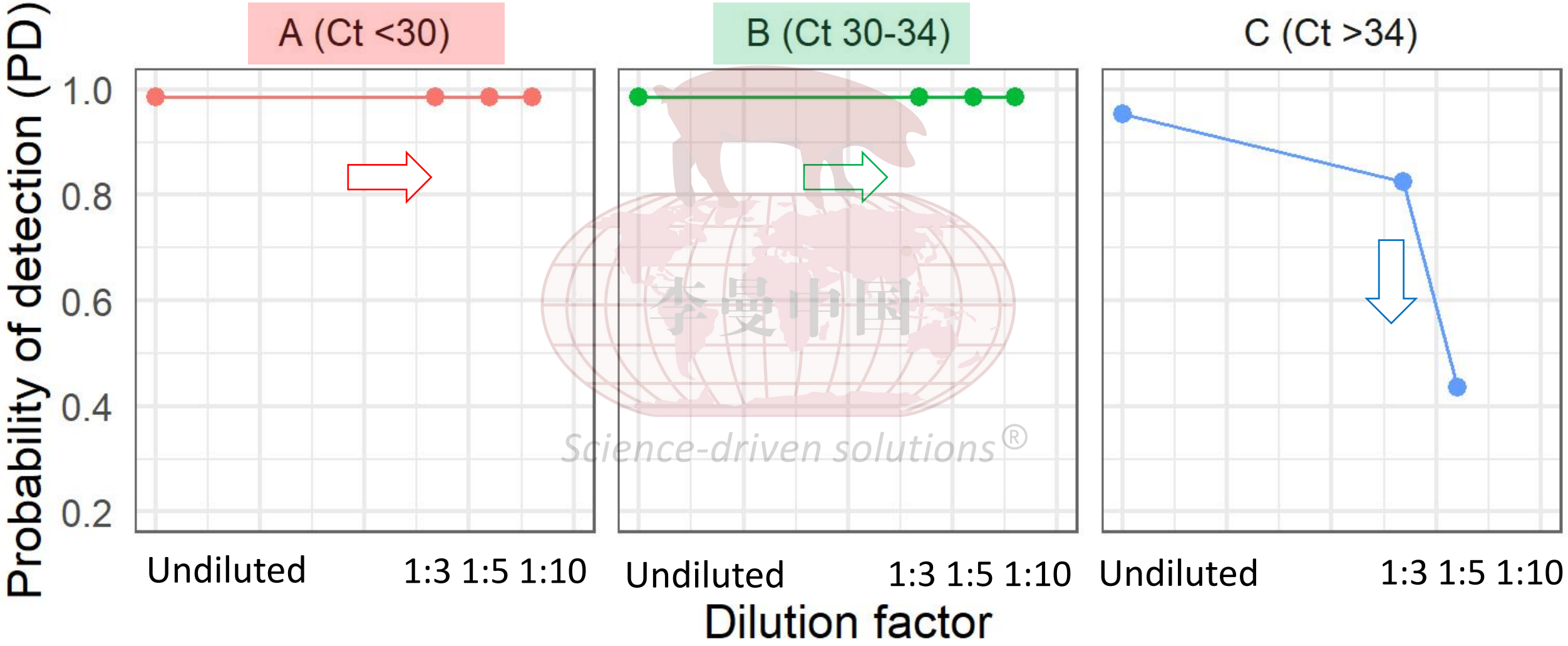
CT VALUE CATEGORY BY EACH SAMPLE TYPE

A	B	C
27-30	30-34	34-38

Undiluted samples were matched: Ct value

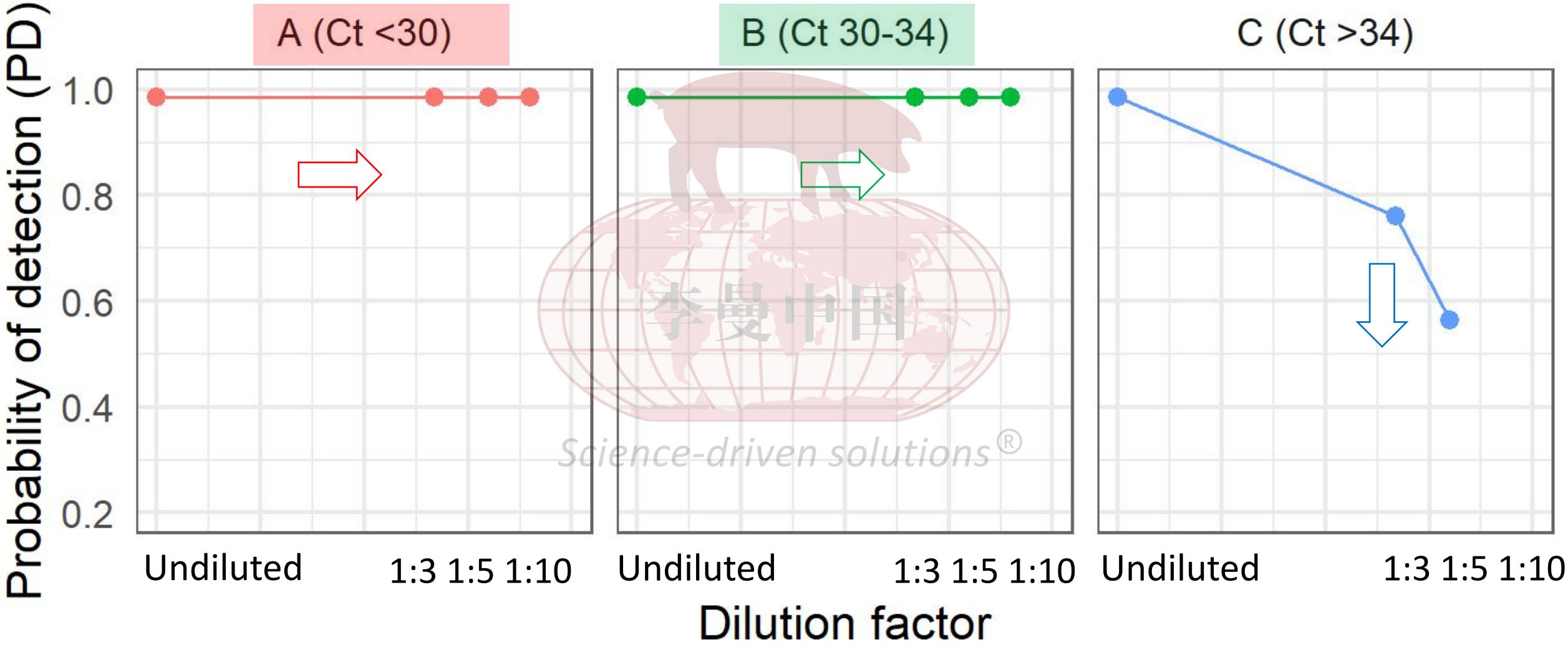


Probability of Detection
FOF: Ct Categories A and B did not decrease



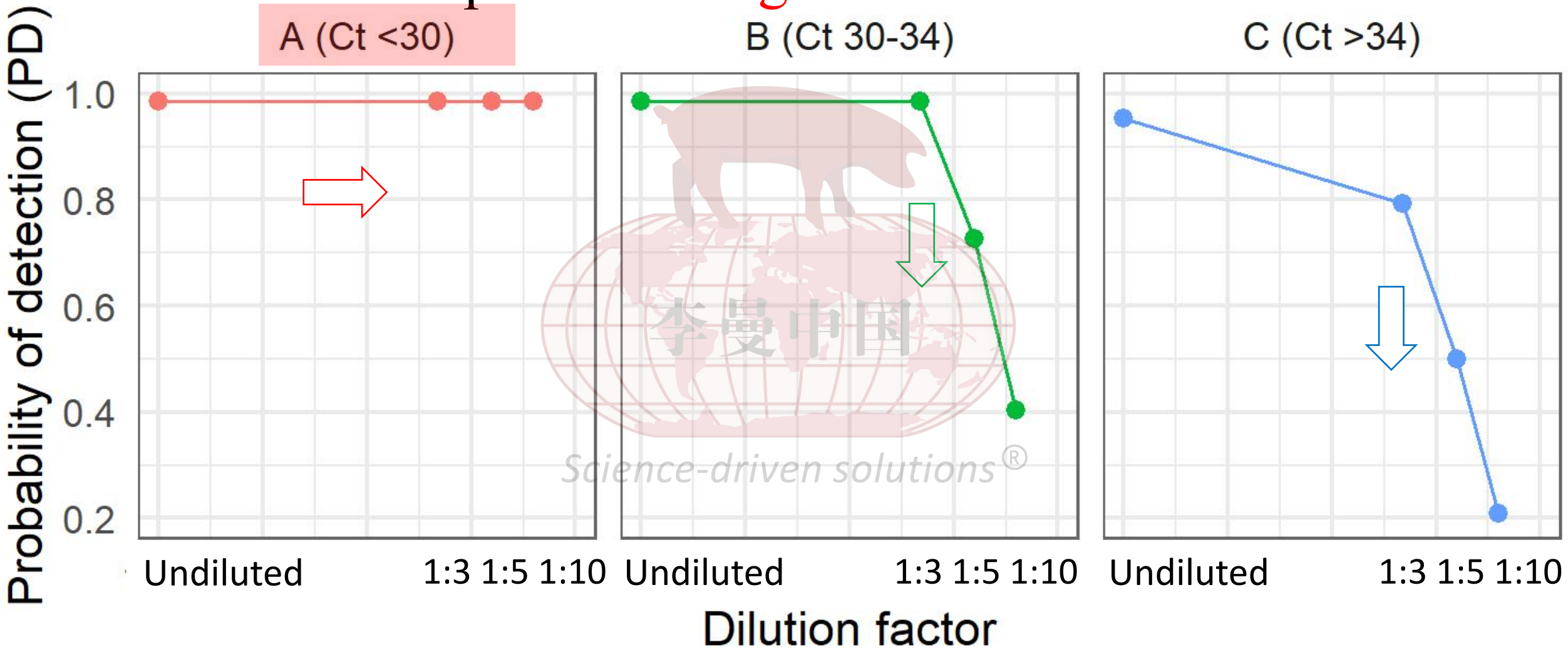
Probability of Detection

Udder Wipes: Ct Categories A and B did not decrease



Probability of Detection

Nasal wipes: Ct Categories A did not decrease



Take homes

- Select appropriate sample type and test to answer your question
- Sample size and frequency of testing
  - The more the merrier
  - Pooling is your friend
  - To be successful include ↑ ↑ ↑ pigs, litters and rooms over time
- Population samples > sensitivity than individual samples

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