Eradication of infectious diseases in pigs

Lessons learned & challenges in the future

Universität Bern | Universität Zürich

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ECPHM EUROPEAN COLLEGE OF PORCINE HEALTH MANAGEMENT

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What we will talk about?

- Principles
- Concepts
- Examples

Eradication of infectious diseases in pigs

Leman China Swine Conference
25^{th}-27^{th} OCT 2024, Chengdu (CN)

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Agenda

1. Understanding the epidemiology of an infection
2. Evaluating the socio-economic value of an eradication
3. Applying sustainable eradication concepts
4. Designing sampling strategies to control the success
5. Designing tailor-made eradication programmes

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Eradication of infectious diseases in pigs

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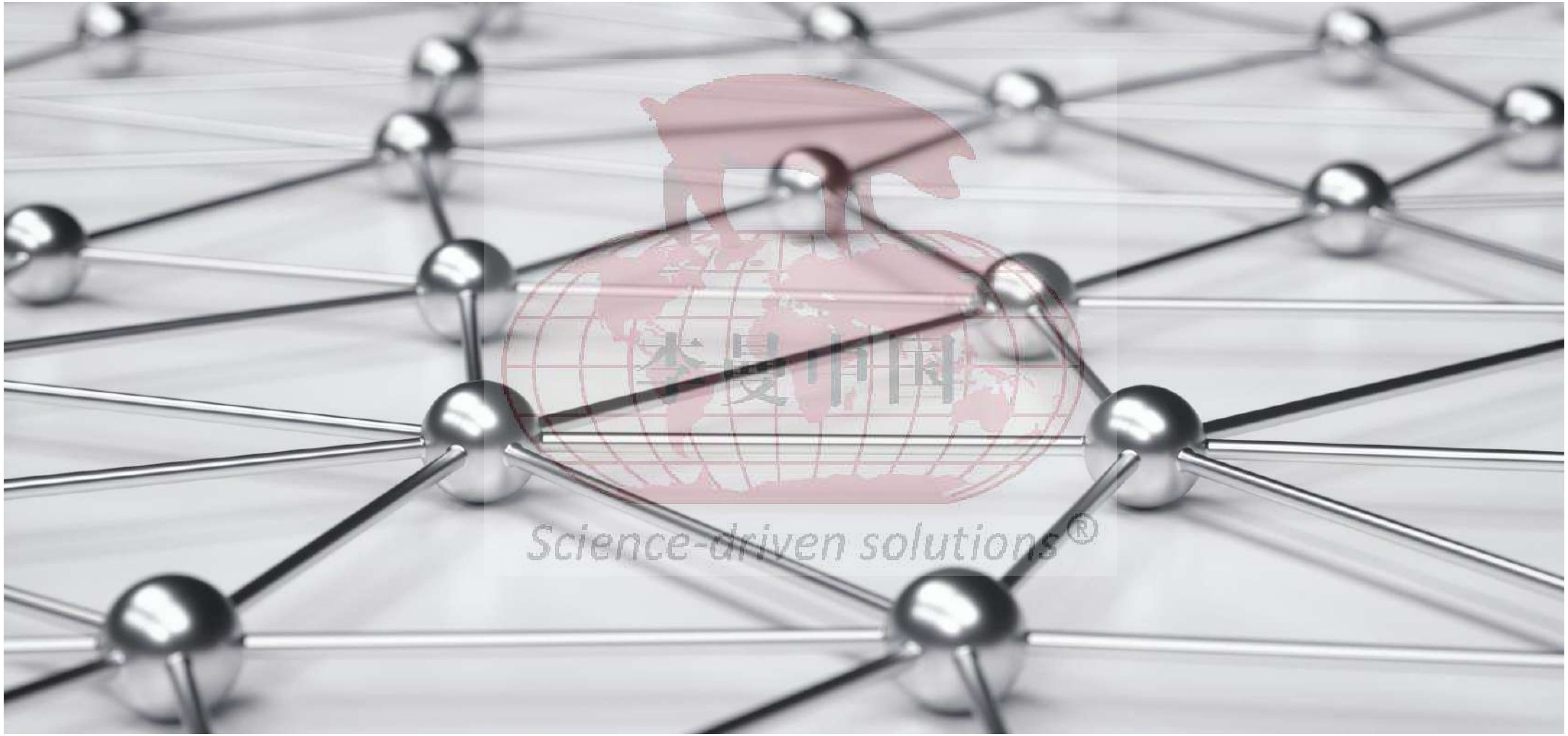
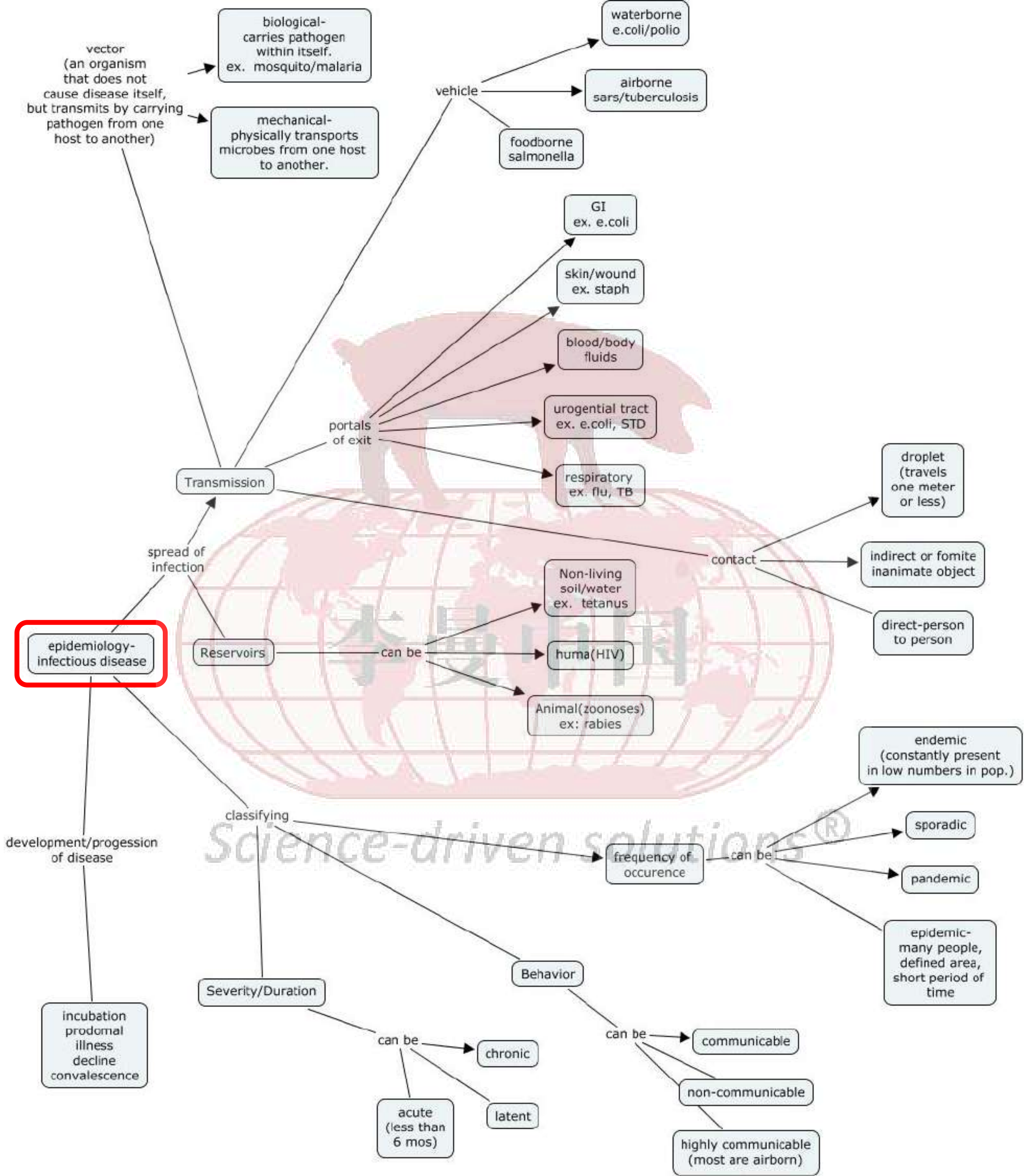
Understanding the epidemiology of an infection





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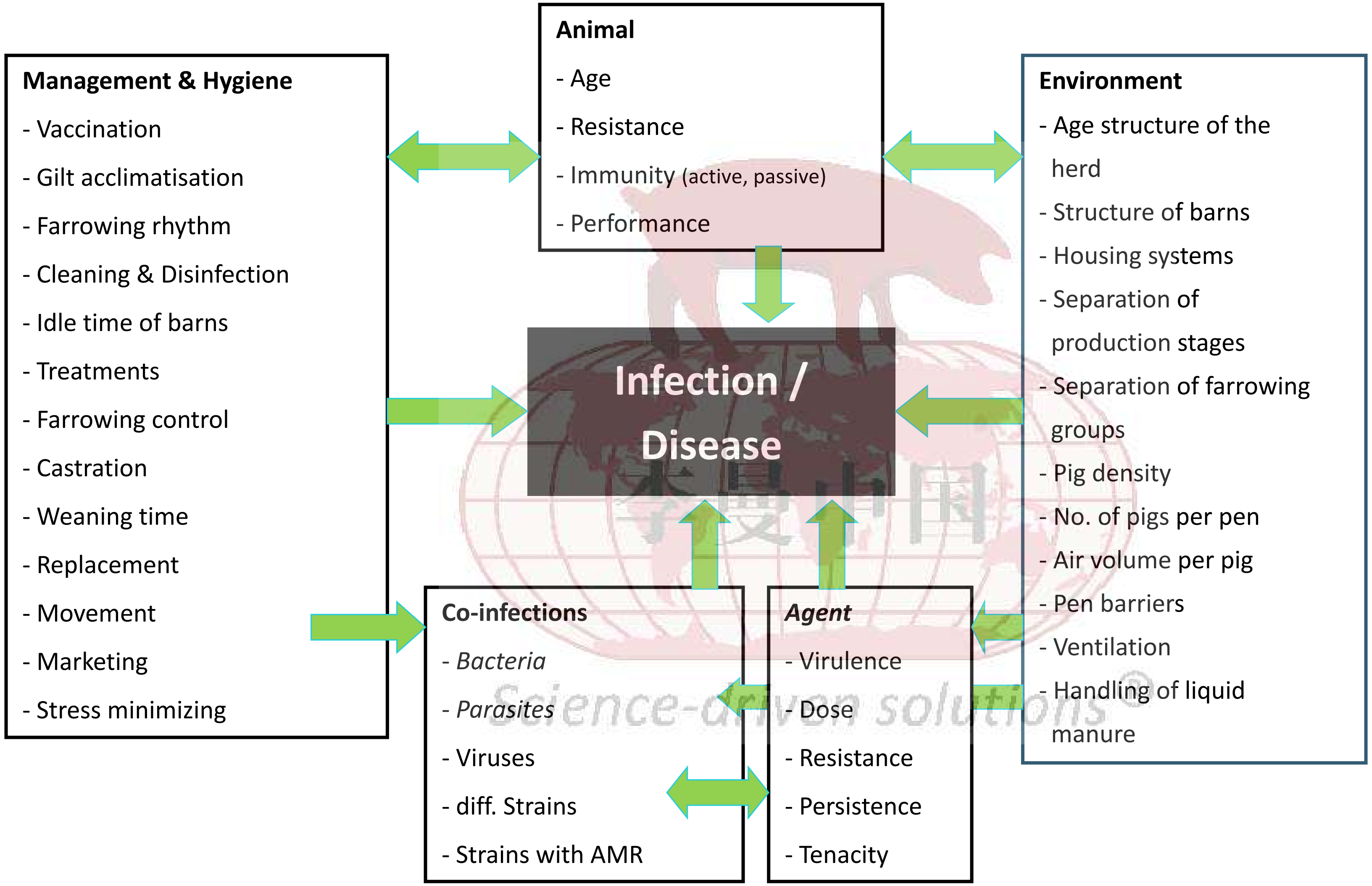


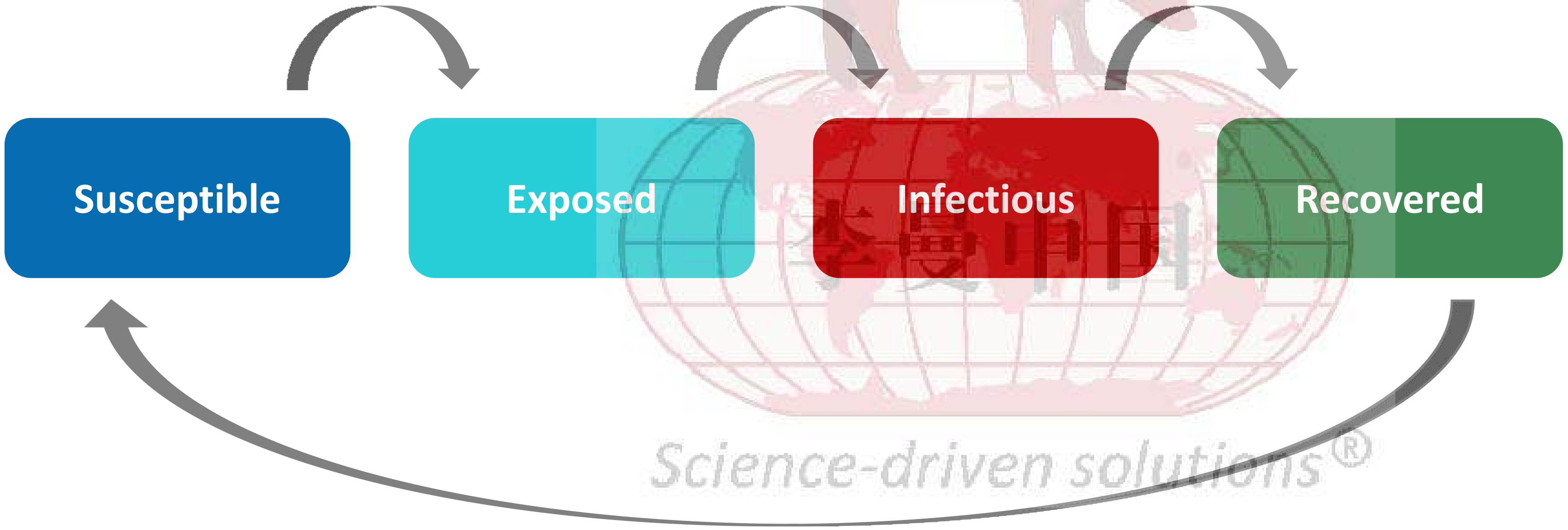
modified from Stärk, 1998

Important knowledge about the epidemiology

We should know about

- Transmission into the herd
- Spread within the herd
- Persistance in animals and/or groups of animals
- Elimination of the pathogen(s) from animals and their environment

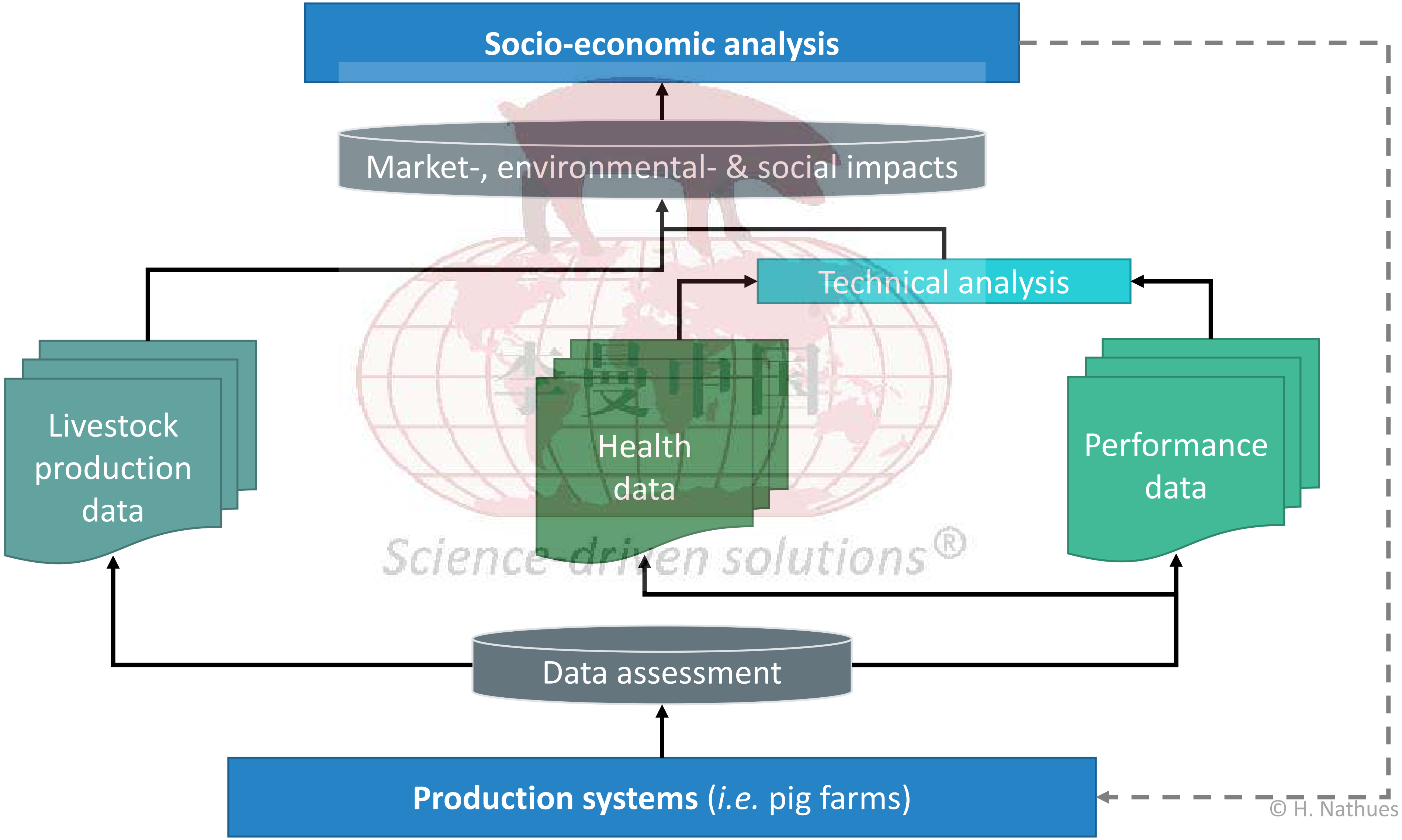
Important knowledge about the epidemiology



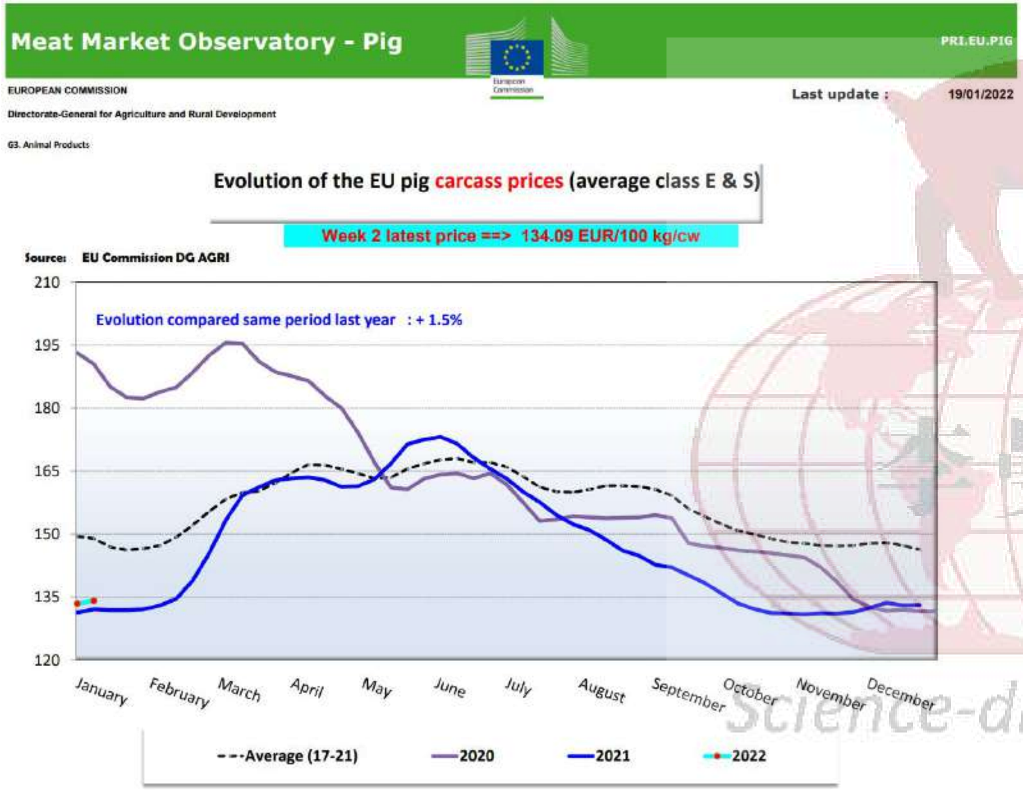
2

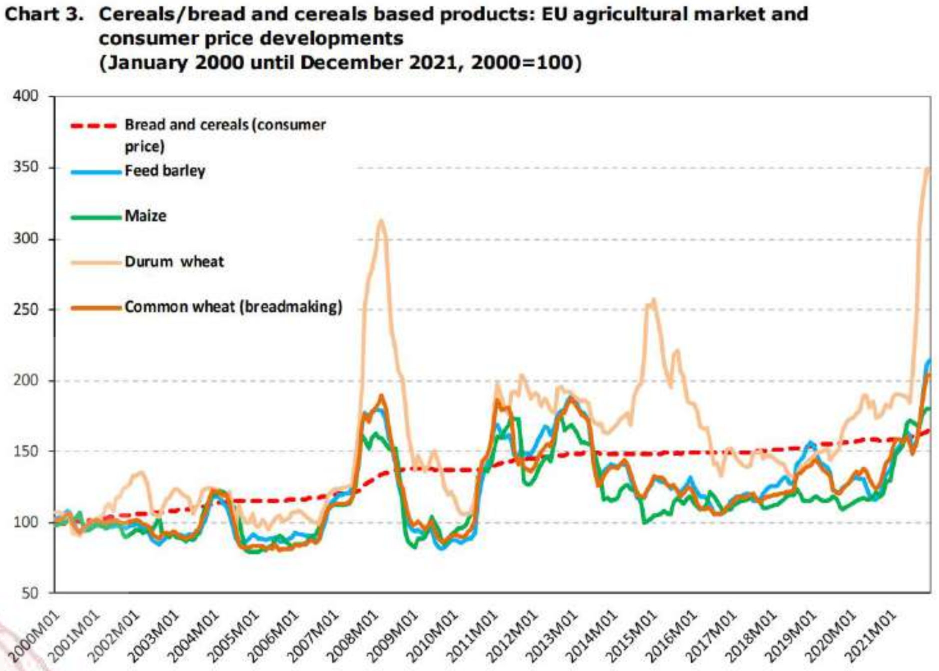
Evaluating the socio-economic value of an eradication

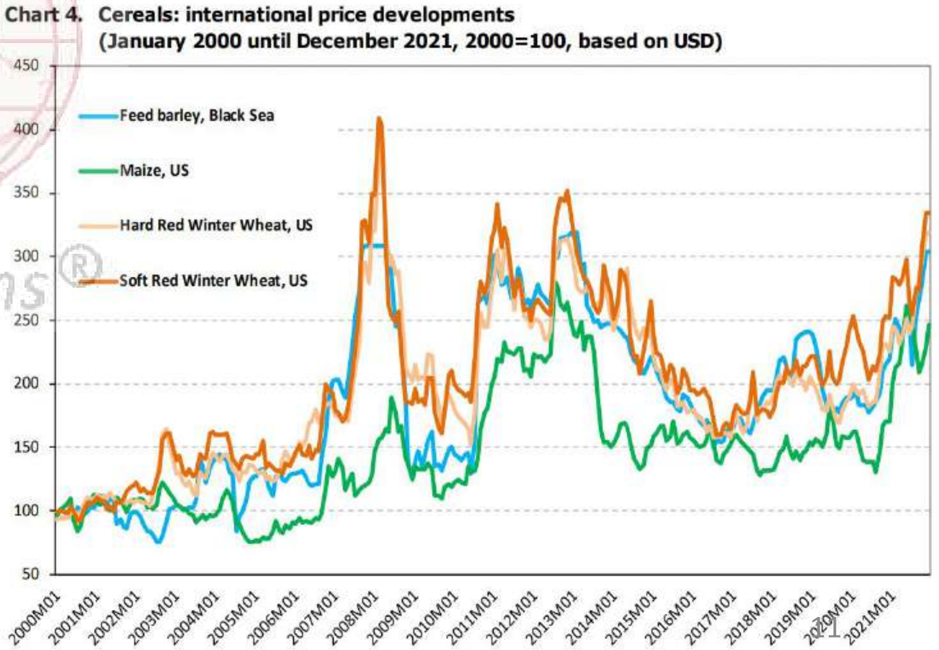
Before we should start any eradication programme …



Livestock production data







In case of PRRS

Preventive Veterinary Medicine 142 (2017) 16–29

Contents lists available at ScienceDirect

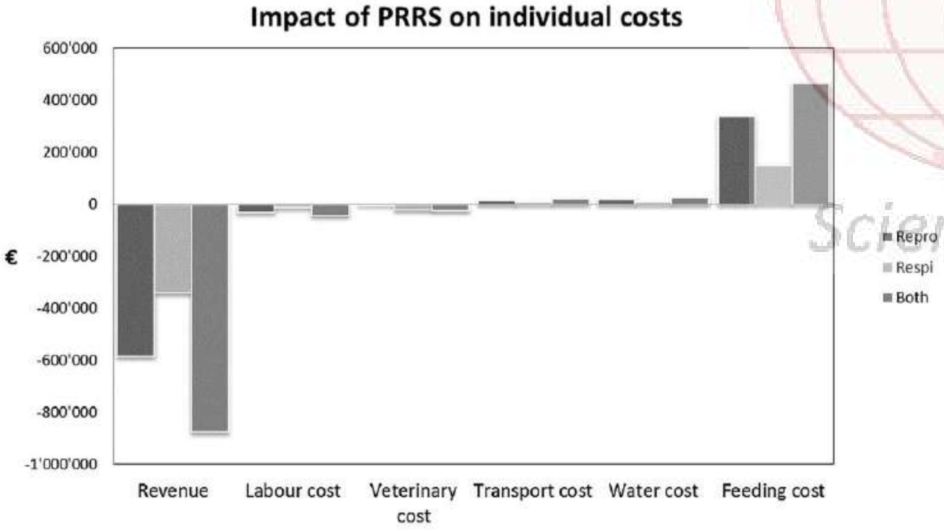
Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

ELSEVIER

Cost of porcine reproductive and respiratory syndrome virus at individual farm level – An economic disease model

H. Nathues[a], P. Alarcon[b], J. Rushton[b], R. Jolie[c], K. Fiebig[d], M. Jimenez[e], V. Geurts[f], C. Nathues[g,*]



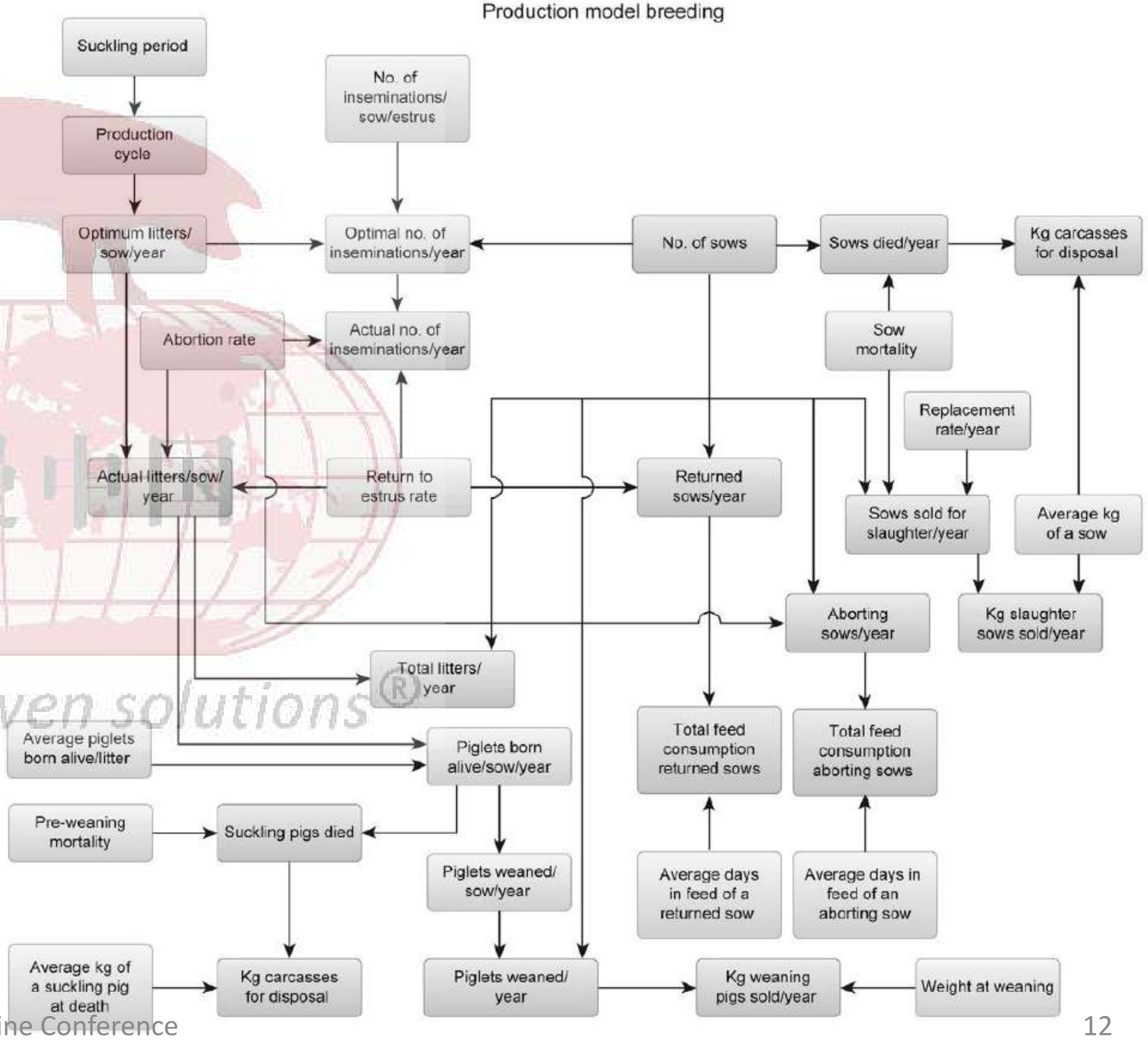


Fig. 1. Schematic production model of the breeding part in a sow herd.

In case of Swine Dysentery

Retrospektive Studie zur Sanierung von Beständen mit Schweinedysenterie (*Brachyspira hyodysenteriae*) in der Schweiz

R. S. S. Cadetg[1], B. Vidondo[2], H. Nathues[1], G. Schüpbach[2], F. Zeeh[1]

Tabelle 4: Direkte Tierverluste und berechnete Ausfallkosten in 68 Schweizer Beständen mit Sanierung von Schweinedysenterie. Als Verlust zählte der Verkauf von Tieren zu einem früheren Zeitpunkt als üblich und das vorzeitige Ausmerzen von Zuchttieren. Zur Berechnung dieser Verluste (Ausfall-Kosten) wurde für Mast- und Zuchtschweine der „Vergleichbare Deckungsbeitrag für 850g/d bei Alleinfutter" (DB) der entsprechenden Alterskategorie im Jahr der Sanierung gemäss AGRIDEA und dem Forschungsinstitut für biologischen Landbau (FiBL) verwendet. Die DB für Absetzferkel wurden freundlicherweise durch die UFA zur Verfügung gestellt. Auf die Berechnung der Ausfallkosten durch Babyferkel wurde verzichtet.

Direkte Tierverluste und berechnete Kosten	Produktionstyp vor Sanierung	n/N*	Median/Mittelwert	Minimum – Maximum	Interquartilsabstand/Standardabweichung
Anzahl Verluste Absetzferkel	Mastbestände	0/4	0	0–0	± 0
	Ferkelerzeuger	9/10	25	0–500	± 200
	Abferkelbestände	22/22	143.5	0–440	± 126
	Deck-Warte-Bestände	0/0	–	–	–
Ausfall-Kosten Absetzferkel (CHF)	Mastbestände	0/0	–	–	–
	Ferkelerzeuger	6/9	1127	300–11422.4	± 2161
	Abferkelbestände	20/22	517	91–55165.5	± 1070
	Deck-Warte-Bestände	0/0	–	–	–
Anzahl Verluste Masttiere	Mastbestände	31/32	0	0–83	± 0
	Ferkelerzeuger	6/7	0	0–357	± 0
	Abferkelbestände	8/10	0	0–200	± 2
	Deck-Warte-Bestände	0/0	–	–	–
Ausfall-Kosten Mastschweine (CHF)	Mastbestände	6/31	850	102–4482	± 1104
	Ferkelerzeuger	1/6	14994	14994–14994	± 0
	Abferkelbestände	3/8	204	51–10200	± 5074
	Deck-Warte-Bestände	0/0	–	–	–
Anzahl Verluste Zuchttiere	Mastbestände	0/0	–	–	–
	Ferkelerzeuger	8/10	40	0–134	± 73
	Abferkelbestände	21/22	0	0–0	± 0
	Deck-Warte-Bestände	4/4	0	0–50	± 12
Ausfall-Kosten Zuchttiere (CHF)	Mastbestände	0/0	–	–	–
	Ferkelerzeuger	7/8	25536	8940–235840	± 56573
	Abferkelbestände	0/21	–	–	–
	Deck-Warte-Bestände	1/4	348	348–348	± 0

*N entspricht der Anzahl Bestände, auf welche die Frage überhaupt zutraf. N kann daher niedriger als das N in den anderen Tabellen sein.

In case of other diseases

3

Applying sustainable eradication concepts

Sustainable eradication concepts

Proven to work in the field

High rate of success

Economically efficient

Eradication of *Mycoplasma hyopneumoniae*

P. Yeske, et al.

Preventive Veterinary Medicine 174 (2020) 104811

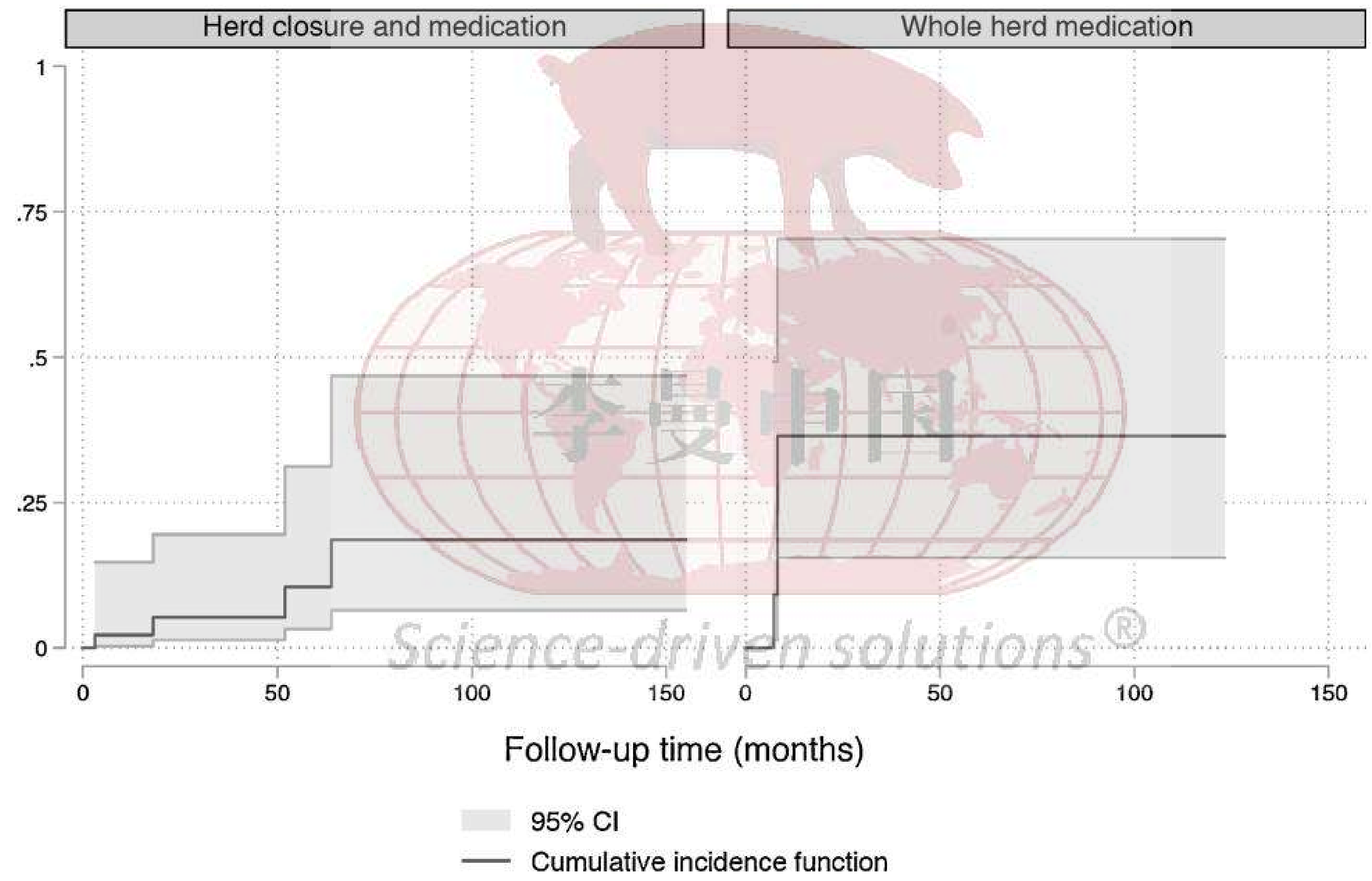


Fig. 1. Cumulative incidence of *Mycoplasma hyopneumoniae* detection during follow-up by eradication method (*herd closure and medication*, or *whole herd medication*).

Eradication of *Brachyspira hyodysenteriae*

Neirynck *et al. Porcine Health Management* (2020) 6:27
https://doi.org/10.1186/s40813-020-00162-2
Porcine Health Management
RESEARCH Open Access

Implementation and evaluation of different eradication strategies for *Brachyspira hyodysenteriae*

Willem Neirynck[1,2], Filip Boyen[3], Ilias Chantziaras[1], Tamara Vandersmissen[4], Philip Vyt[5], Freddy Haesebrouck[3], Jeroen Dewulf[1] and Dominiek Maes[1*]

Eradication was successful in four farms. **Two of them** (farrow-to-finish and finishing herd) had applied **total depopulation** and respected a vacancy period of at least 3 weeks. **A third** farm (gilt farm) **practised partial depopulation**, the rooms remained empty for 28 days and changed the source of breeding gilts. **The fourth** farm **practised partial depopulation**, the stables remained empty for 3 weeks, **and used antimicrobial medication**. The eradication programme was not successful in six farms.

The «Swiss method» of eradication

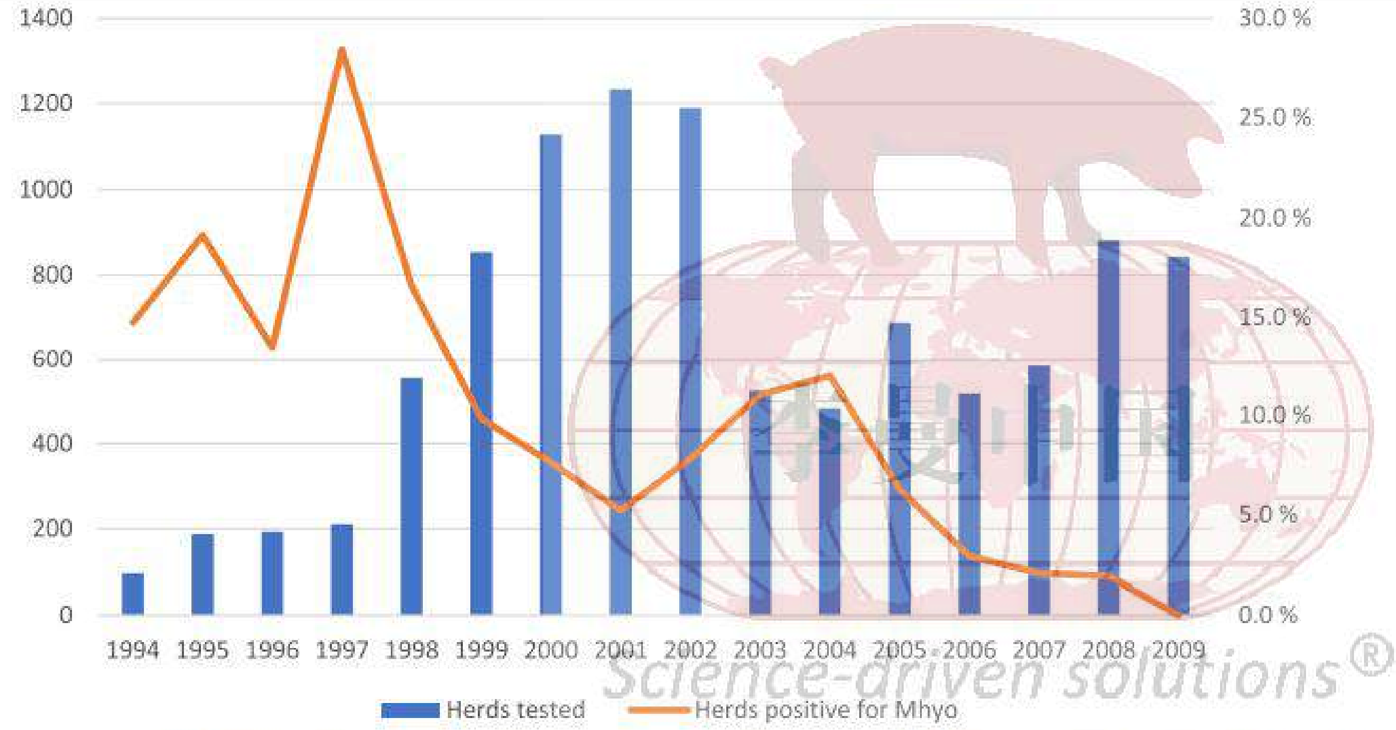
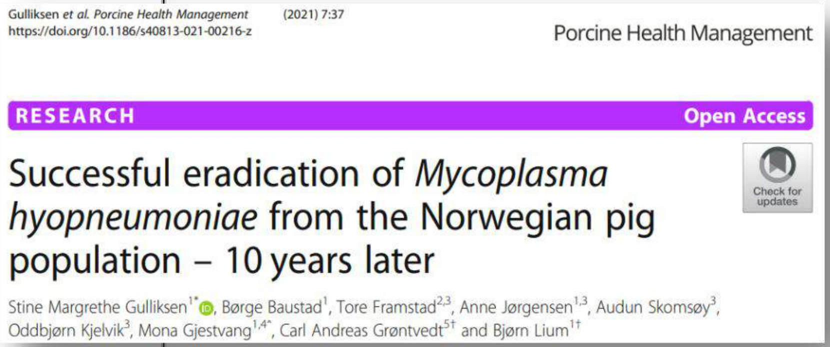


Fig. 1 Number of Norwegian pig herds tested per year, and the proportion of Mhyo positive herds. Legend: Number of Norwegian pig herds tested per year between 1994 and 2009, and the proportion of herds positive for antibodies against *Mycoplasma hyopneumoniae* (Mhyo). Most herds were tested more than once


Gulliksen *et al. Porcine Health Management* (2021) 7:37
https://doi.org/10.1186/s40813-021-00216-z
Porcine Health Management
RESEARCH Open Access

Successful eradication of *Mycoplasma hyopneumoniae* from the Norwegian pig population – 10 years later

Stine Margrethe Gulliksen[1*], Børge Baustad[1], Tore Framstad[2,3], Anne Jørgensen[1,3], Audun Skomsøy[3], Oddbjørn Kjelvik[3], Mona Gjestvang[1,4*], Carl Andreas Grøntvedt[5†] and Bjørn Lium[1†]

Economic efficiency

Preventive Veterinary Medicine 152 (2018) 89–102

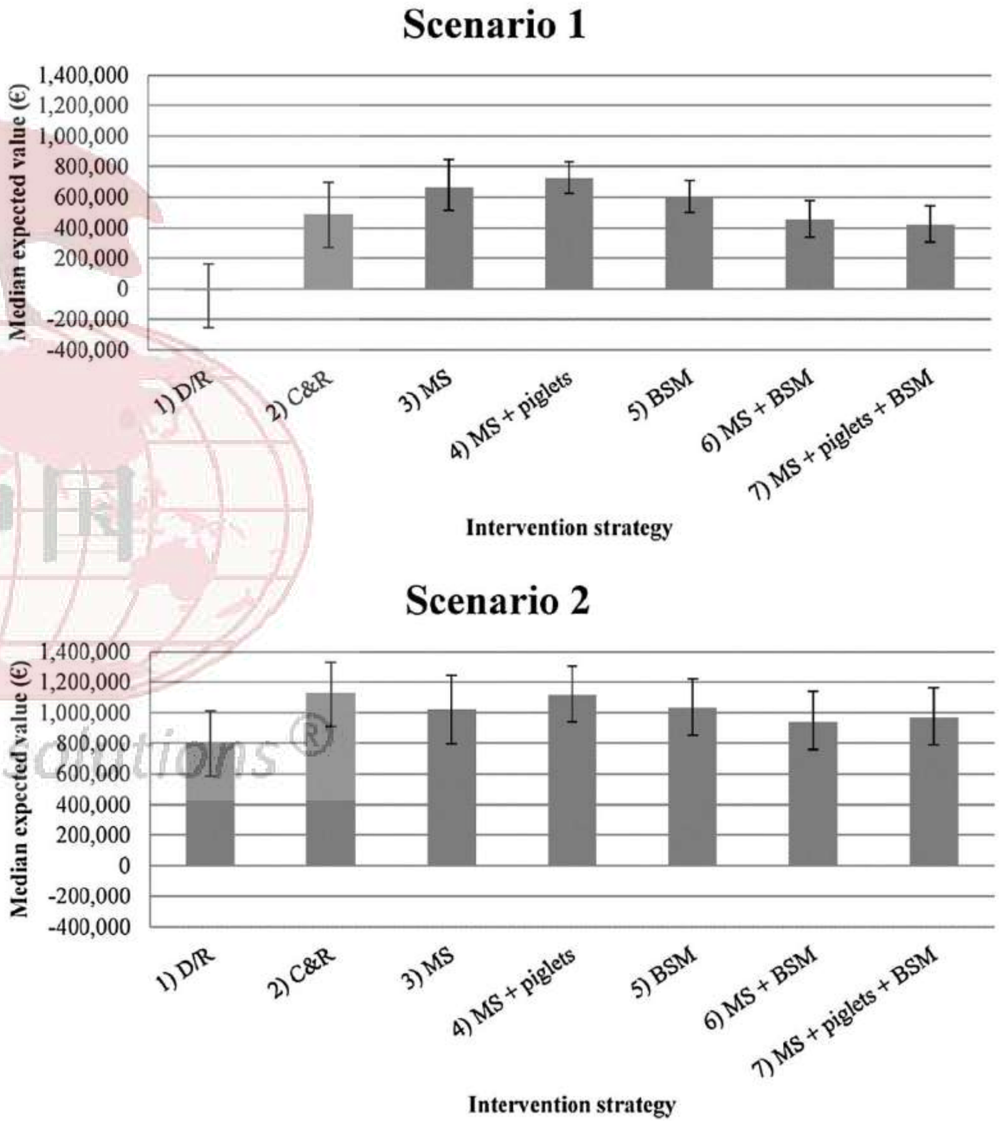
Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Modelling the economic efficiency of using different strategies to control Porcine Reproductive & Respiratory Syndrome at herd level

H. Nathues[a], P. Alarcon[b], J. Rushton[b], R. Jolie[c], K. Fiebig[d], M. Jimenez[e], V. Geurts[f], C. Nathues[g,*]



Depopulation/Repopulation (D/R) is often less efficient compared to Close & Roll-over (C&R)

Sustainable eradication concepts

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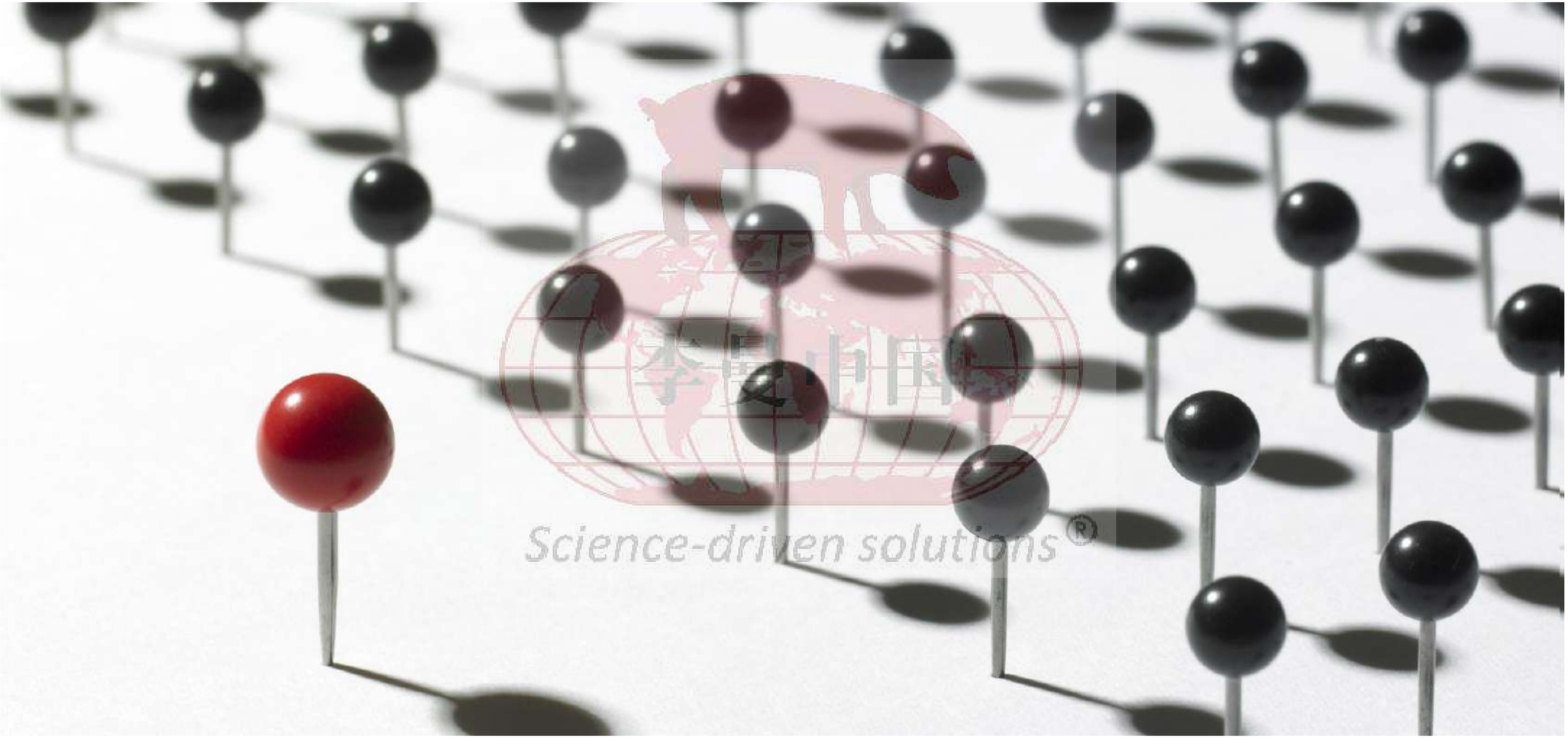
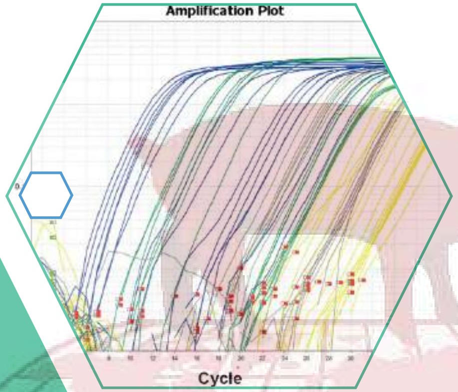
	Pros	Cons
Depopulation/Repopulation	- Works with nearly every infection - Very high success rate	- Very expensive - Loss of genetic material
Close & Roll-over (load, close, homogenize)	- Cost efficient - Saves genetic material - Positive cash-flow	- Uncertainty of success
Test & Removal	- Potentially most cost efficient - Saves genetic material - Positive cash-flow	- Only when prevalence is <25%! - May fail due to false negatives
Others (mass treatment, etc.)	- Easy to apply	- Uncertainty of success

4

Designing sampling strategies to control the success



Select the «best option»



Method

$$\frac{\frac{z^2 \times p\,(1-p)}{e^2}}{(\frac{z^2 \times p\,(1-p)}{e^2 N}}$$

Sample site

Sample size

In case of PRRSV on country level (OIE guidelines)

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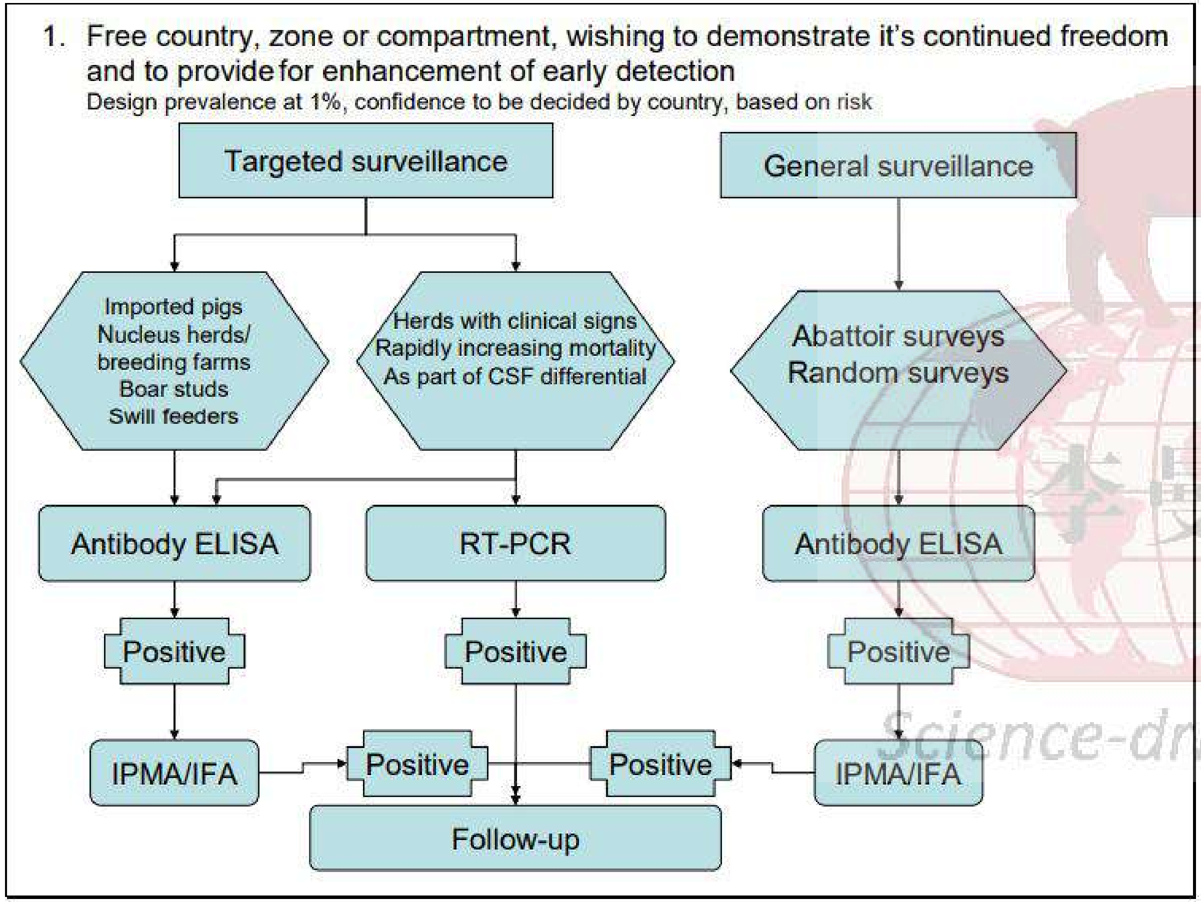
The following specimens should be collected:

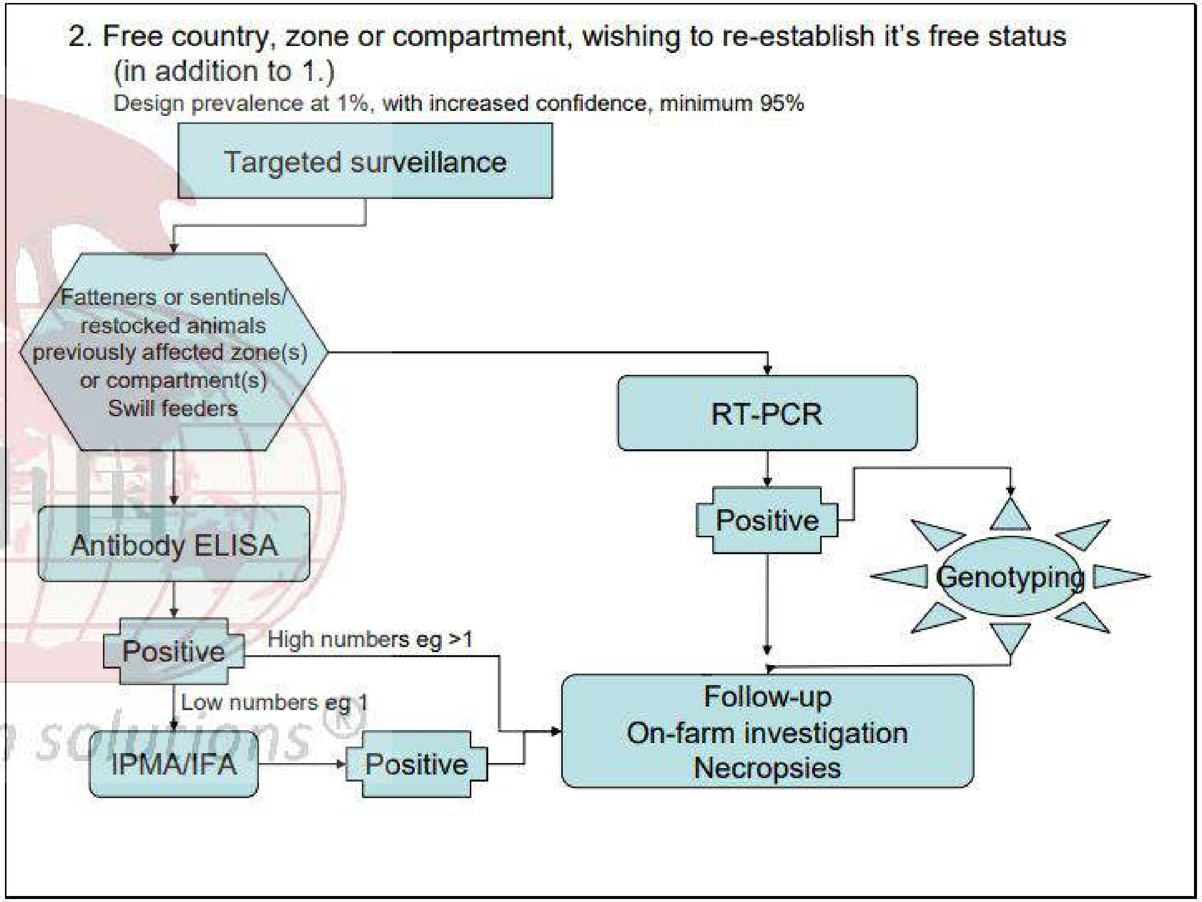
- **For virus isolation and RT-PCR**
  - **Whole blood** (EDTA) **and also serum**, lung, respiratory tract, spleen and tonsils of affected animals. Samples from mummified or aborted litters are unlikely to yield virus but can still be useful for RT-PCR.
- **For antibody testing (serology)**
  - **Serum from up to 20 exposed animals in the herd.**

Specimens should be chilled and forwarded unfrozen on water ice or with frozen gel packs.

- RT-PCR
  - Whole blood (EDTA), buffy coat and clarified homogenates of the above tissues are best. At this time, there is no fully validated PCR that has international acceptability. Please consult the OIE Manual for suggested methods.
- Serological tests
  - IgM can be detected within 7 days of infection and IgG can be detected within 14 days. Humoral antibody titres reach a maximum about 5–6 weeks after infection. Antibody can be detected by ELISA and by the indirect staining of pre-prepared monolayers of infected cells (IPMA and IFA). Antibody levels can drop quite quickly in the absence of circulating virus.

In case of PRRSV on country level (OIE guidelines)





In case of PRRSV on herd level

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COMMENTARY PEER REVIEWED

Terminology for classifying swine herds by porcine reproductive and respiratory syndrome virus status

Derald J. Holtkamp, DVM, MS; Dale D. Polson, DVM, PhD; Montserrat Torremorell, DVM, PhD; and committee members Bob Morrison, DVM, PhD, MBA (chair); Dyneah M. Classen, DVM; Lisa Becton, DVM; Steve Henry, DVM; Max T. Rodibaugh, DVM; Raymond R. Rowland, PhD; Harry Snelson, DVM; Barb Straw, DVM, PhD; Paul Yeske, DVM, MS; Jeff Zimmerman, DVM, PhD

"When possible, pooling of samples to increase sample size, frequency of testing, or both, and targeted sampling of subpopulations to improve herd-level sensitivity, are recommended."

: Recommended protocol to assess PRRSV shedding status of weaning-age pigs for Category II-A or II-B breeding herds

	Requirements
Test(s) performed	Polymerase chain reaction
Animals tested	Weaning-age pigs*
Specimen(s) collected	Serum (blood, notch/swab, tail/swab)
Sampling or whole-herd testing (every animal in population)	Sampling
If sampling:	
Targeted subpopulation (if any) sampled	Light-weight males from gilt litters may increase sensitivity (optional)
Systematic sampling procedure	One pig per litter, both pig and litters selected randomly
Minimum number of samples per herd test	30 samples, determined by target prevalence to be detected of 10%, and 95% confidence level, for any population size
Pooling strategies (if any)	Pools of five
Procedures to rule out false-positives	None
Minimum number of periodic herd tests	Minimum of four to account for variation in prevalence and increase confidence of finding positives if present
Frequency of herd tests (minimum frequency)	Every 30 days or more frequently to confirm status Frequency to reconfirm status after initial tests depends upon reason for classifying herd
Decision rules that classify the herd	None positive over a 90-day period (four consecutive negative herd tests if sampling every 30 days); no clinical signs in breeding herd

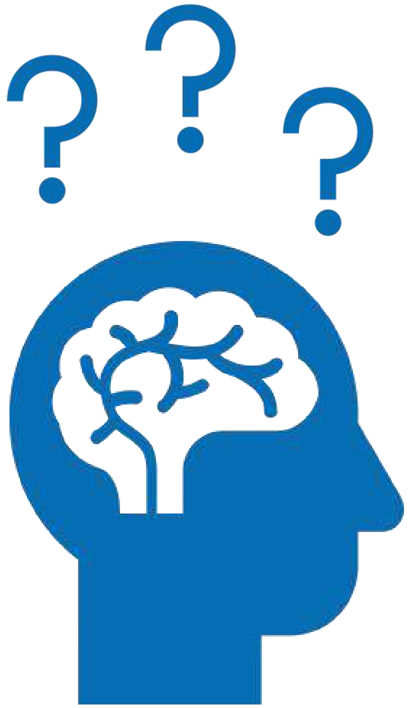
* Weaning-age pigs defined as 7 days before and 3 days after weaning regardless of age.
PRRSV = porcine reproductive and respiratory syndrome virus

In case of PRRSV on herd level

COMMENTARY PEER REVIEWED

Proposed modifications to porcine reproductive and respiratory syndrome virus herd classification

Derald J. Holtkamp, DVM, MS; Montserrat Torremorell, DVM, PhD; Cesar A. Corzo, DVM, MS, PhD; Daniel C. L. Linhares, DVM, MBA, PhD; Marcelo N. Almeida, DVM, MS; Paul Yeske, DVM, MS; Dale D. Polson, DVM, MS, PhD; Lisa Becton, DVM; Harry Snelson, DVM; Tara Donovan, DVM; Jeremy Pittman, DVM; Clayton Johnson, DVM; Carles Vilalta, DVM, PhD; Gustavo S. Silva, DVM, PhD; Juan Sanhueza, DVM, PhD



Update in 2021:

- Testing as before (blood samples collected by the vet)
- Testing of processing fluids (collected by the farmer)
- Testing of oral fluids (collected by the farmer)

PLoS One. 2016; 11(11): e0166300.
Published online 2016 Nov 7. doi: 10.1371/journal.pone.0166300
PMCID: PMC5098819
PMID: 27820859

Comparison of PRRSV Nucleic Acid and Antibody Detection in Pen-Based Oral Fluid and Individual Serum Samples in Three Different Age Categories of Post-Weaning Pigs from Endemically Infected Farms

Nick De Regge* and Brigitte Cay

Martin Beer, Editor

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Table 3. Comparison of PRRSV specific antibody detection in oral fluid and serum via ELISA. A litter was considered PRRSV positive in serum as soon as one serum sample originating from that litter tested positive.

		OF		
		pos	neg	
serum	pos	44	0	44
	neg	2	9	11
		46	9	55

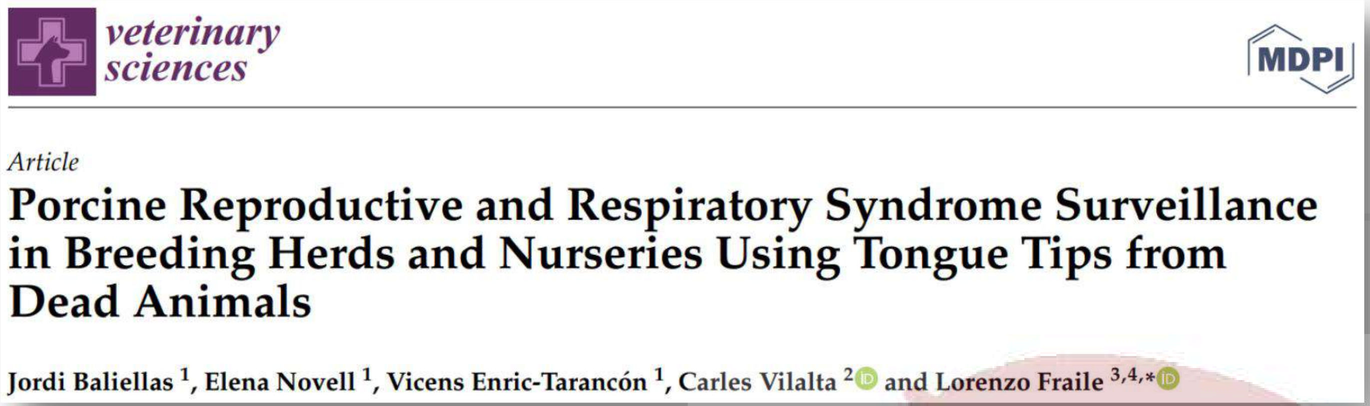
-> Relative specificity: 85%

Table 2. Comparison of PRRSV detection in oral fluid and serum via qRT-PCR (a) and overview of relative test characteristics and mean percentage of PRRSV positive pigs per pen for the different age categories (b). A litter was considered PRRSV positive in serum as soon as one serum sample originating from that litter tested positive.

a.			OF		
			pos	neg	
	serum	pos	30	12	42
		neg	1	27	28
			31	39	70

b.		relative sensitivity	relative specificity	kappa	mean (± SEM) % PRRSV positive pigs / pen
	overall	71	96	0,637	30 ± 4
	8–12	89	100	0,8	55 ± 8
	16–20	93	91	0,838	29 ± 7
	24–28	10	100	0,104	6 ± 2

-> Relative sensitivity: 71%


veterinary sciences

MDPI

Article

Porcine Reproductive and Respiratory Syndrome Surveillance in Breeding Herds and Nurseries Using Tongue Tips from Dead Animals

Jordi Baliellas [1], Elena Novell [1], Vicens Enric-Tarancón [1], Carles Vilalta [2] and Lorenzo Fraile [3,4,*]

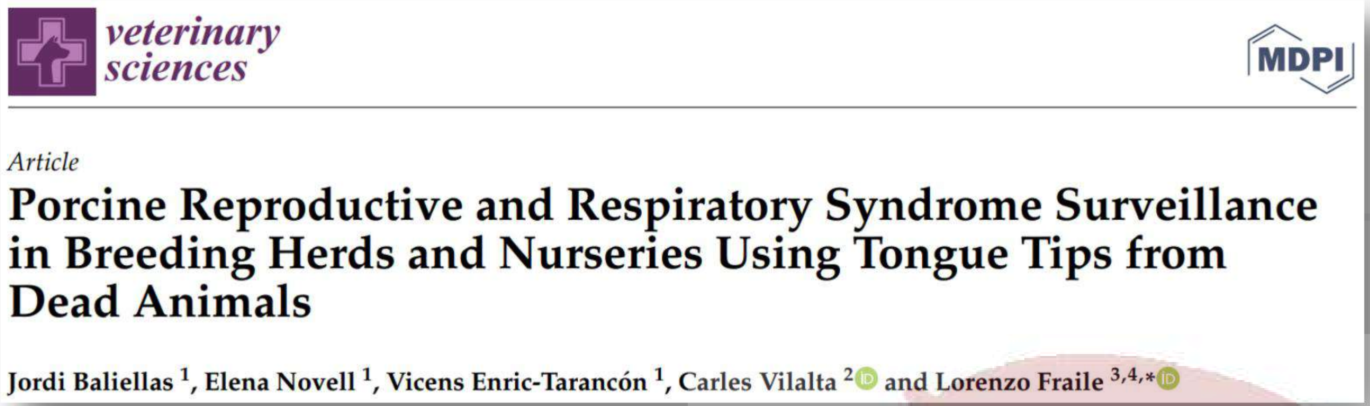
- 30 blood samples
  - 10% prevalence
  - 95% confidence
- 30-100 tongue samples
- Kappa index of 0.55

«Tongue samples more sensitive than blood samples»

Table 1. Sow farm and sample characteristics to study the agreement between paired serum and tongue samples (between brackets) for Porcine Reproductive and Respiratory Syndrome virus (PRRSV) diagnosis in a production batch.

Farm (Pair)	Farm Size [1]	Type of Farm [2]	PRRSV History [3]	Age [4]	Sample Date	Timing from Diagnosis to Sampling	PRRSV Batch Results Serum/Tongues	Agreement (Y/N) [5]
4 (1)	2500	FTF	Positive	3 weeks	5 February 2019	371	−/+	N
4 (2)	2500	FTF	Positive	1 day	5 February 2019	371	−/+	N
4 (3)	2500	FTF	Positive	1 day	12 March 2019	406	+/+	Y
4 (4)	2500	FTF	Positive	3 weeks	12 March 2019	406	−/+	N
4 (5)	2500	FTF	Positive	1 day	9 May 2019	464	−/+	N
4 (6)	2500	FTF	Positive	1 day	28 July 2020	910	+/+	Y
5 (1)	2300	FTF	Positive	1 day	12 March 2019	464	+/+	Y
5 (2)	2300	FTF	Positive	1 day	28 July 2020	206	+/+	Y
6 (1)	1700	FTF	Positive	1 day	6 March 2019	15	+/+	Y
6 (2)	1700	FTF	Positive	3 weeks	6 March 2019	15	+/+	Y
8 (1)	2400	FTF	Positive	3 weeks	19 February 2019	120	−/+	N
8 (2)	2400	FTF	Positive	1 day	19 February 2019	120	+/+	Y
9 (1)	2350	FTF	Positive	1 day	11 March 2020	109	+/+	Y
9 (2)	2350	FTF	Positive	3 weeks	11 March 2020	109	+/+	Y
24 (1)	3000	FTF	Positive	1 day	16 July 2020	87	−/+	N
24 (2)	3000	FTF	Positive	1 day	18 June 2020	59	+/+	Y
36 (1)	2200	FTW	Positive	1 day	28 July 2019	203	+/+	Y
36 (2)	2200	FTW	Positive	1 day	18 September 2019	255	+/+	Y
47 (1)	750	FTW	Positive	1 day	10 September 2019	369	+/+	Y
50 (1)	2000	FTF	Positive	1 day	9 December 2020	330	+/+	Y
50 (2)	2000	FTF	Positive	1 day	3 November 2020	294	+/+	Y
50 (3)	2000	FTF	Positive	1 day	8 September 2020	238	+/+	Y
52 (1)	3080	FTF	Positive	1 day	18 August 2020	120	+/+	Y
54 (1)	650	FTF	Negative	1 day	25 April 2019	NA	−/−	Y
55 (1)	2400	FTF	Positive	1 day	15 January 2020	93	+/+	Y

[1] Number of sows in the farm. [2] FTW: farrow-to-wean; FTF: farrow-to-feeder. [3] PRRSV history: negative (never infected with PRRSV) or positive (infected with PRRSV) farm. [4] Age of sampling. [5] Y = yes/N = no. NA = non-applicable because the farm is PRRSV-negative.


veterinary sciences
MDPI

Article

Porcine Reproductive and Respiratory Syndrome Surveillance in Breeding Herds and Nurseries Using Tongue Tips from Dead Animals

Jordi Baliellas [1], Elena Novell [1], Vicens Enric-Tarancón [1], Carles Vilalta [2] and Lorenzo Fraile [3,4,*]

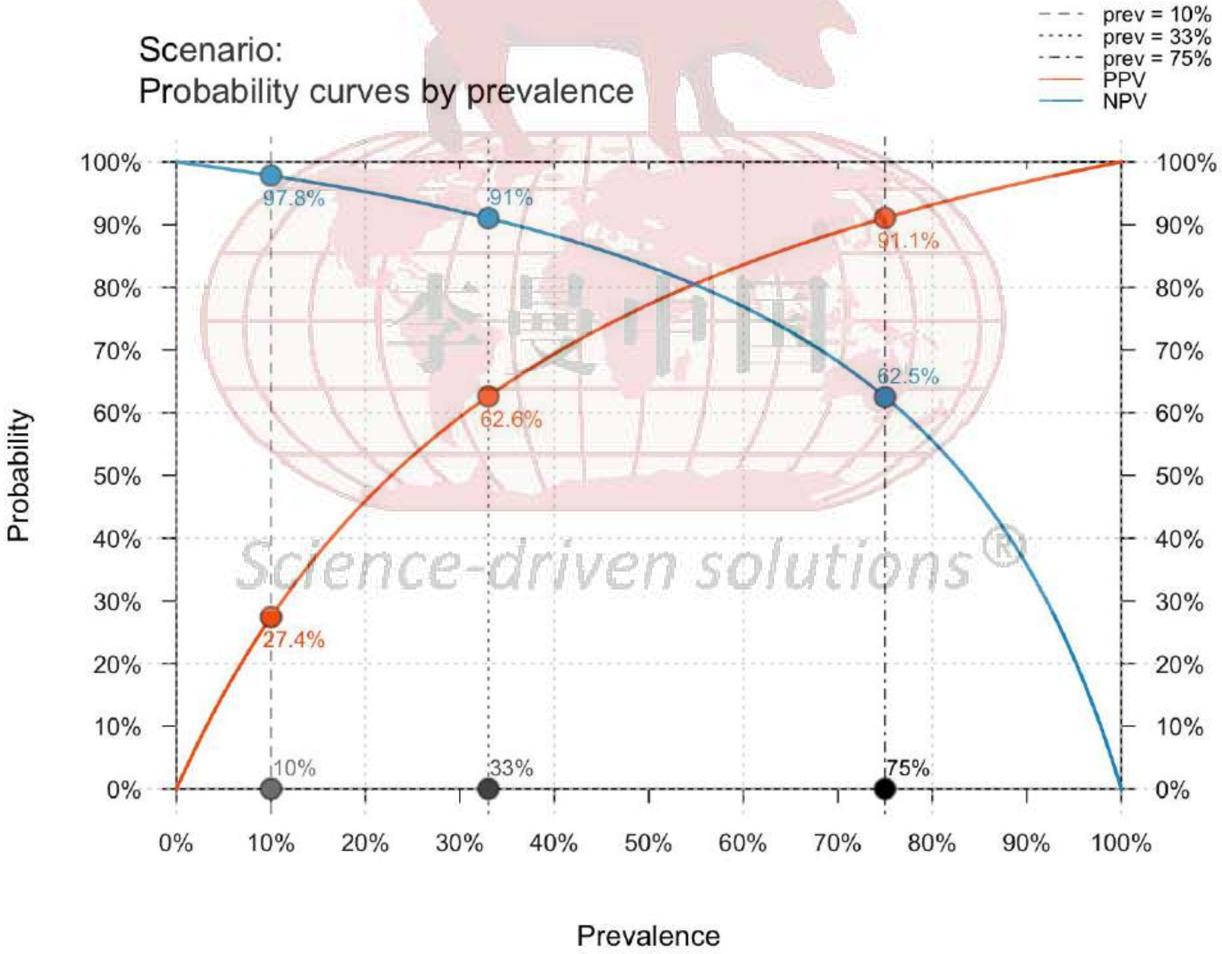
- The median herd size was 2350 sows
- 30/1000 >>> max. possible prevalence: 9.4%
- 100/1000 >>> max. possible prevalence: 2.9%

- Kappa index of 0.55 is considered 'moderate'

- Repeated sampling in the same herd leads to clustering
- **Estimating diagnostic test accuracies in complex population structures requires Bayesian latent class analysis or similar methods**

Negative predictive value (NPV)

$$NPV = \frac{specificity \, * (1 - prevalence)}{specificity \, * (1 - prevalence) + (1 - sensitivity) * prevalence}$$



https://hneth.github.io/riskyr/reference/plot_curve.html

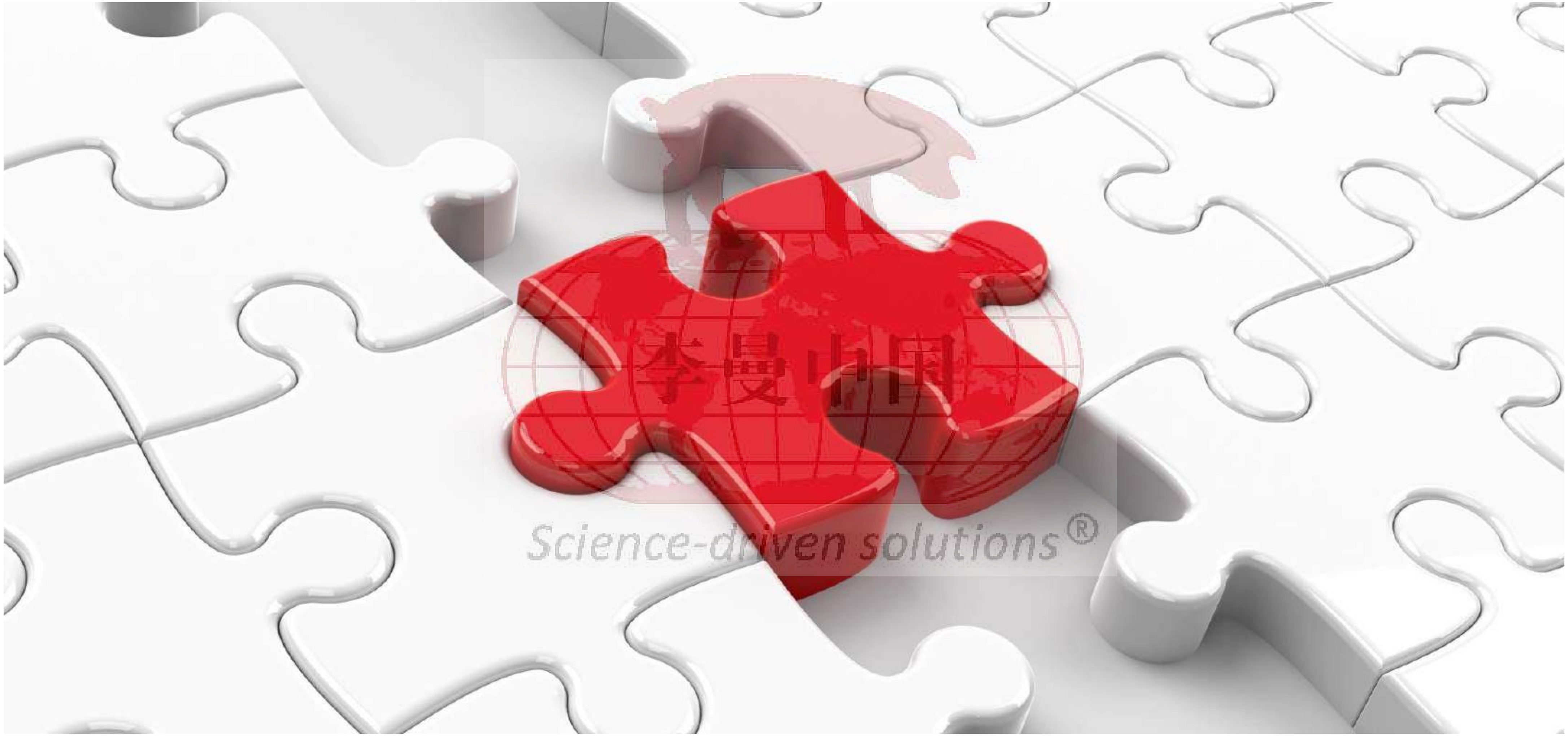
For most of the diseases on herd level

- Collect blood samples
  - estimated prevalence: 5% (max. 10%)
  - confidence: 95%
- Test these by RT-PCR and/or ELISA
- Repeat testing according to risk

Never blindly trust …

5

Designing tailor-made eradication programmes



Designing tailor-made eradication programmes

1. Know the epidemiology of the infection in the herd
2. Evaluate the socio-economic value of the eradication
3. Apply a sustainable eradication concept
4. Implement an appropriate sampling strategy to really control the success

Eradication of infectious diseases in pigs

ONE SIZE DOES NOT FIT ALL

BE TRANSPARENT & OPENLY COMMUNICATE

NEVER BLINDLY TRUST

SELECT BEST OPTIONS

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Eradication of infectious diseases in pigs

Leman China Swine Conference
25th-27th OCT 2024, Chengdu (CN)

Heiko Nathues
Clinic for Swine
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Thank you very much for your attention!

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