Challenges in influenza control

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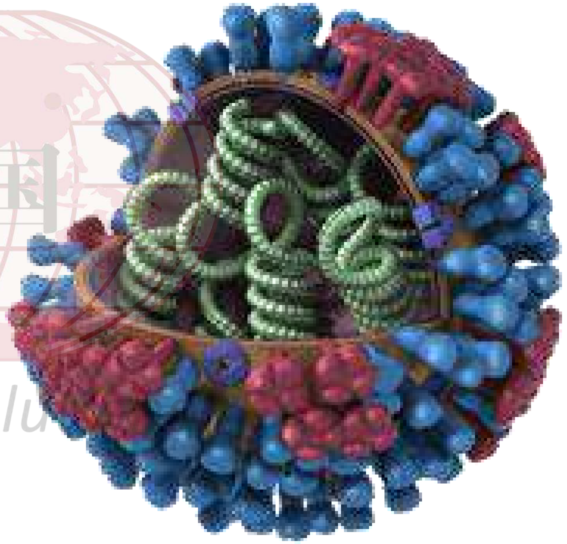
My key messages for today

- Influenza is an important pathogen of the porcine respiratory disease complex and a public health threat
- Gilts and piglets are key subpopulations to control influenza
- Piglets are a source of virus to other pigs, the sows and the environment
- Maternal immunity helps but is not enough to fully prevent infections
- Management and vaccination practices are key to control influenza – indirect transmission

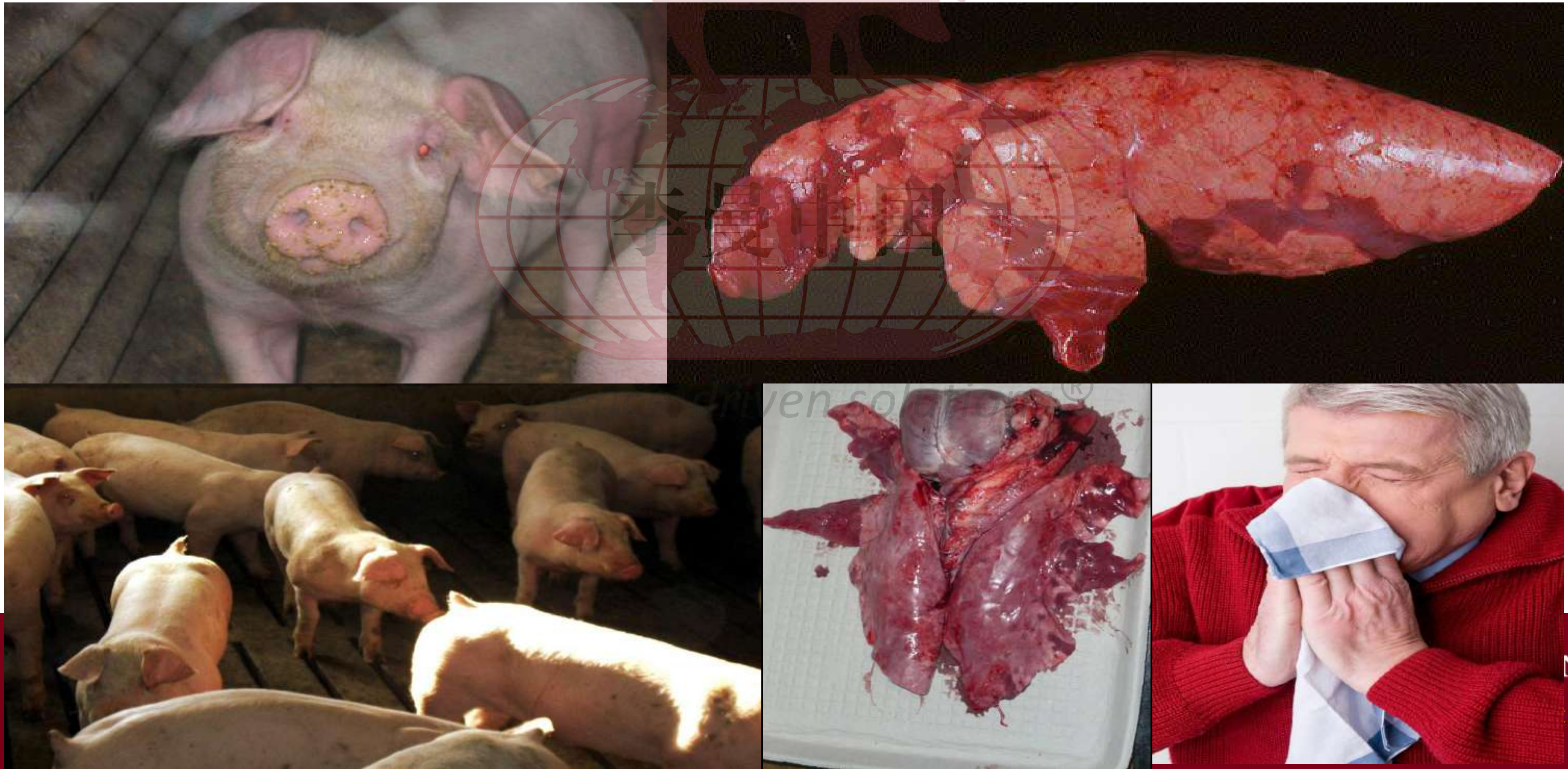
The virus

- Influenza A virus is an RNA segmented virus prone to change
- Multispecies
  - Humans
- Endemic



Influenza A in pigs

Endemic in swine (H1N1, H1N2 and H3N2)
Important respiratory pathogen of the PRDC complex with high morbidity and low mortality
Difficult to control and a public health concern



Influenza is costly on its own and even more costly as part of co-infections

2012 AASV Annual Meeting: Integrating Science, Welfare, and Economics in Practice

Table 1: Productivity and economic impact of SIV, PRRS, and *M hyopneumoniae*

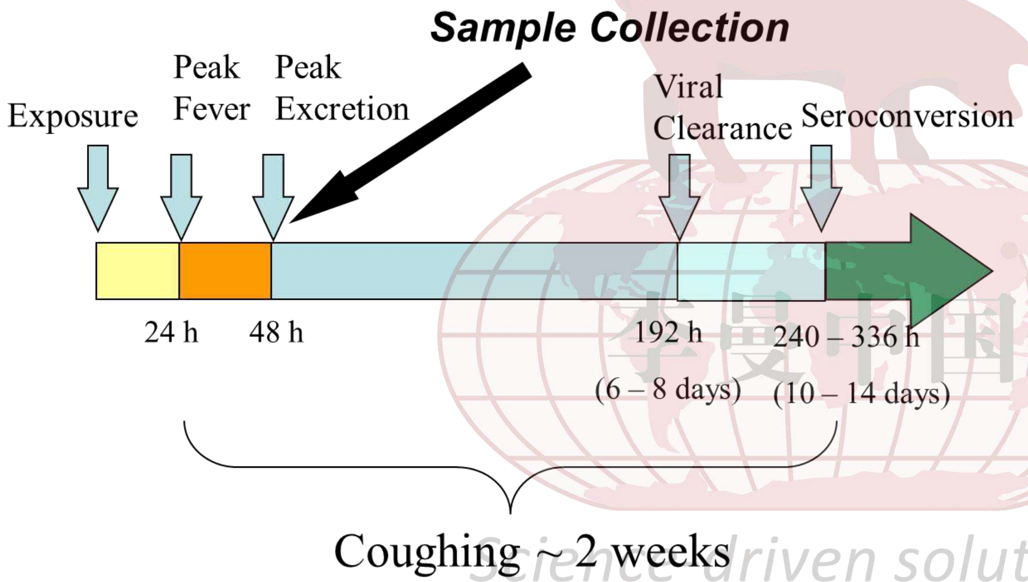
Pathogen/combination	Difference from baseline in %MCT	Difference from baseline in ADG	Difference from baseline in loss per head placed
M hyo	2.15%	0.04	$0.63
PRRS	1.68%	-0.11	$5.57
SIV	1.87%	-0.04	$3.23
PRRS and M hyo	5.43%**M**P	-0.14*M*P	$9.69
PRRS and SIV	4.34%**S**P	-0.16**S	$10.41
SIV and M hyo	3.46%**M*S	-0.18**S	$10.12

** M,P,S = combinations vs. M/P/S; $P < 0.05$
* M,P,S = combinations vs. M/P/S; $P < 0.1$

MCT: mortality, culls, tail-enders

Dykhuis et al., 2015

Infections at the pig level

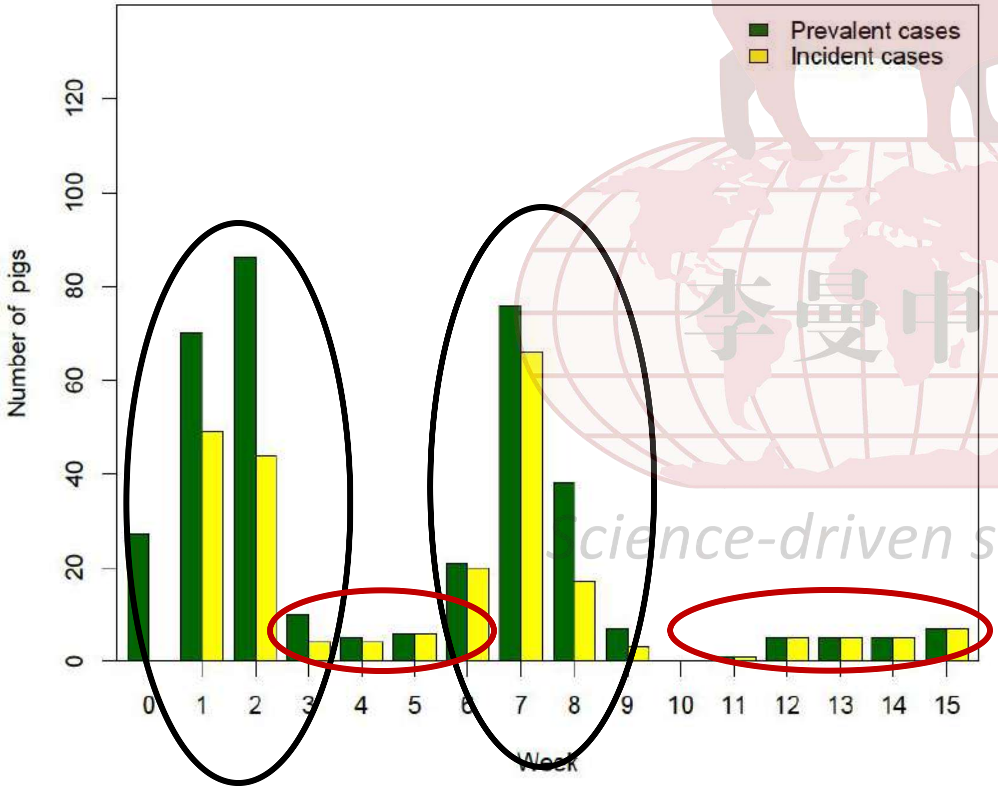


Individual influenza Infections are short and self-limiting

Influenza infections timeline

Figure courtesy of Dr. Culhane

However, infections at the group level can be prolonged



From weeks to months!!

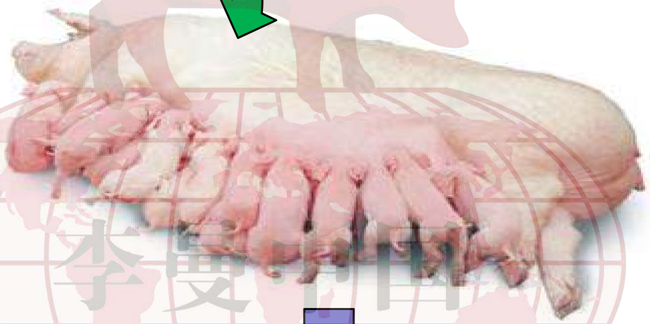
Recruitment of susceptible individuals or populations are key to maintaining flu infections endemic

Diaz et al., 2015

Infection dynamics matter!

Replacements

Sow farms are the perfect place for influenza virus to persist!!



Gestation/farrowing

Weaned pigs

Piglets and gilts are key subpopulations for introducing, maintaining and spreading influenza

RESEARCH ARTICLE

Association between Influenza A Virus Infection and Pigs Subpopulations in Endemically Infected Breeding Herds

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Table 4. Results from the multivariate analysis (Mixed effects model).

Variable	Group	OR (95% CI)
Subpopulation	Gilts	
	New gilts	7.9 (1.4, 43.9)*
	Piglets	4.4 (1.1, 17.1) *

Diaz et al., 2015

Introduction of influenza positive gilts increases likelihood of influenza in piglets at weaning

Factors	Categories	Probability of influenza positive at weaning	Risk Difference	Risk Ratio	Odds Ratio	p-value
Influenza positive gilts at entry	Yes	0.45	0.18	1.67	2.21	<.0001
	No	0.27	Ref.	Ref.	Ref.	

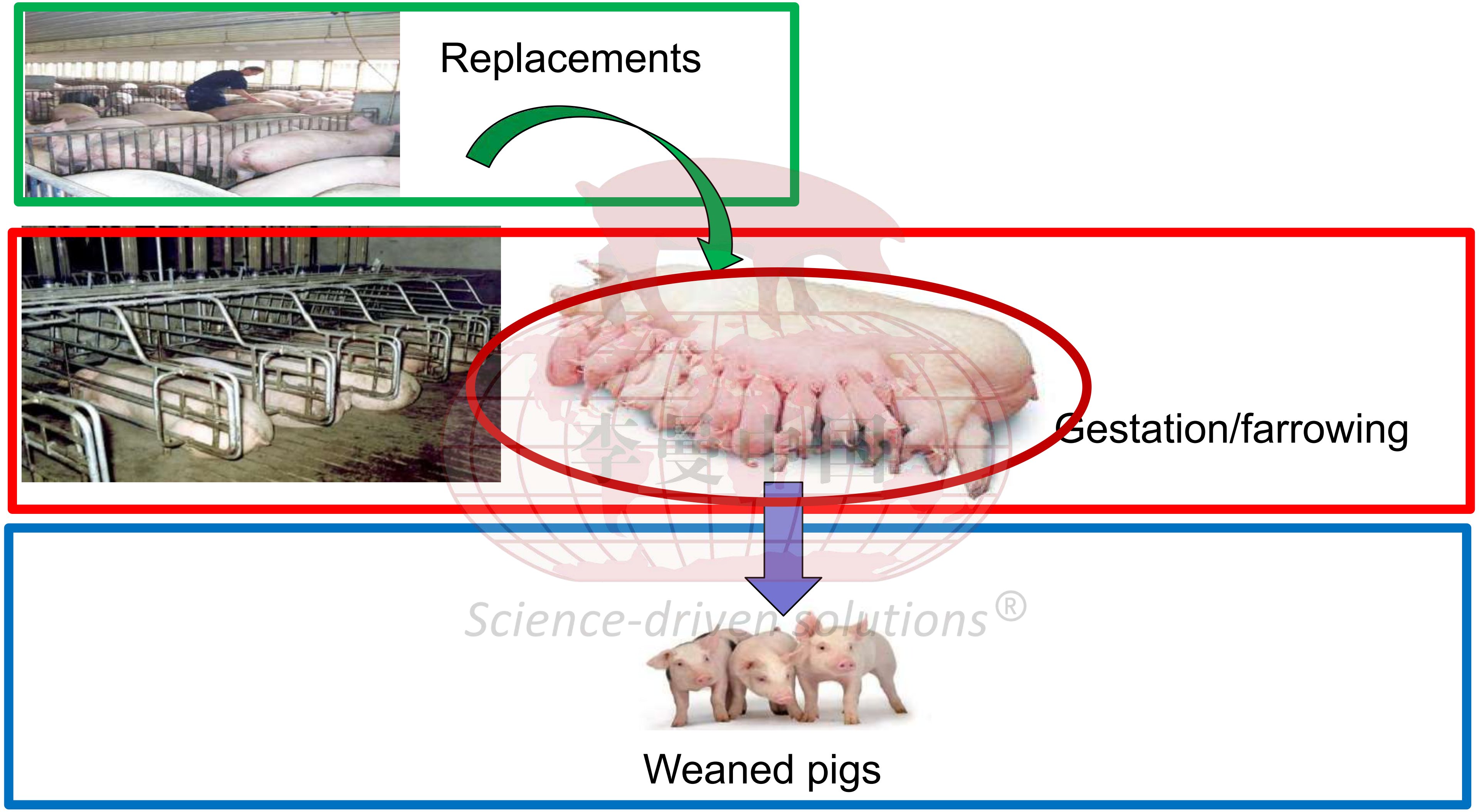
Season-adjusted multivariable analysis of farm factors associated with influenza A virus infection in piglets at weaning.

Chamba et al.,

Gilts…are a big challenge

- Gilts (even internal replacements) may be a source of virus introduction
- Variability between groups of gilts
- Isolation/quarantines not set up to prevent influenza introductions
  - Larger groups of gilts may require longer isolations
- Even if negative stock, likely that gilts will get infected on arrival if flu exist in gilt development unit
- Vaccination

Piglets a key subpopulation



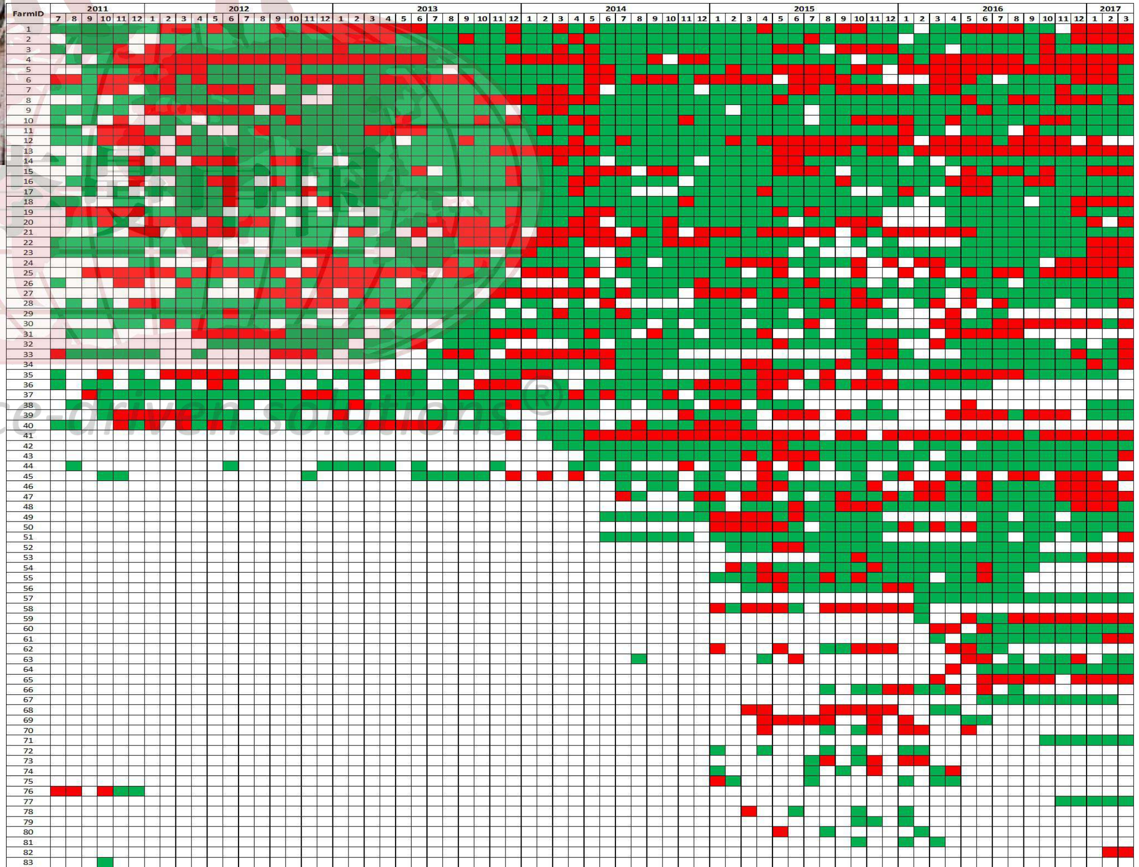
How often are pigs weaned influenza positive?

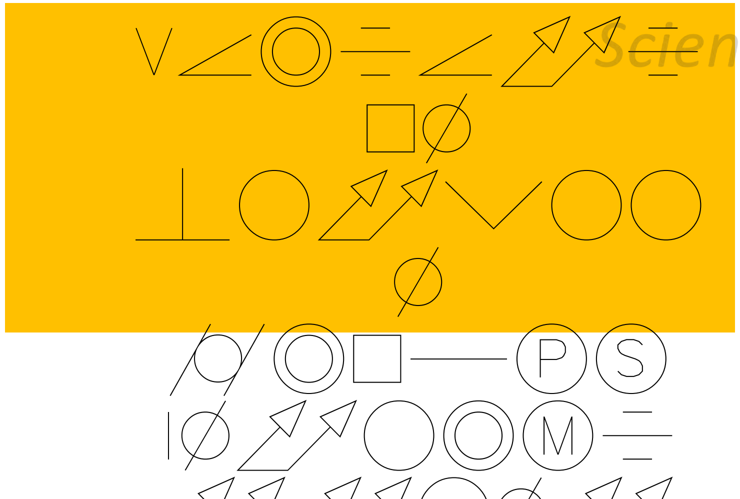
Percentage of positive groups:

Study 1: 75/305 (25%)

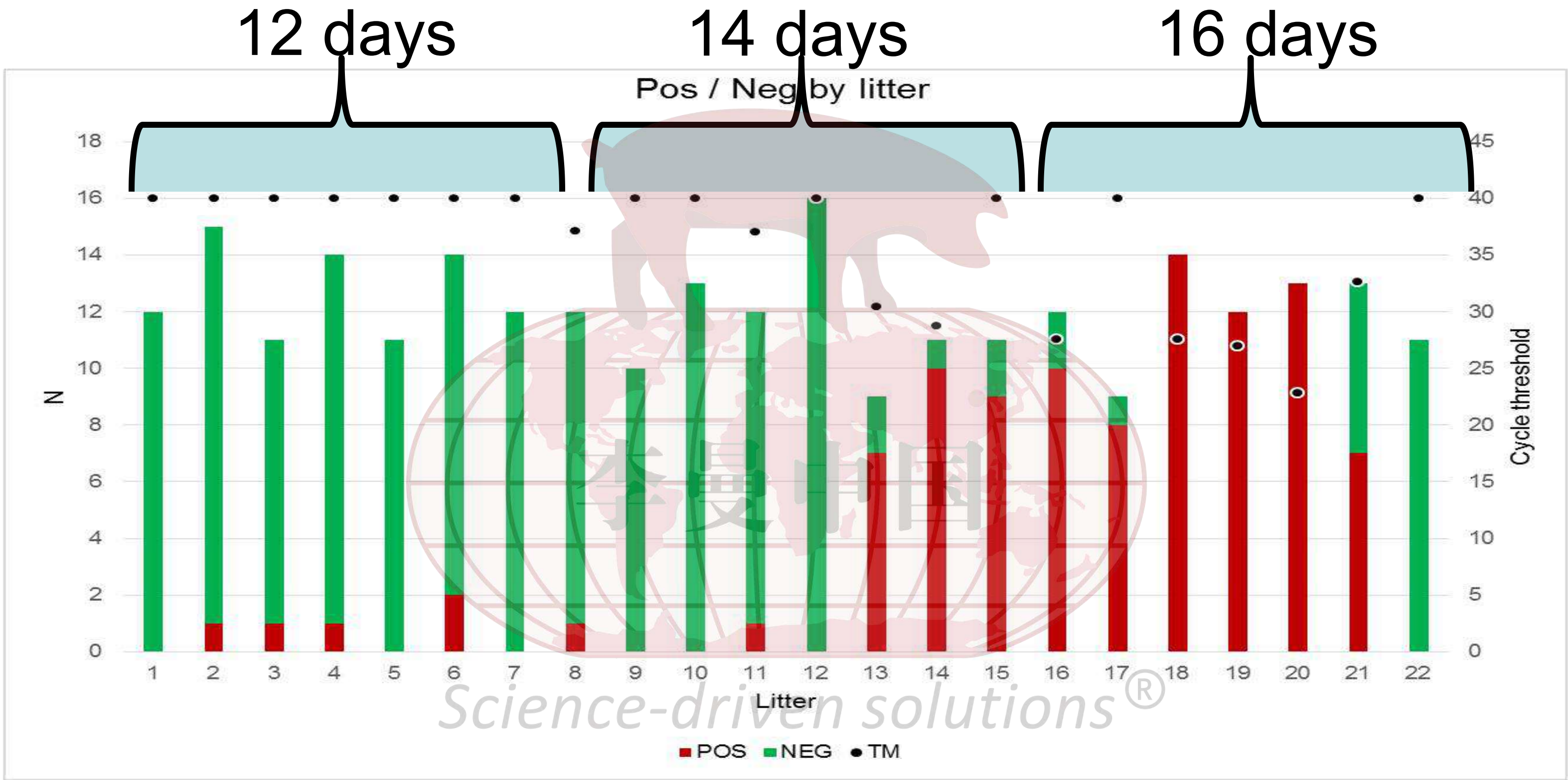
Study 2: 427/1523 (28%)

Study 3: 64/177 (36%)





Piglets are born negative, but….

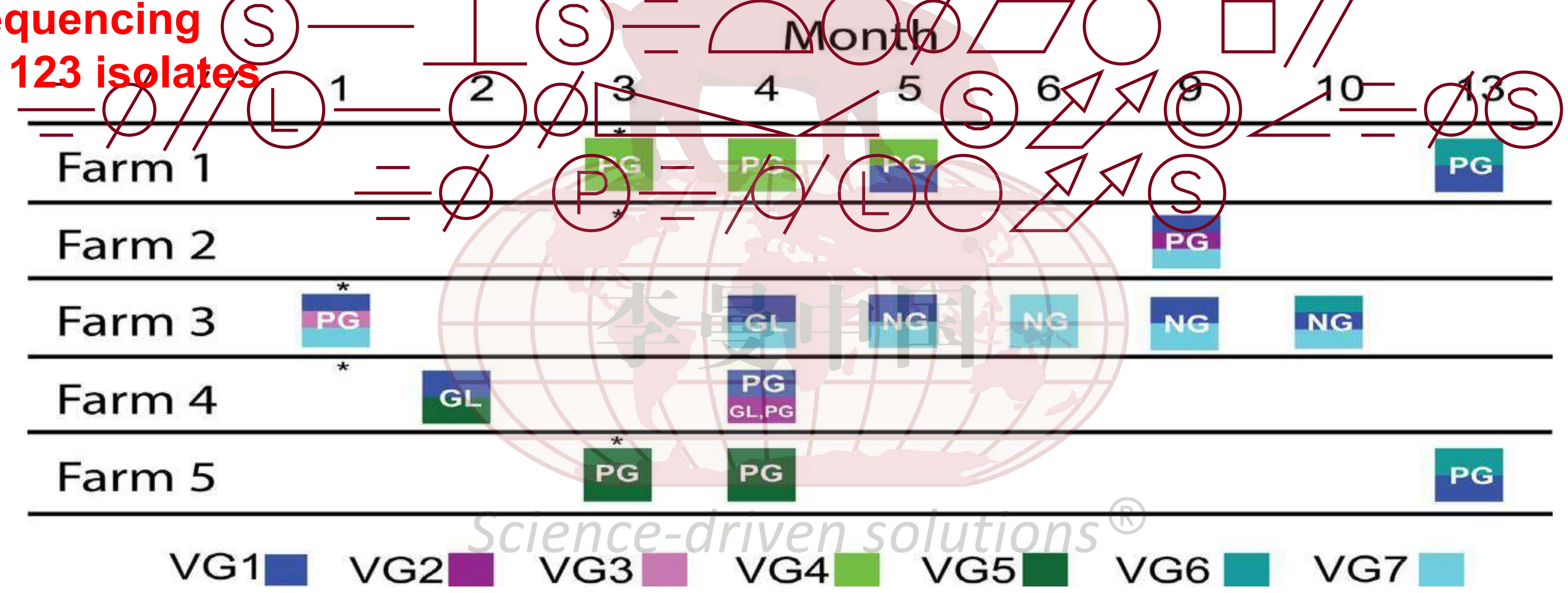


Influenza positive litters (%) at processing

Prevalence at weaning ranged 40-90%

Co-circulation of strains is common in piglets

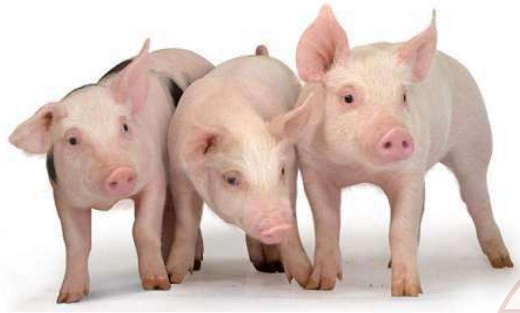
Whole genome sequencing of 123 isolates



IAV isolates distributed by month, viral group, farm, and subpopulation (new gilts [NG], gilts [GL], and piglets [PG]).

Andres Diaz et al. J. Virol. 2017; doi:10.1128/JVI.00745-17

Piglets can become infected with influenza in multiple ways



Contaminated snouts = Contamination of other pigs, tools, materials, hands, coveralls, environment, etc

Air = Inhalation & environmental contamination

Direct and indirect transmission routes are important

Allerson et al., 2013

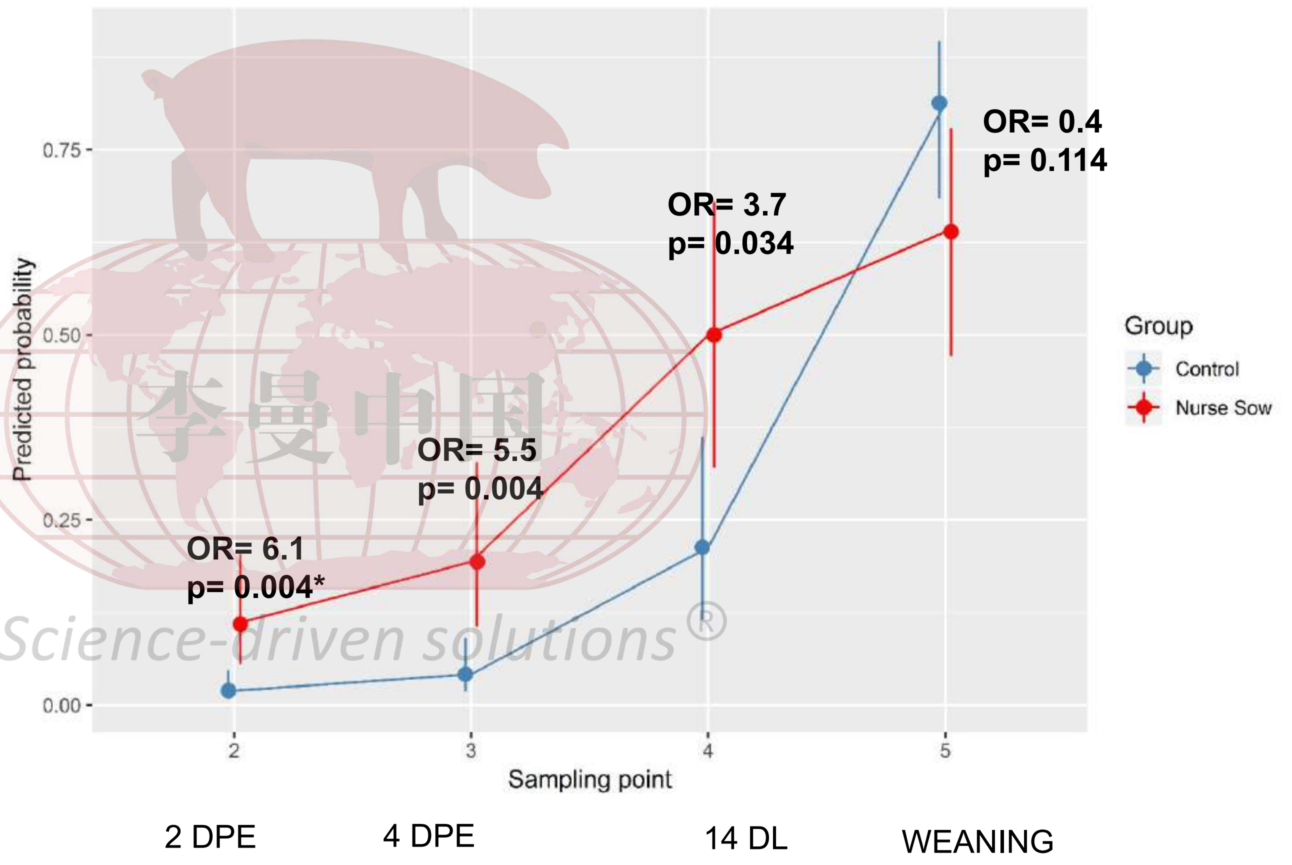
Influenza sow to pig transmission

- Not intra utero
- Not (commonly) at farrowing
- Mechanically during adoptions and at weaning

Pigs adopted by nurse sows were more likely to become infected

Adopted piglets had higher influenza detection rates during the overall suckling period

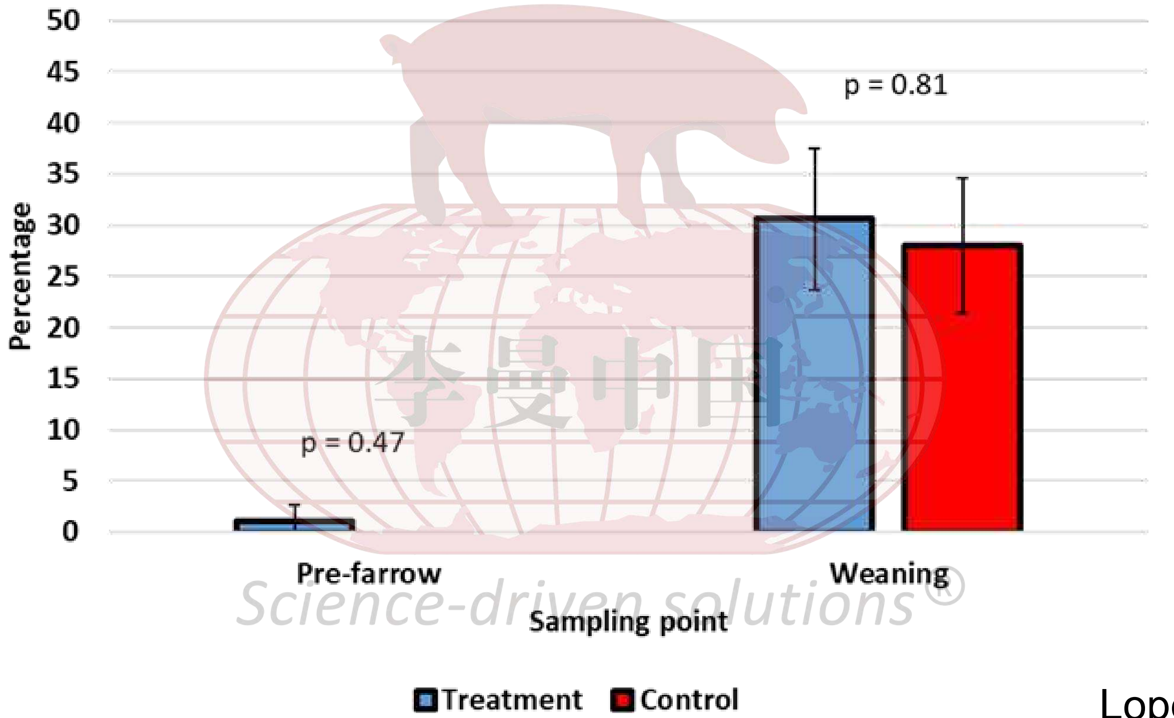
Trend reverted at weaning



* Unadjusted p values

Very low prevalence of influenza on sows due to farrow

Proportion of positive sows by treatment and day of sample collection

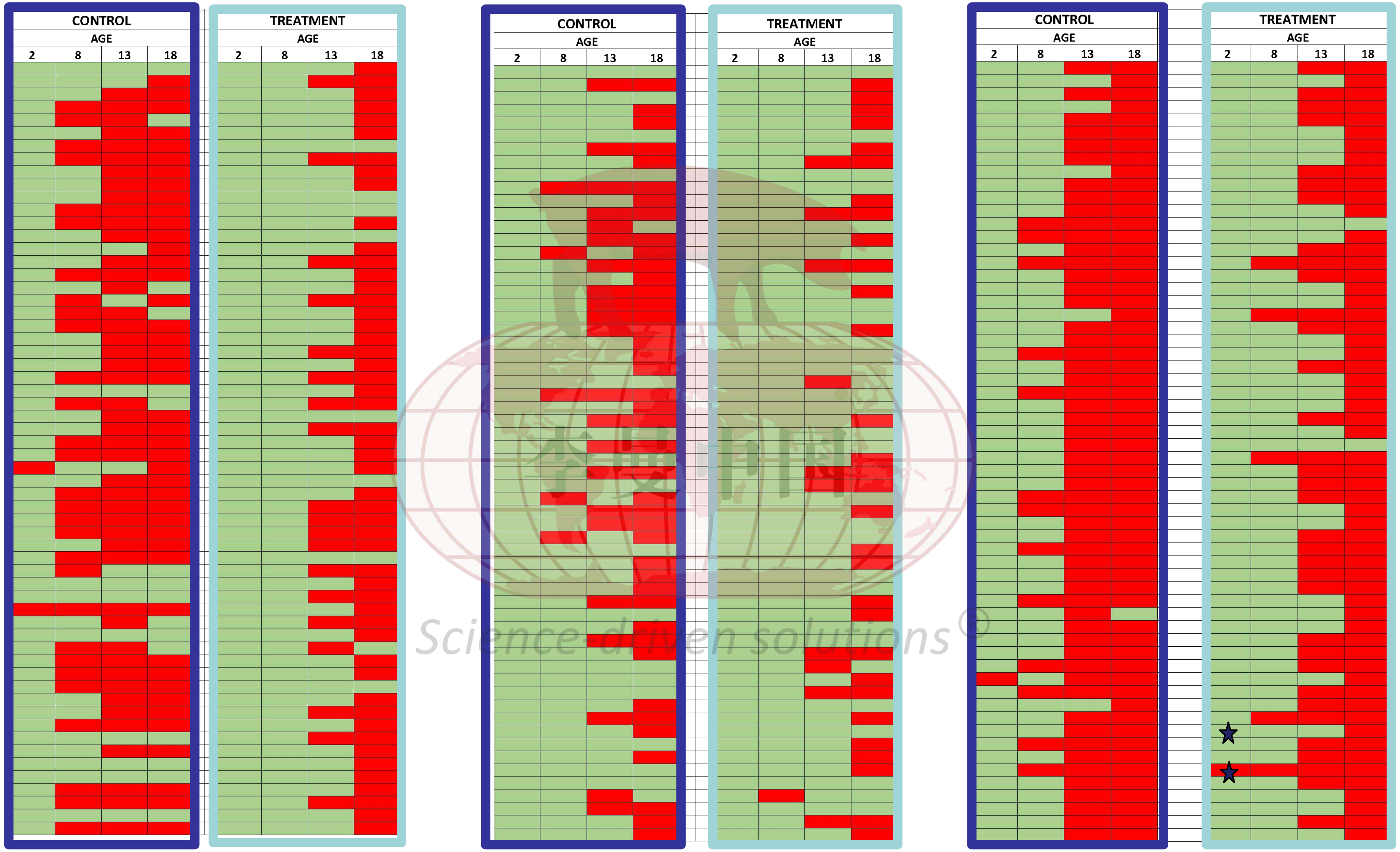


P value vas calculated using a chi square test using the total proportion of positive litters on each sampling point by experimental groups

Lopez et al., 2022 (under review)

Piglets are a source of infection to the sows

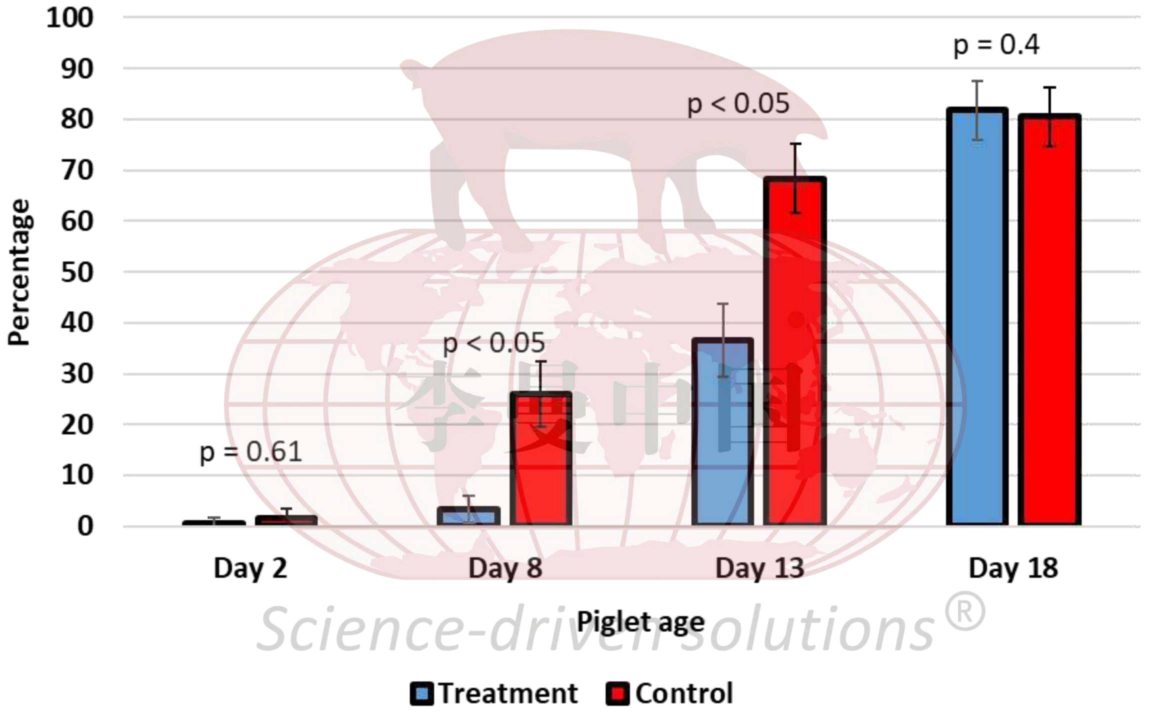
Influenza dynamics by litters in rooms with and without strict internal biosecurity protocols



Lopez et al., 2022
(under review)

Effect of internal biosecurity practices on influenza infection (udder wipes)

RT-PCR proportion of positive litters by treatment and day of sample collection



Internal biosecurity practices delayed IAV infections but did not affect status at weaning

Lopez et al., 2022

High level of influenza contamination in hands and tools

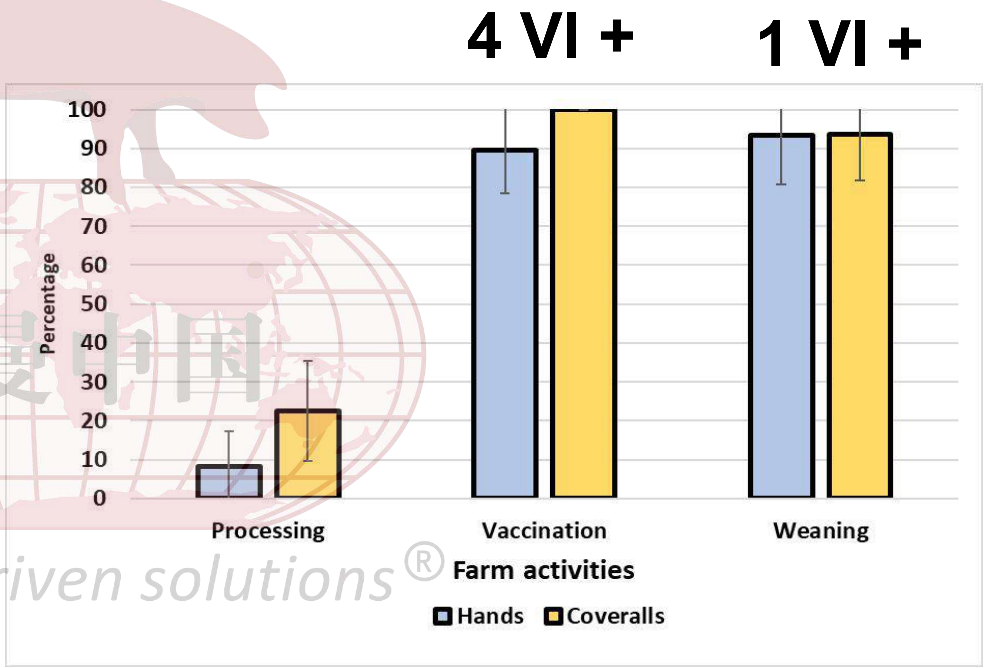
Proportion of positive wipes of carts, tools and farm worker hands by RT-PCR.

Farm	Cart/Tools	Hands
A	Not collected	19/35 (54.3)
B	5/15 (33.3)	19/37 (51.4)
C	8/13 (61.5)	27/39 (69.2)
Total	13/28 (46.4)	65/111 (58.6)

3 VI + **5 VI +**

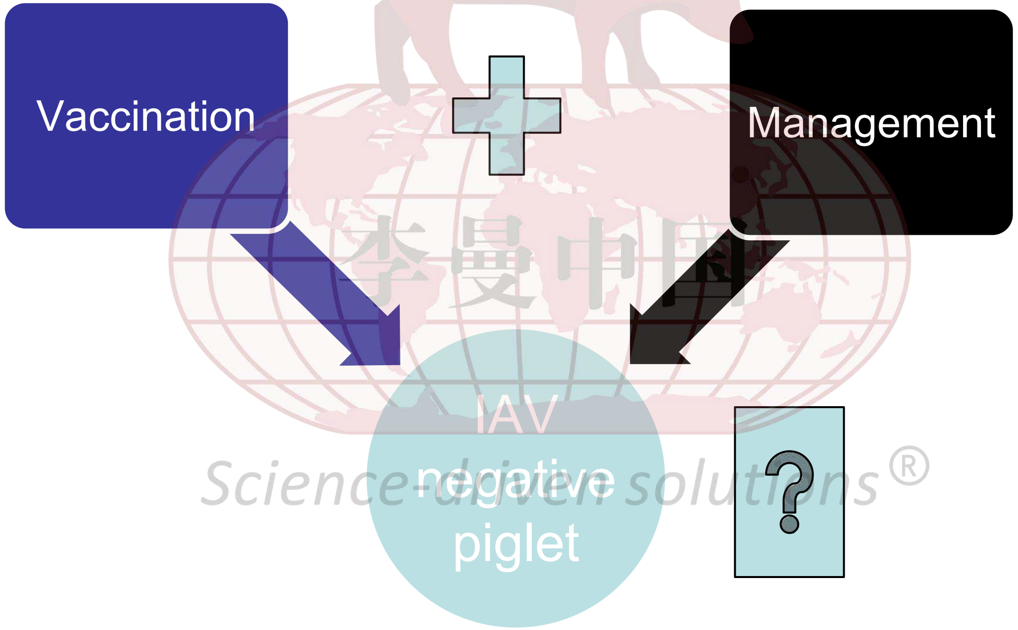
Which farm activities were more likely to result in influenza contamination of farm workers?

- Activities performed on piglets of weaning age resulted in higher IAV contamination.
- IAV can be detected early in lactation.
- Hands and coveralls had similar contamination rates

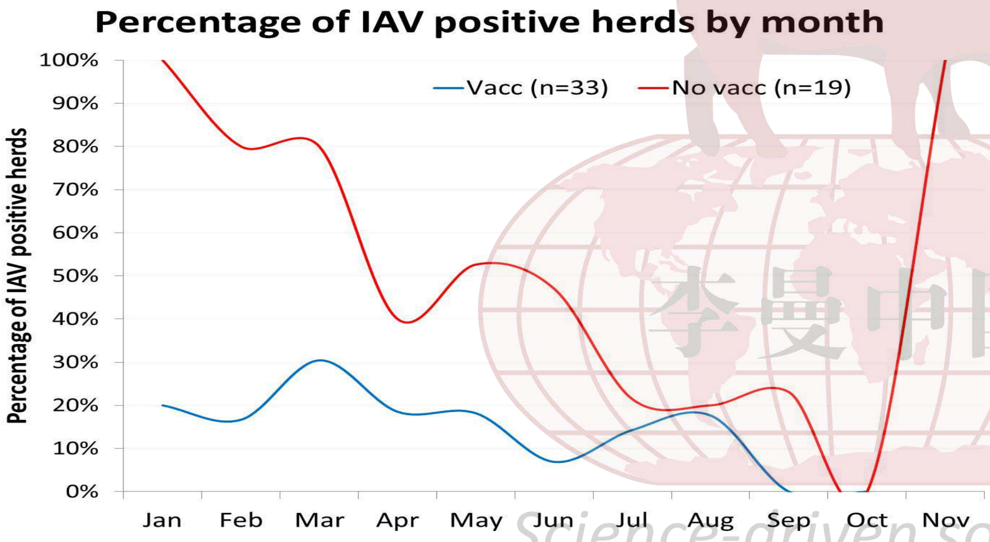


Recommendations

Evaluation of internal biosecurity measures combined with sow vaccination to wean influenza negative piglets



Sow vaccination can reduce influenza in weaning-age pigs



OR=0.26 [0.09-0.73], p=0.01

Vaccination decreased by 74% the odds of detecting positive groups of piglets at weaning compared to no vaccination.

Sow vaccination reduces influenza in piglets at weaning

Factors	Categories	Probability of influenza positive	Risk Difference	Risk Ratio	Odds Ratio	p-value
Influenza sow vaccination protocol	Whole-herd (WH)	0.20	-0.21	0.49	0.36	0.0042
	Pre-farrow (PF)	0.25	-0.16	0.61	0.49	0.0154
	No vaccination	0.41	Ref.	Ref.	Ref.	Ref.
	WH vs. PF	-	-0.05	0.80	0.73	0.4303

Season-adjusted multivariable analysis of farm factors associated with influenza A virus infection in piglets at weaning.

Management and sow vaccination combined

Effect on IAV prevalence at weaning

Table 5. Number (percentage) of influenza A virus rRT-PCR positive litters before and after intervention measured by udder skin wipes by farm. Statistical significance was measured between pre-intervention and post-intervention positive proportions.

Experimental group	Farm	Pre-intervention prevalence (%)	Post-intervention prevalence (%)	P value^
Control	F	73/90* (81)	71/90 (79)	0.7
Treatment	A	62/90 (69)	56/90 (62)	0.34
Treatment	B	31/90 (34)	12/90 (13)	0.001
Treatment	C	7/90 (8)	0/90 (0)	0.01
Treatment	D	13/90 (14)	0/90 (0)	<0.001
Treatment	E	12/90 (13)	0/90 (0)	0.001
Total treatment+	-	125/450 (27.8)	68/450 (15.1)	<0.0001

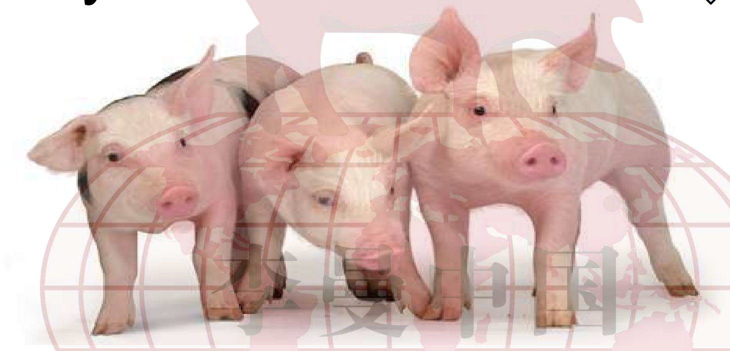
***Number of positive samples / total number of samples tested (percentage).**
^P values were obtained using a Pearson's Chi-squared test.
+Total values were summarized using farms assigned to the treatment group.

4 farms had significant reductions in IAV prevalence

Comprehensive control of influenza

↑ Sow vaccination
Passive immunity

↓ Pig, sow, people, fomite movement between litters



Surveillance
A process driven mentality
Biosecurity (and worker & vet vaccination)

Comprehensive approach to Influenza control

Gilts

Introduction and reservoir of viruses

Introduction and maintenance in piglets

Maintenance and spread to sows, other piglets and growing pigs

Lactating (nurse) sows

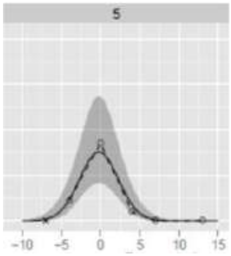
Piglets

Piglets also a source of environmental contamination and contamination of fomites

Gestation

Piglets

Fomites/air a source of infection to piglets



My key messages for today

- Influenza is an important pathogen of the porcine respiratory disease complex
- Gilts and piglets are key subpopulations to control influenza
- Piglets are a source of virus to sows and the environment
- Maternal immunity helps but is not enough to fully prevent infections
- Management and vaccination practices are key to control influenza – indirect transmission

Questions?