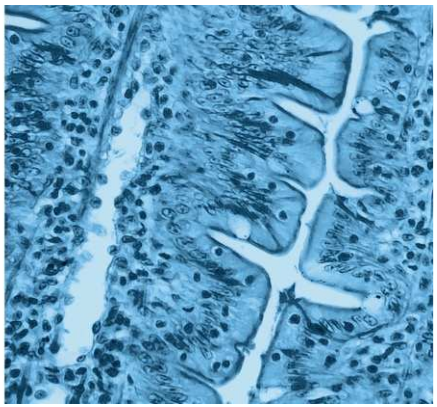
SCHOTHORST FEED RESEARCH

BANFF PORK SEMINAR

January 2020





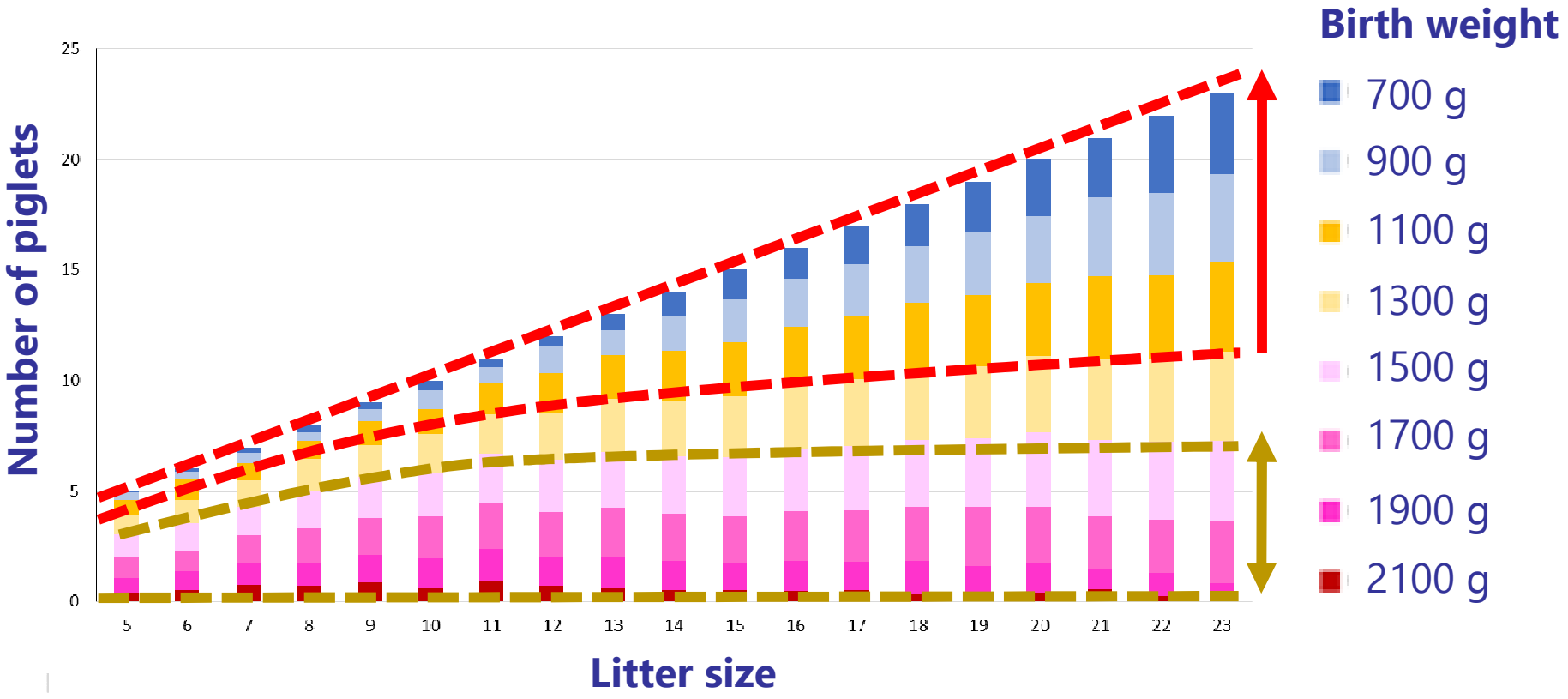
Feeding Nursery Pigs Without Dietary Antibiotics

Francesc Molist, PhD, DVM

Knowhow to feed

Genetic development sow - consequences

- Bigger litters → more piglets with a low birth weight (<1100 g)



(SFR / 3113 litters / 2011-2017, unpublished)

Types of feed piglets encounter in their life

Colostrum
The first 24 hours

Milk replacer

Weaning

Creep feed

Sow milk

Post weaning

Week 1 | Week 2 | Week 3 | Week 4 | Week 5....

PW diet

Pre-weaning

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- Important colostrum intake.
- Long-lasting effects are due to different programming of the gut immune system. What are the long lasting effect of modifying the gut microbiota?
- Creep feed supplementation as early as possible.
- Develop an stable microbiota and oral tolerance & a robust GIT.
- Minimize the negative effects associated with weaning.
- Role of complex diets vs. simple diets pre-weaning is poorly understood.

Development of the gut microbiota: interventions via de sow and/or via pre-weaning diet(s)

SIMPLE AND UNSTABLE COMMUNITY

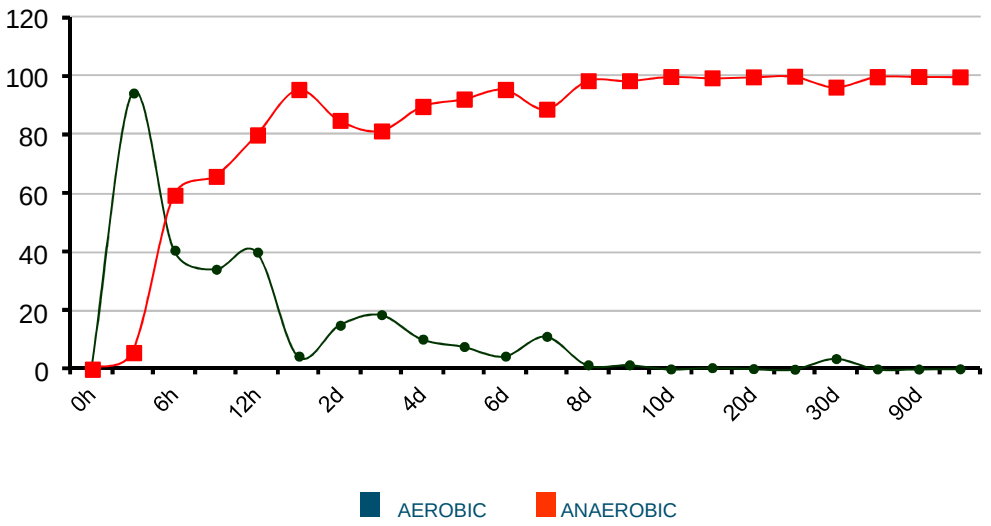
COMPLEX AND STABLE COMMUNITY

ANAEROBIC

ANAEROBIC FACULTATIVE

STERILE GIT

Vagina | Feces | Farm



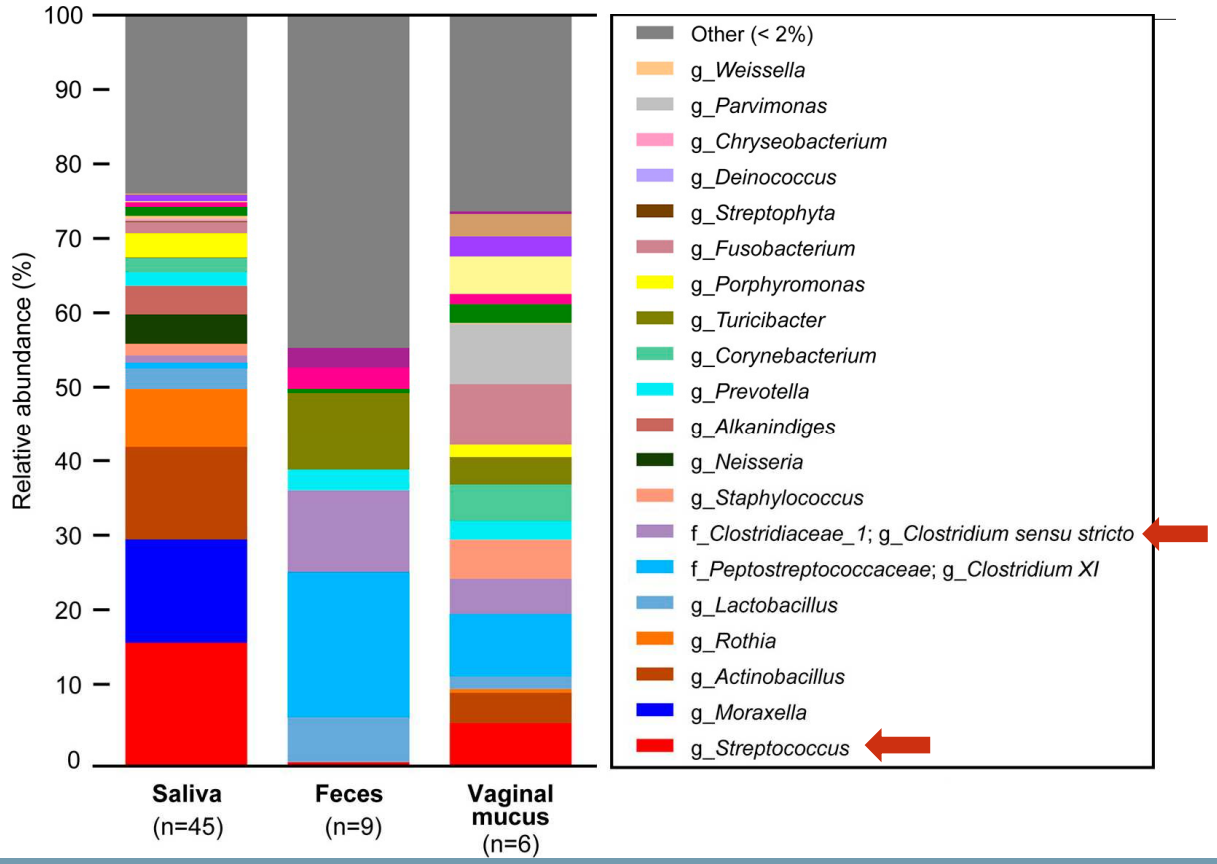
>500 different species

ANAEROBIC 99%

90 % Gram +
10 % Gram -

Swords, 1993

Composition of bacteria in the sows



Probably we need different strategies to reduce *S. suis* problems vs. Clostridium neonatal diarrheas

Feeding strategies in pre-weaning diets

Colostrum
The first 24 hours

Milk replacer

Focus on developing microbiota and innate immune system > **Role for prebiotics via milk replacer or creep feed?**

Focus on having a robust GIT and preparing the piglets for the weaning period > **Role complex vs. simple diets**

Weaning

Creep feed

Sow milk

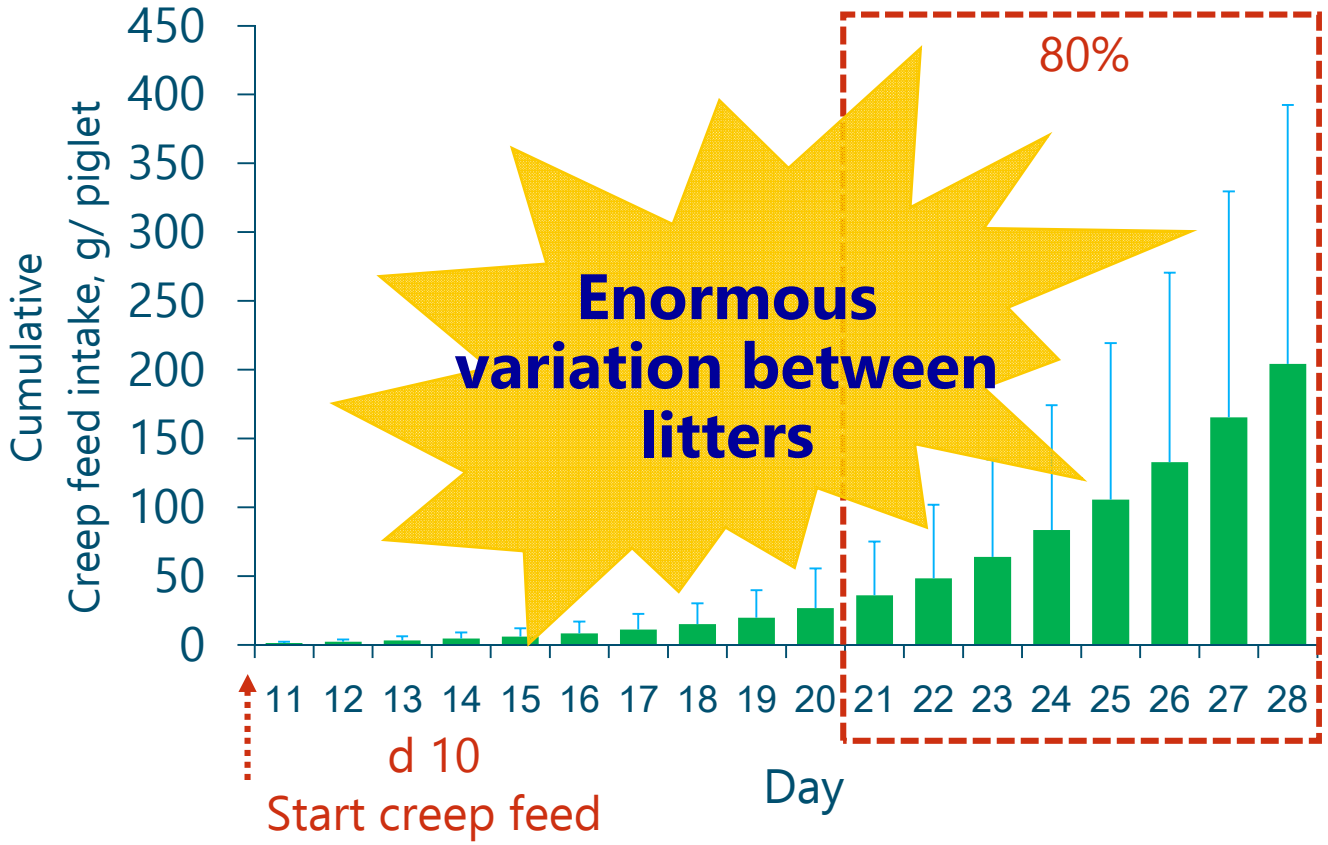
Post weaning

Week 1 | Week 2 | Week 3 | Week 4 | Week 5....

Diet around weaning

Pre-weaning management strategies

- Pre-weaning creep feed intake

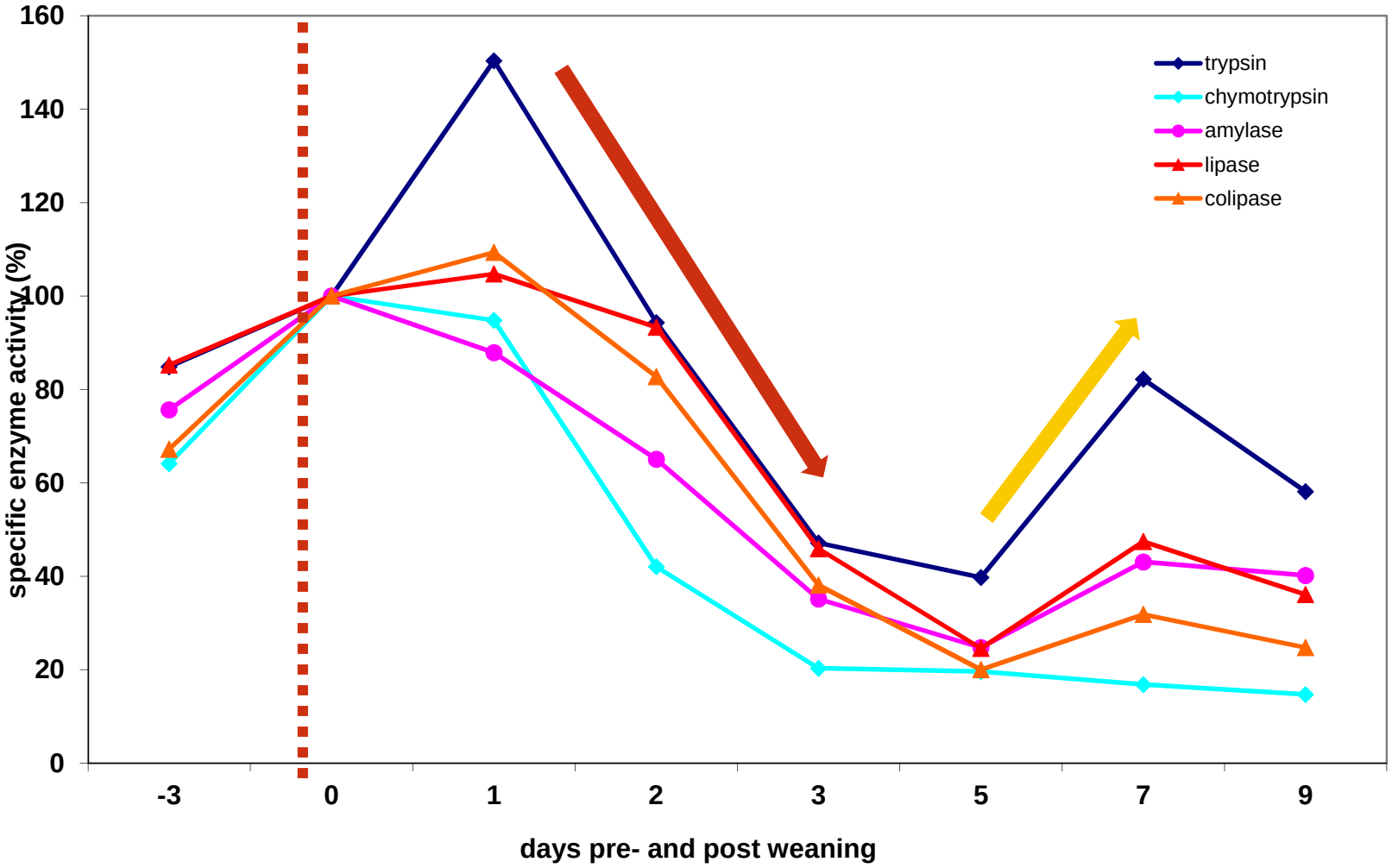


Huting et al., 2017

Post-weaning

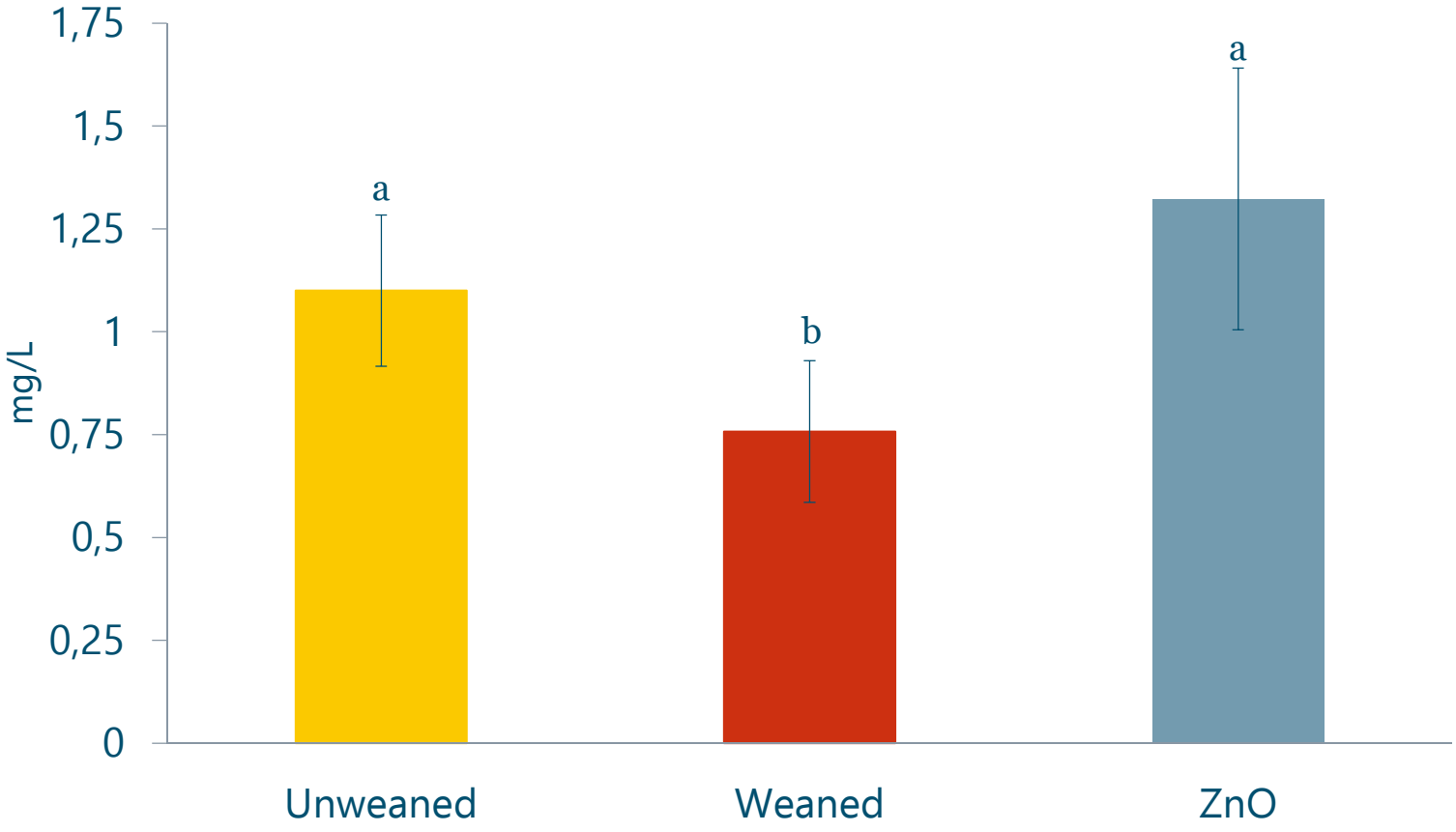
- Important feed intake with control of substrate.
- Phase feeding with nutrient adaptations can help to minimize the risk factors.
- Important management to reduce stress.
- Better knowledge nutrition and vaccination.
- Better understanding substrate – bacteria interactions.
- Animals should remain healthy and then they should grow

PW effect on pancreas enzymes



Hedemann, 2004

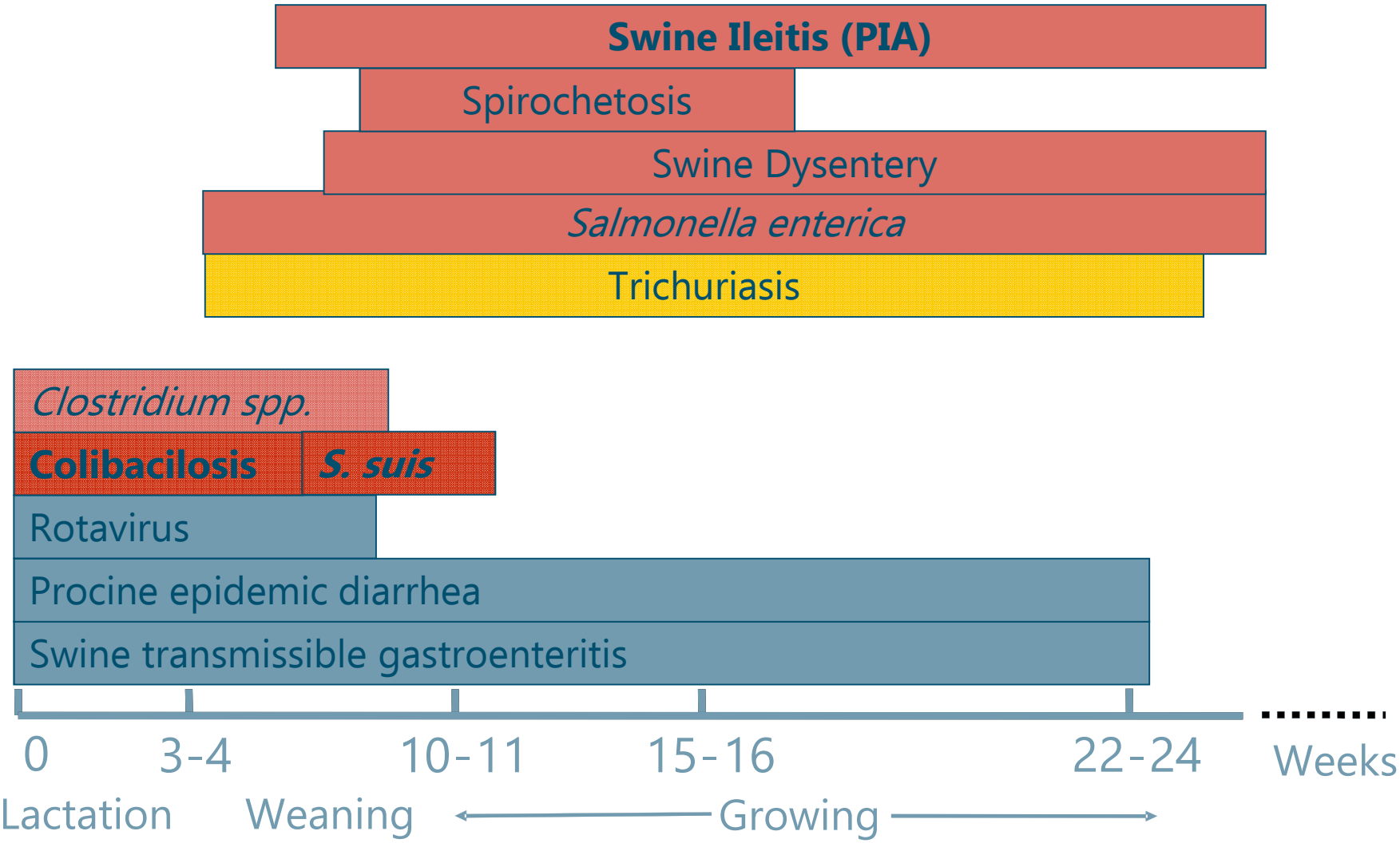
Zn concentration in Plasma at 28 d of life



Davin et al., 2018

- **Weaning creates a deep in the Zn plasma levels.**
- **Supplementation of 2000 ppm of ZnO was the only solution to keep Zn plasma levels high. What means this?**

Current gut health challenges in the pig industry



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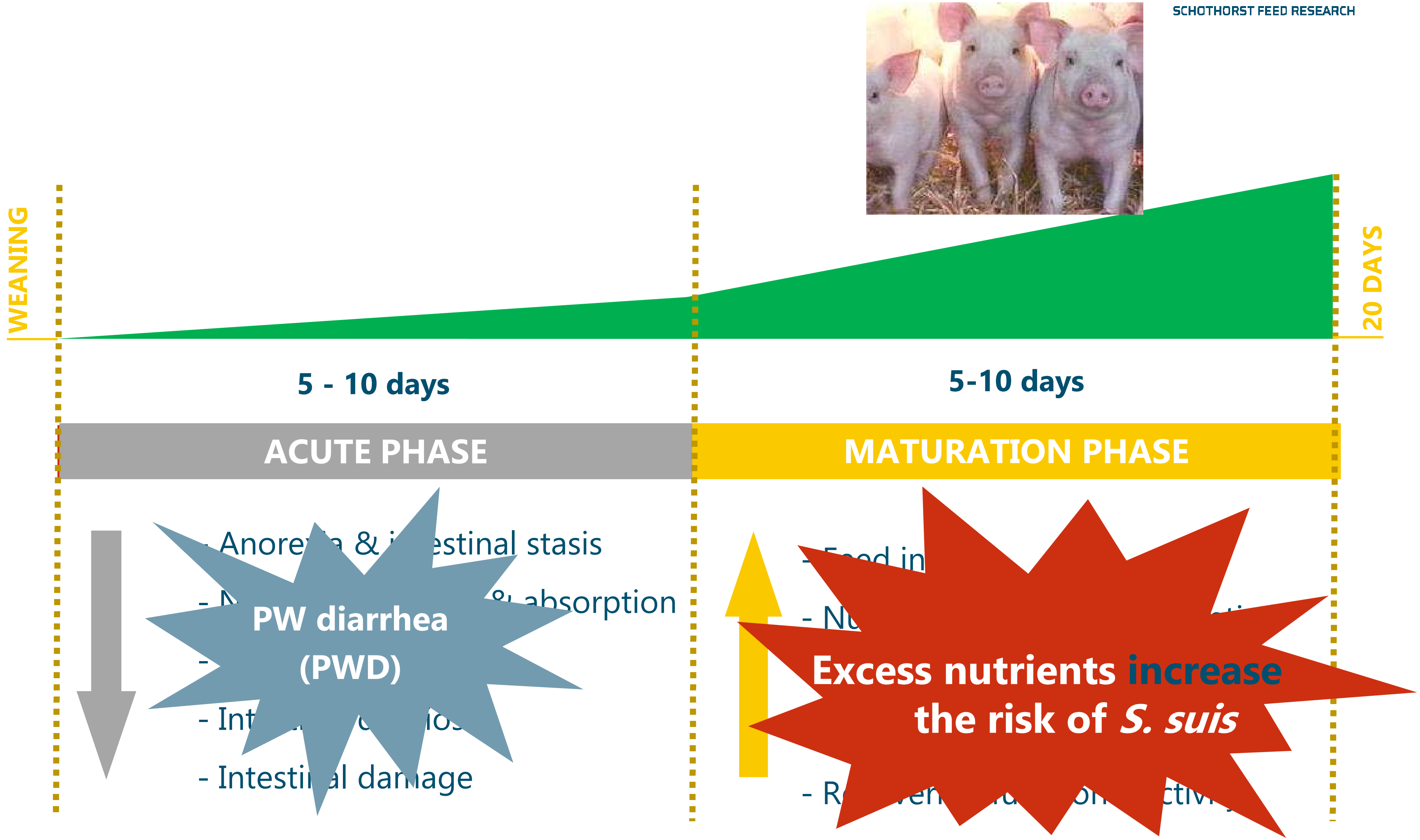

S. suis outbreak: a multifactorial problem!

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Stress + coinfections

Conditional pathogenic S. suis

Unmatured GIT + over eating

Leaky gut + sub-clinical

Pathogenic S. suis

Excess nutrients

Pathogenic S. suis's replication and invasion in the host, and the transmission to penmates

How we can help the piglets to have a good start?

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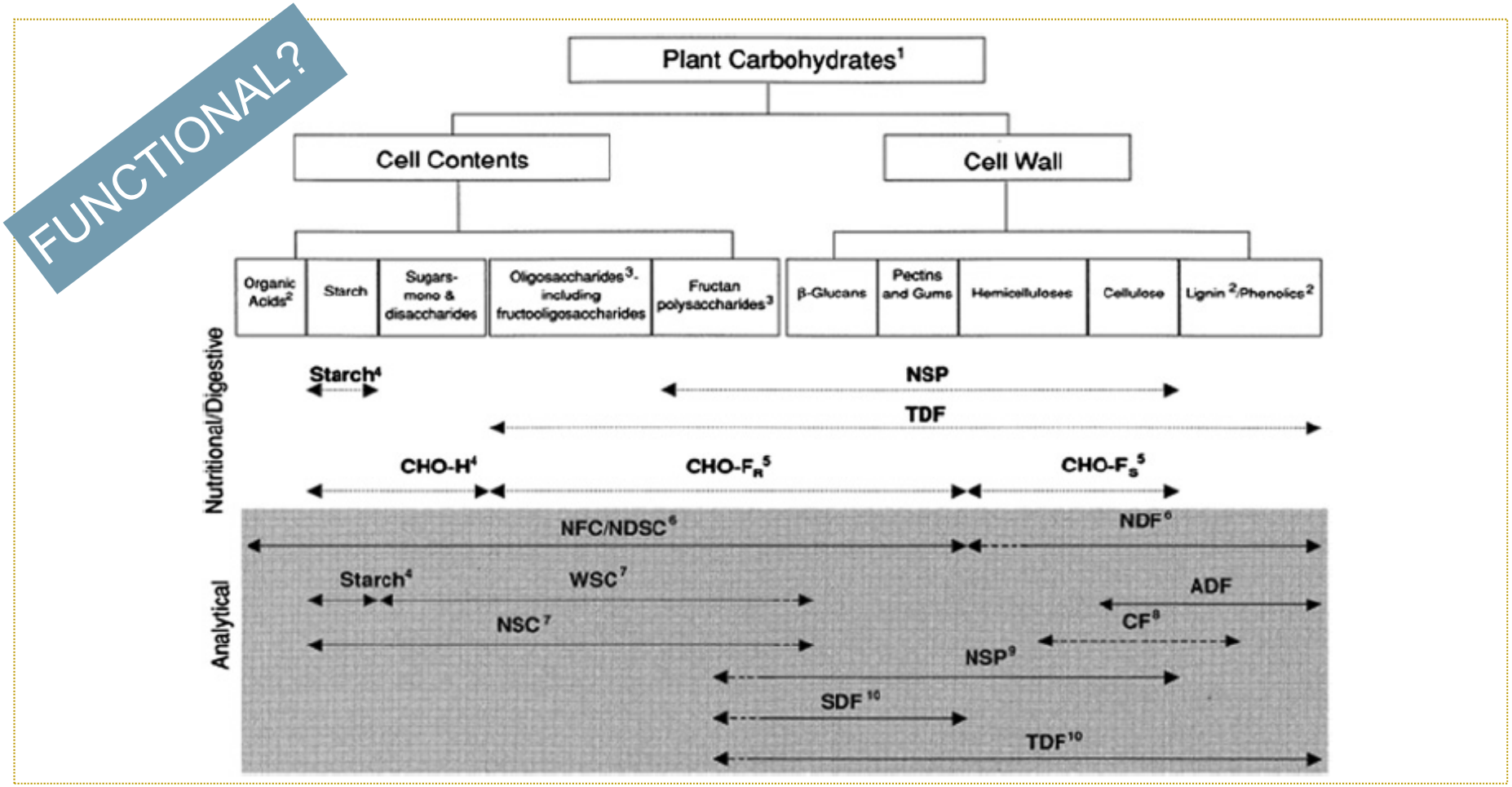
MODIFIERS OF THE MICROBIOTA OF THE GIT

- Acidifiers
- Prebiotics
- Probiotics
- Symbiotics
- Plant extracts
- Minerals: ZnO & Cu
- Dietary fibre
- Low CP diet
- Role of fat

PROMOTERS OF FOOD CONSUMPTION AND PRODUCTION ENHANCERS

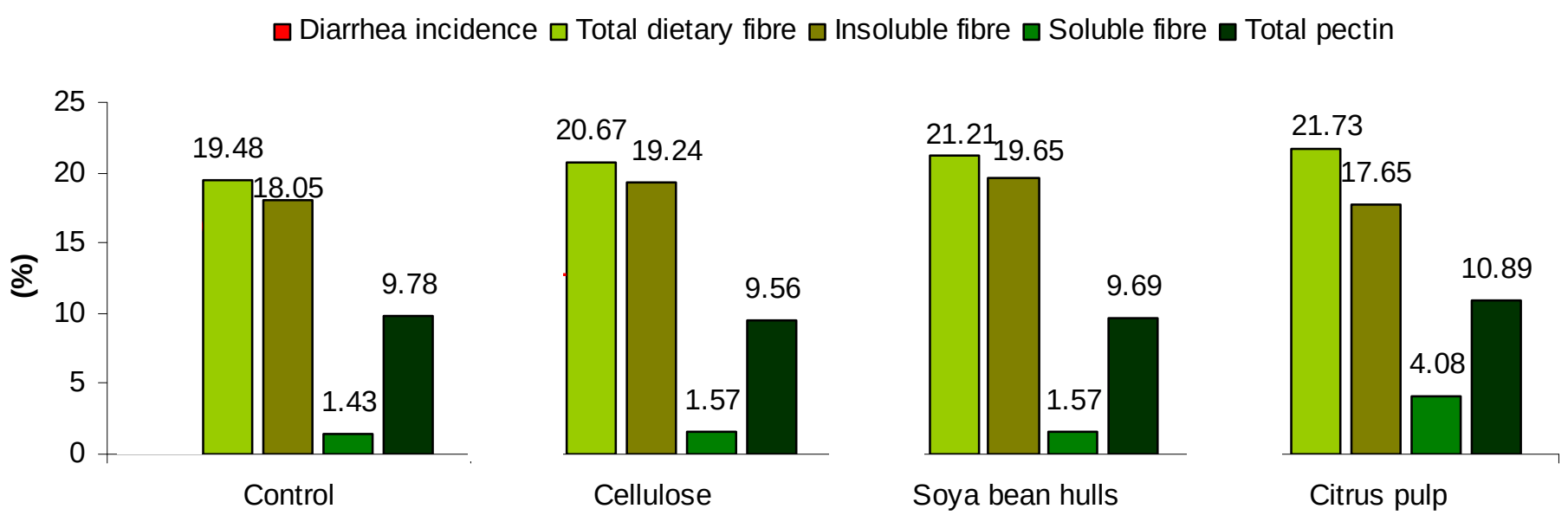
- Palatable ingredients
- Digestible ingredients
- Flavours
- Synthetic amino acids

Is the analytical characterization of dietary fiber a good approach?



Kerr and Shurson et al., 2013

Effect of diet composition on diarrhea incidence the first 2 weeks PW



21 and 35 days of age

	C	CEL	SH	CP
Corn	47.13	45.09	44.19	38.73
Soybean meal	29.63	29.98	29.49	29.32
Milk product[2]	17.14	17.14	17.14	17.14
Soybean oil	1.48	1.96	1.86	1.62
Citrus pulp	-	-	-	9.00
Soybean hulls	-	-	3.00	-
Purified cellulose	-	1.50	-	-

The analytical characterization does not predict the functional effect of fibre ingredients in piglets.

Fonseca et al., 2012

What is the role of fibre in PW diets?

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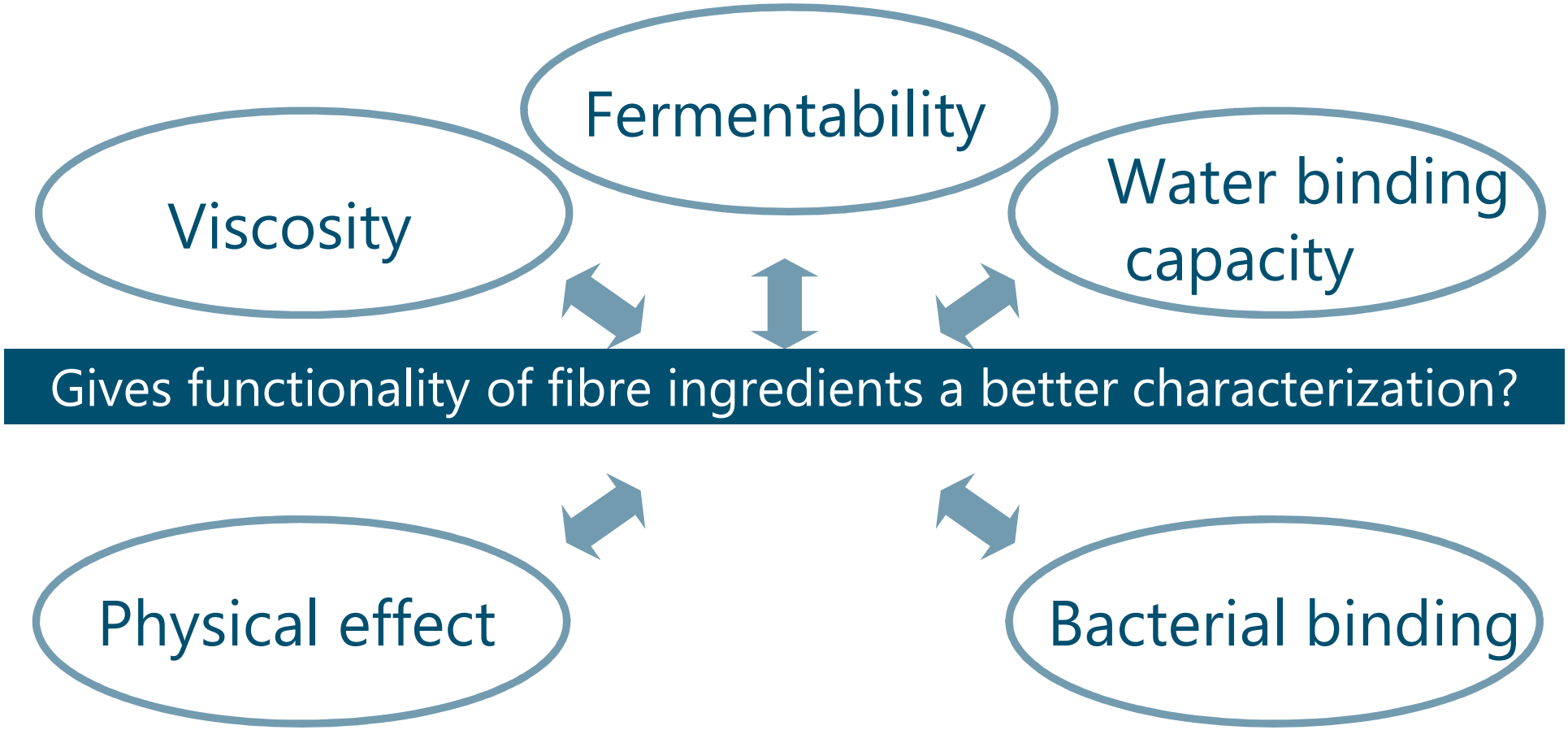
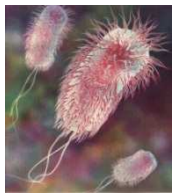
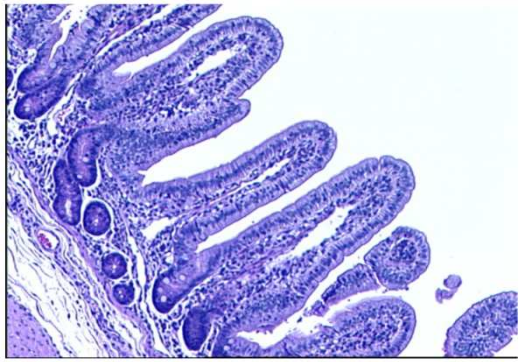


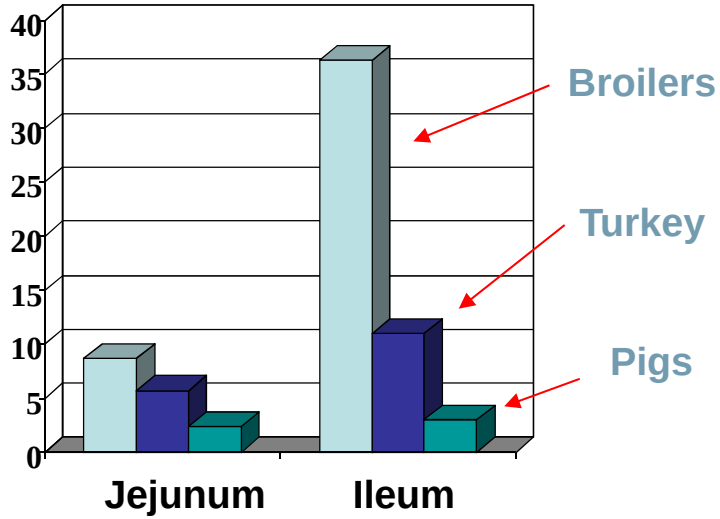
Viscosity

- **Slow gastric empty rate**
- **Increase nutrient absorption**





Intestinal Viscosity (mPa.s)



(Danicke et al., 1999)

- **Reduce enzymatic digestion**
- **Decrease and stop intestinal transit**
- **Increase risk of bacterial growth in the intestine**
- **Hidrolize bile salts**

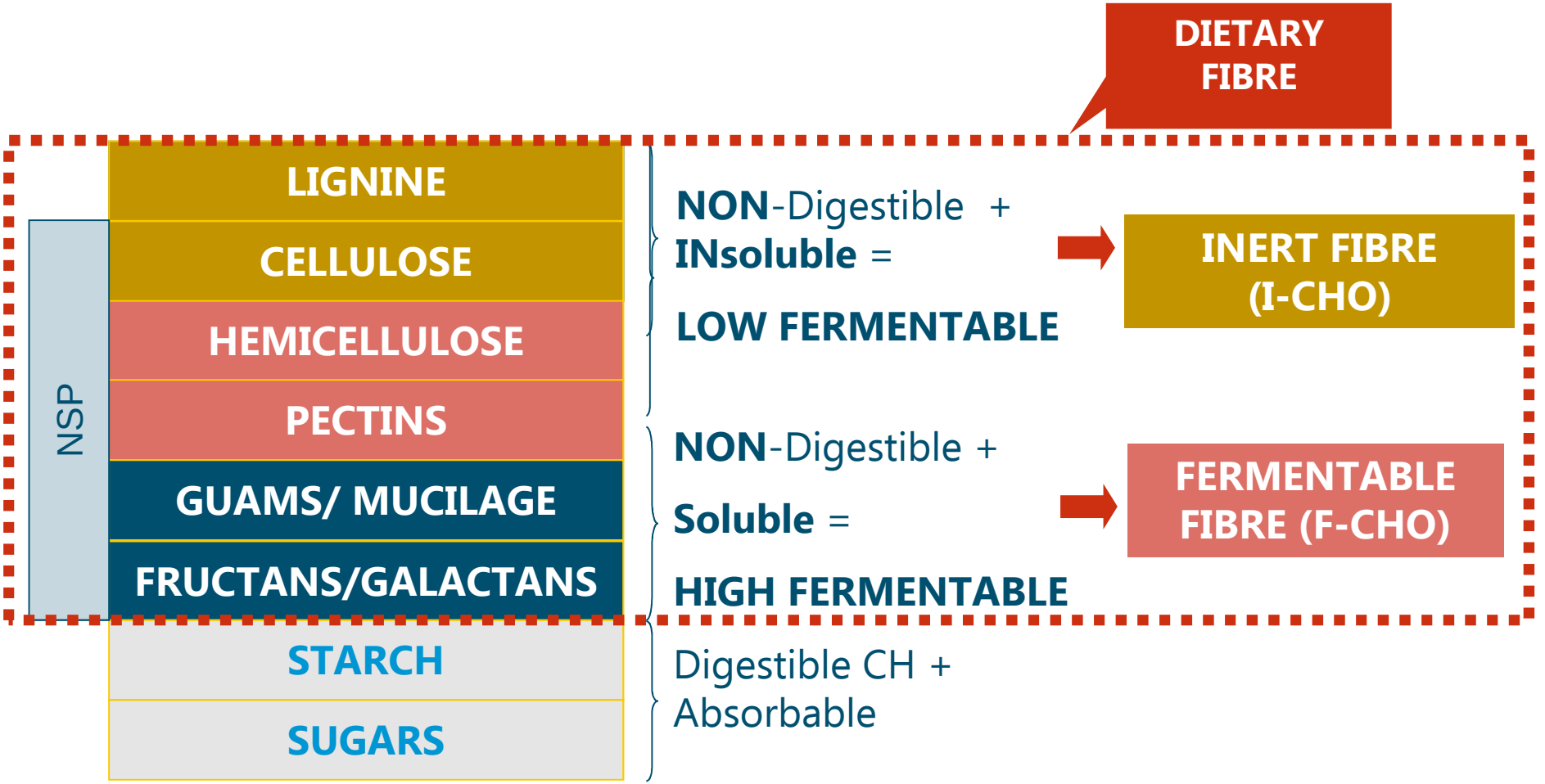
Effect of digesta viscosity in post-weaning diarrhea

	Days after weaning			
	Day 7	Day 8	Day 9	Day 10
Rice	0/8	1/8	0/8	0/8
Rice+ low viscous CMC	5/8	3/8	4/8	4/8
Rice+ high viscous CMC	7/7	7/7	7/7	5/7
P-value	<0.005	<0.005	<0.005	<0.005

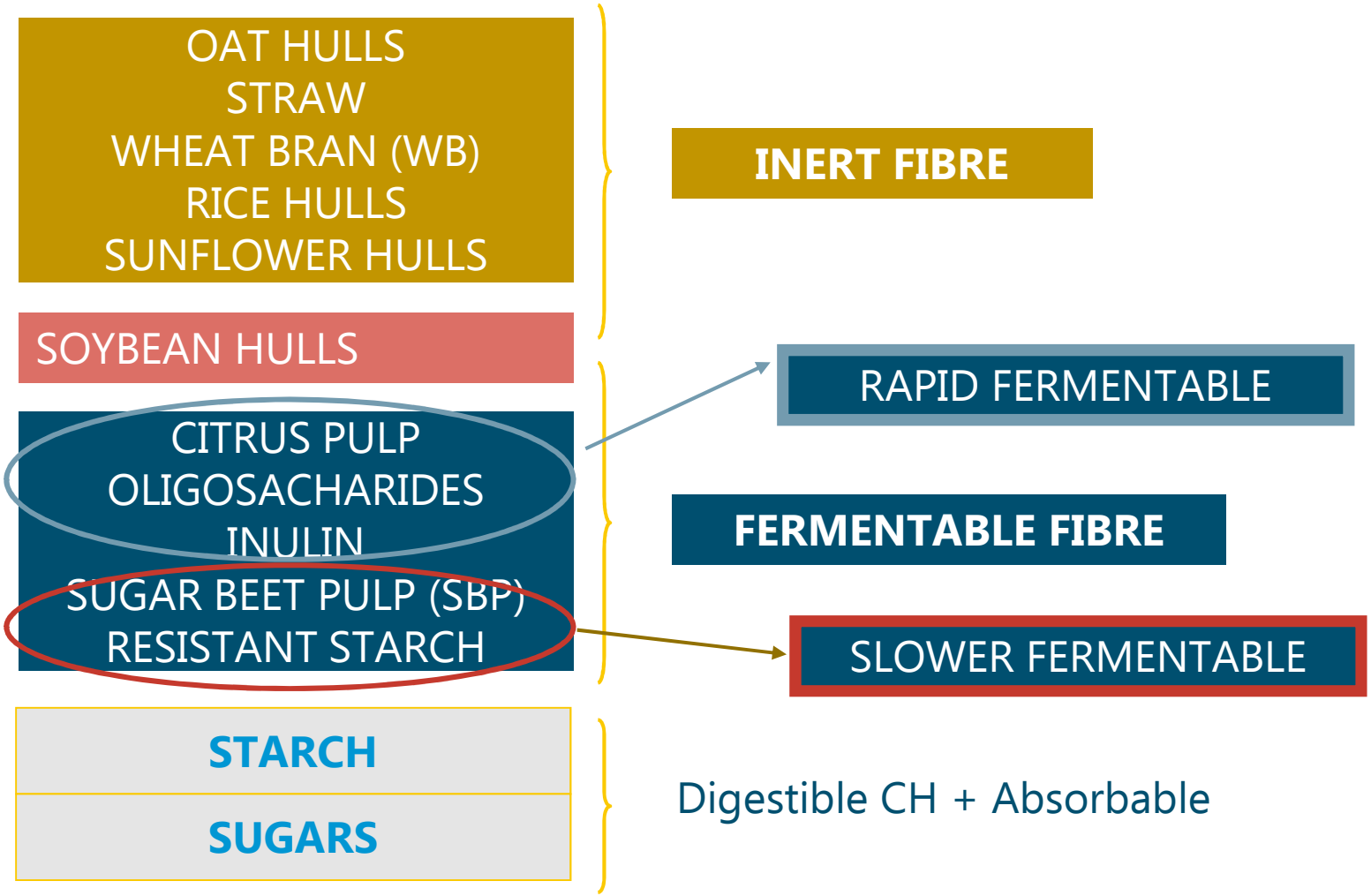
McDonald et al., (2001)

Increasing the digesta viscosity, especially in the ileum, increases the risk of post-weaning diarrhea

Fermentability & Solubility



Fermentability & Solubility



Is the inclusion of inert fibre better than fermentable fibre in PW diets?

INERT FIBRE

Improve digestive function
Modifies microbiota GIT
Enhances microbial fermentation
Reduces nutrient digestibility
Penalizes animal performance

NSPs

FERMENTABLE FIBRE

Slows gastric emptying
Proximal fermentation in the hindgut
Increases luminal viscosity

Diet composition

Fermentable (x3)

Inert (x1)

Table 1. Formulation and chemical composition of the experimental diets[1]

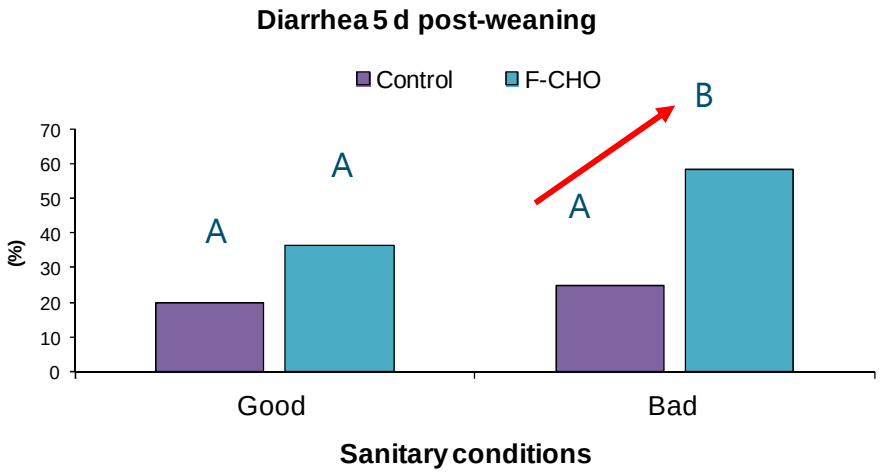
	Experimental diet			
	Phase I		Phase II	
Item	Control I	Fiber I	Control II	Fiber II
Ingredient, g/kg (as-fed basis)				
Wheat	225	198	350	303
Corn	200	175	200	172
Barley	120	105	150	129
Soybean meal (48% CP)	240	230	250	230
Dried whey	150	150	-	-
Dehydrated sugar beet pulp	-	60	-	90
Soybean hulls	-	20	-	30
Vegetable oil	25	25	10	10
Dicalcium phosphate	10	9.8	11.2	11.5
Calcium carbonate	11.3	9	11.2	7.3
L-Lys·HCl	5.6	5.2	4.6	4.2
DL-Met	2.7	2.7	1.6	1.6
L-Thr	2.5	2.4	1.9	1.9
L-Trp	0.8	0.8	0.4	0.4
Salt	2	2	4	4
Premix[1]	5	5	5	5
3-phytase[2]	0.1	0.1	0.1	0.1
Calculated composition, g/kg DM				
NE, MJ/kg	10.4	10.0	9.8	9.3
Digestible Lys	13.0	12.5	11.6	10.9
Digestible P	3.8	3.7	3.2	3.1
Chemical composition, g/kg DM				
Ash	64.5	64.9	58.8	60.1
CP (N × 6.25)	219.1	212.3	220.2	213.0
Ether extract	47.2	46.0	31.6	32.2
Starch	381.5	341.5	488.8	425.9
GE, MJ/kg	18.77	18.65	18.55	18.41
Crude fiber	32.5	48.9	35.8	63.9
NDF	109.6	112.5	122.3	153.2
ADF	34.6	50.1	39.3	69.0
ADL	2.1	8.6	3.9	9.9
Total dietary fiber	120.9	169.1	145.8	216.8
Water insoluble fiber	102.6	140.7	122.7	186.1

Montagne et al., 2012

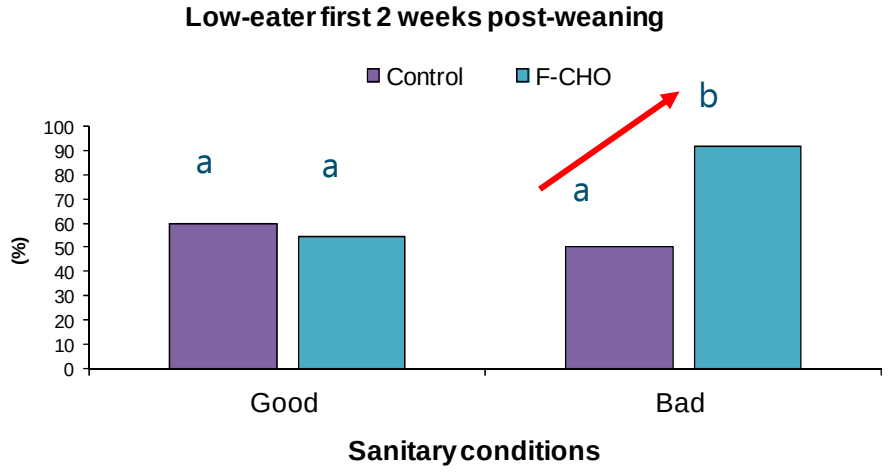
2x2 Experimental design:

- **Level of F-CHO**: high and low
- **Sanitary conditions**: good and bad

Interaction between F-CHO and health status of the animals



P diet x sanitary conditions = 0.07

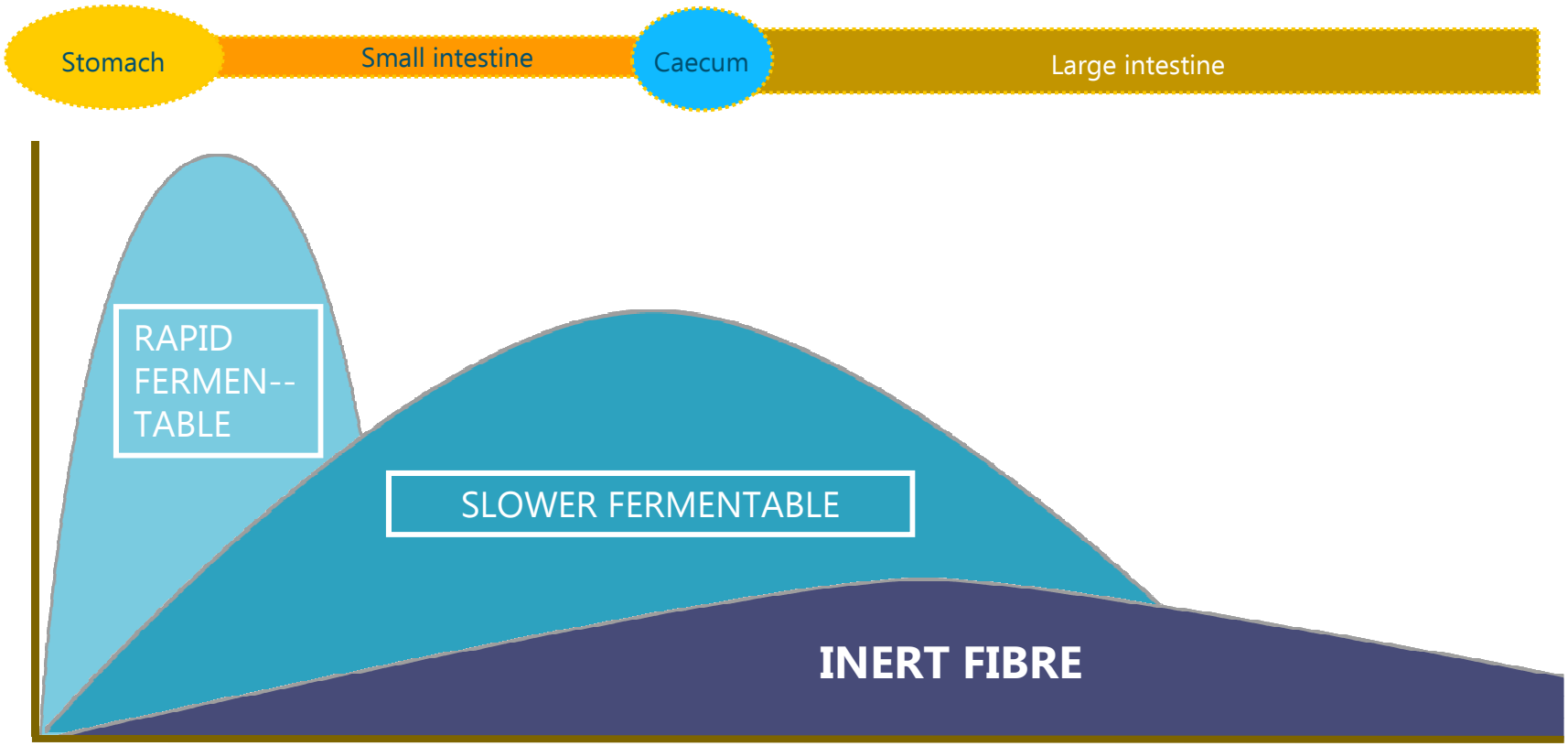


P diet x sanitary conditions = 0.01

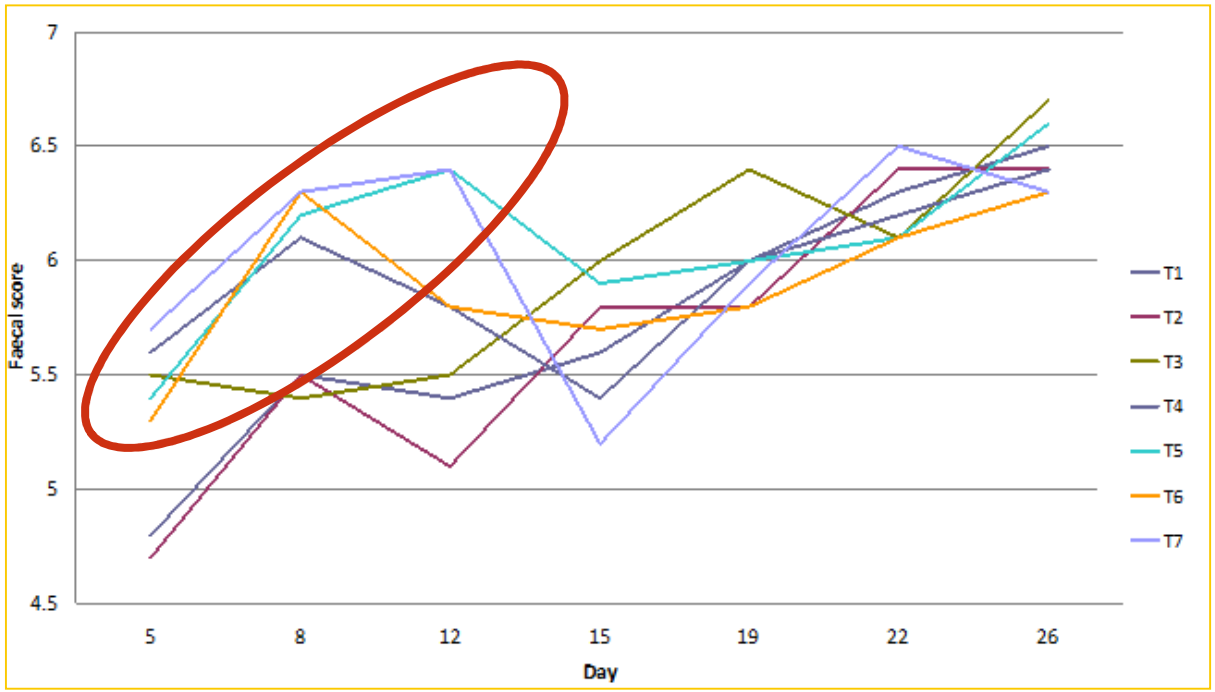
Montagne et al., 2012

In situations with bad sanitary conditions, the utilization of F-CHO sources in the first week post-weaning is an additional risk factor

FERMENTATION KINETICS
Piglets need a fully developed GIT to ferment fibre ingredients



Feacal score results during the first 4 weeks PW



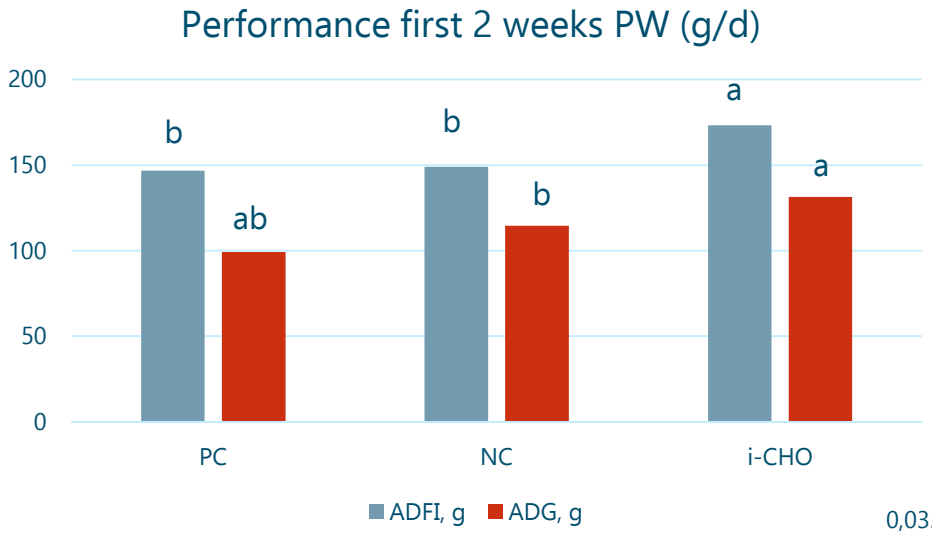
Diluting the diet with I-CHO sources improved the faecal score

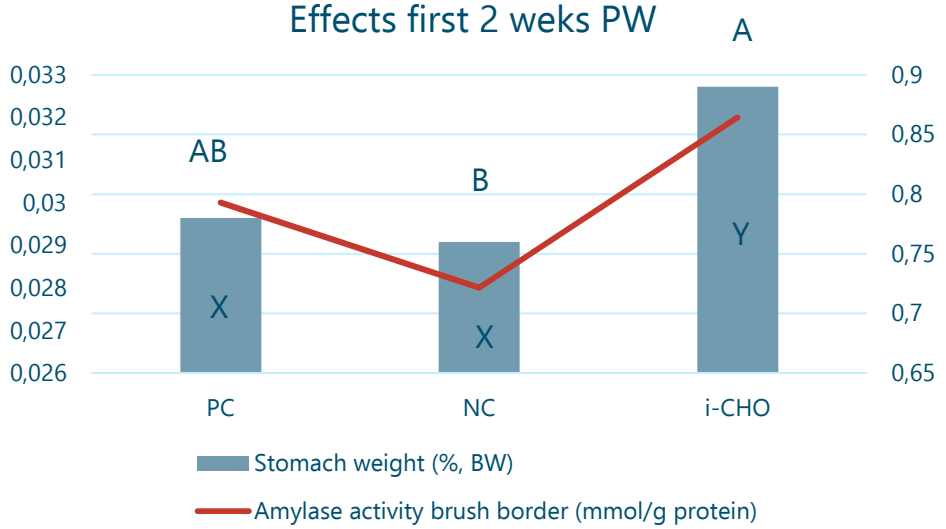
Treatment	T1 Control	T2 6% Soya hulls	T3 12% Soya hulls	T4 6% Sunflower hulls	T5 12% Sunflower hulls	T6 6% Wheat straw	T7 12% Wheat straw

Dietary dilution with inert fibre

Calculated nutrient composition

	PC	NC	I-CHO
NE (Kcal)	2350	2330	2030
Moisture (g/kg)	107	119	116
Ash (g/kg)	79	80	85
Crude protein (g/kg)	163	191	169
Crude fat (g/kg)	46	54	52
Crude fibre (g/kg)	27	29	74
I-CHO (g/kg)	**50**	**48**	**128**
F-CHO (g/kg)	**85**	**96**	**96**
Calcium (g/kg)	7.0	7.0	7.0
Digestible P* (g/kg)	3.6	3.6	3.6
C18:2 (g/kg)	13.7	15.4	14.8
C18:3 (g/kg)	1.4	1.4	1.4





- **Diluting the diets (15%) with ICHO increases ADFI and ADG in the first 2 weeks PW.**
- **Diluting the diet with ICHO is related to bigger stomachs and higher activity of the brush borders enzymes.**

Healthy piglets higher growth potential!?

Lysine: a dose-response study

	Treatments	Week 1-2		Week 3-4	
		AID (g/kg)	SID (g/kg)	AID (g/kg)	SID (g/kg)
1	Low	9.6	9.9	8.8	9.1
2	Medium	10.8	11.1	9.8	10.1
3	High	11.8	12.1	10.8	11.1
4	Very high	13.0	13.3	11.9	12.2

(SFR 2016)

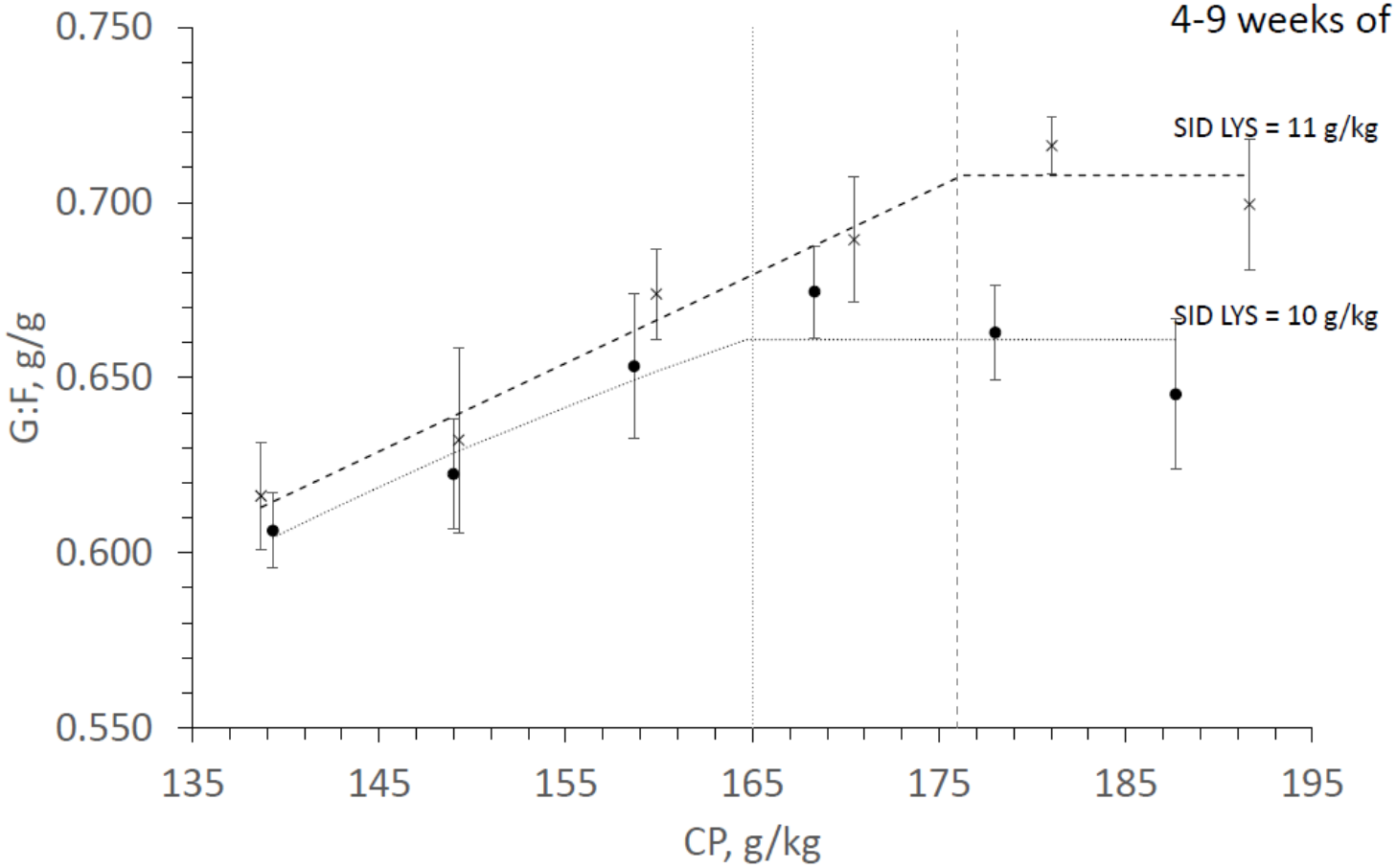
- **BW start: 8 kg, 6 replicates per treatment; Diets were iso-energetic**

Results Lysine

Treatment	1	2	3	4	KSV	P-value
Lysine, %	Low	Medium	High	Very high		
Days 0-14						
ADG (g/d)	219ab	203a	240b	250b	32.81	**0.033**
ADFI (g/d)	298	276	305	288	30.46	0.228
FCR	**1.37c**	**1.37bc**	**1.27b**	**1.16a**	0.097	**<0.001**
Faecal score	5.7	5.7	5.6	5.7	0.531	0.873
Days 14-28						
ADG (g/d)	473a	524ab	525ab	572b	54.42	**0.013**
ADFI (g/d)	754	782	758	747	56.30	0.578
FCR	**1.59c**	**1.49b**	**1.45b**	**1.31a**	0.075	**<0.001**
Faecal score	6.1	5.6	5.6	5.9	0.603	0.315

- **In conditions of no PW diarrhea problems the animals reacted positive with an increase Lys level > higher growth potential**

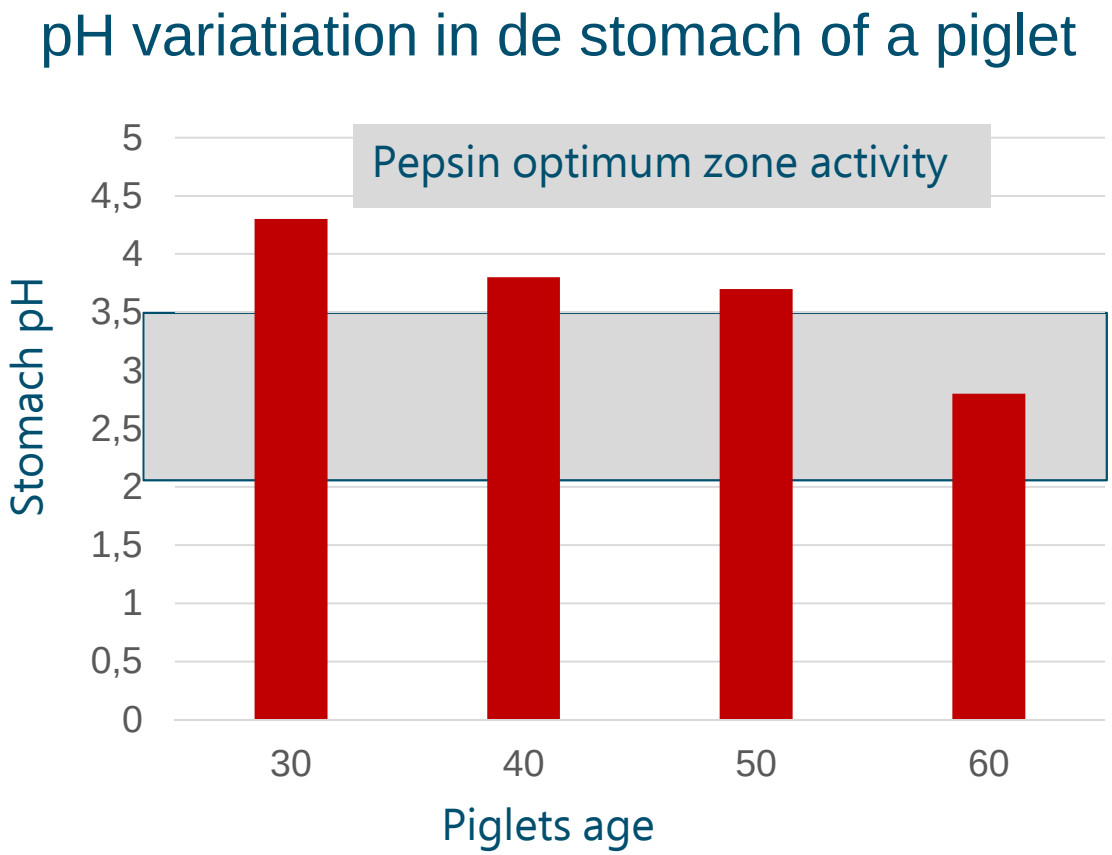
Effect of CP level on feed efficiency



Millet et al. 2018

- **In order to avoid restrictions on growth is necessary to control the ratio Synthetic Lys/ SID Lys.**
- **Piglets do not only need Lys to grow!**

Protein digestion and stomach pH in piglets



- **Piglets younger than 60 days have difficulties to acidify stomach pH**

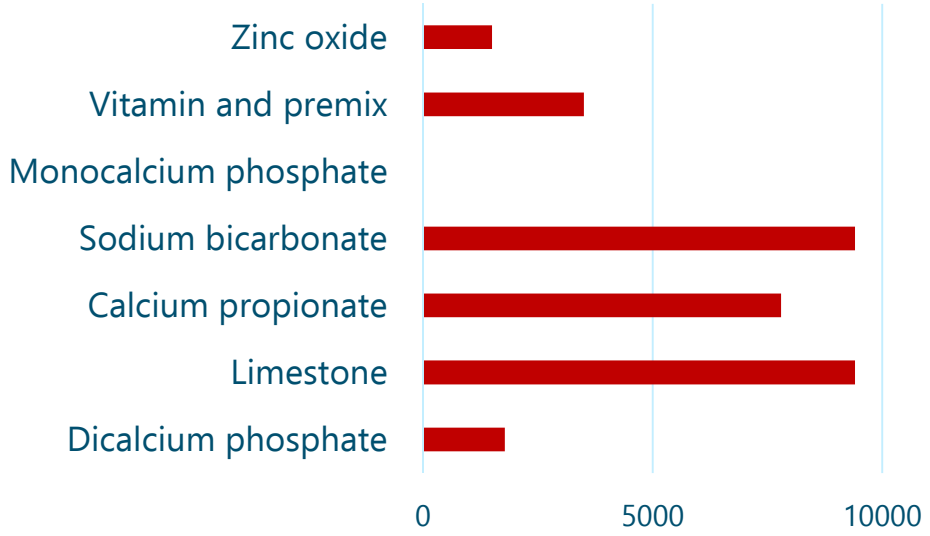
Acid binding capacity (ABC)

The Acid Binding Capacity – ABC) is the amount of acid or base (in mEq) required to change the pH to a certain value. This is usually pH 4, which results in the **ABC-4 value**

Higher ABC-4 = higher buffer capacitity

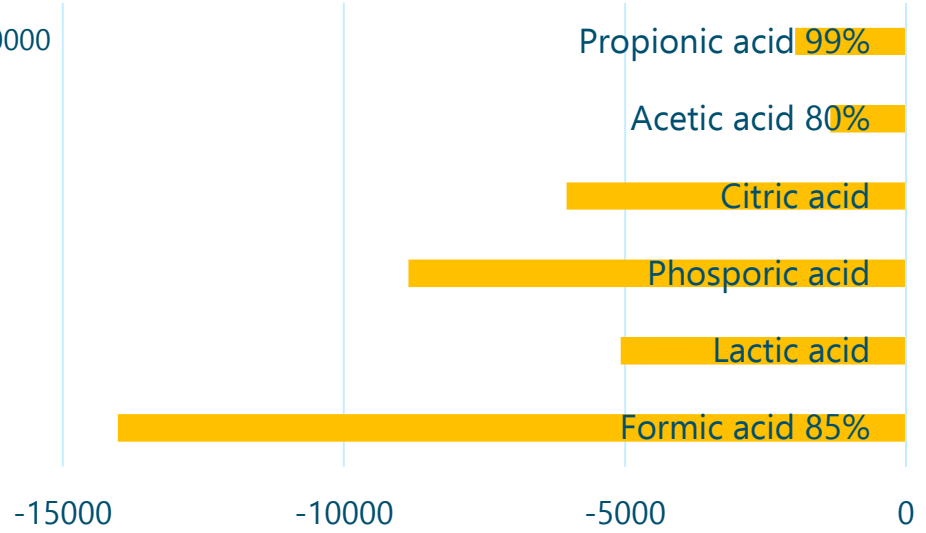
- Energy (starch and fat): little influence on ABC-4
- Crude protein sources: strong impact on ABC-4: high buffering capacity > control CP level in piglets!
- Minerals: strong impact on ABC-4: high buffering capacity
- Organic acids: strong impact on ABC-4: reduce pH

Acid binding capacity (mEq/kg)



Minerals have a large impact on the ABC. Therefore, reduce minerals that will have a negative impact on the pH in the stomach (high ABC-4 value)

Organic acids will help to reduce the pH in the stomach (acidifying effect)



Fiber & CP fermentation

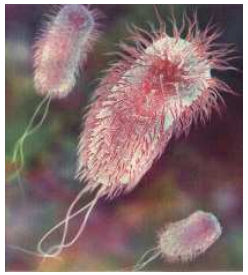
Level of protein

(15 %) → Performance

¡ Importance! Essentials Aa (Iso, Val)

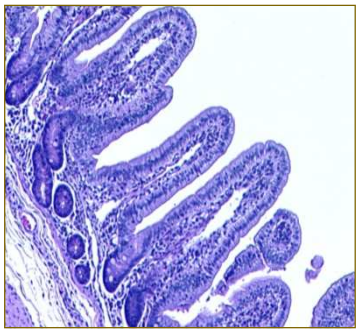
(19 %) + Fermentable Carbohydrates in pigs of 35 d old

(23 %) → Protein Fermentation

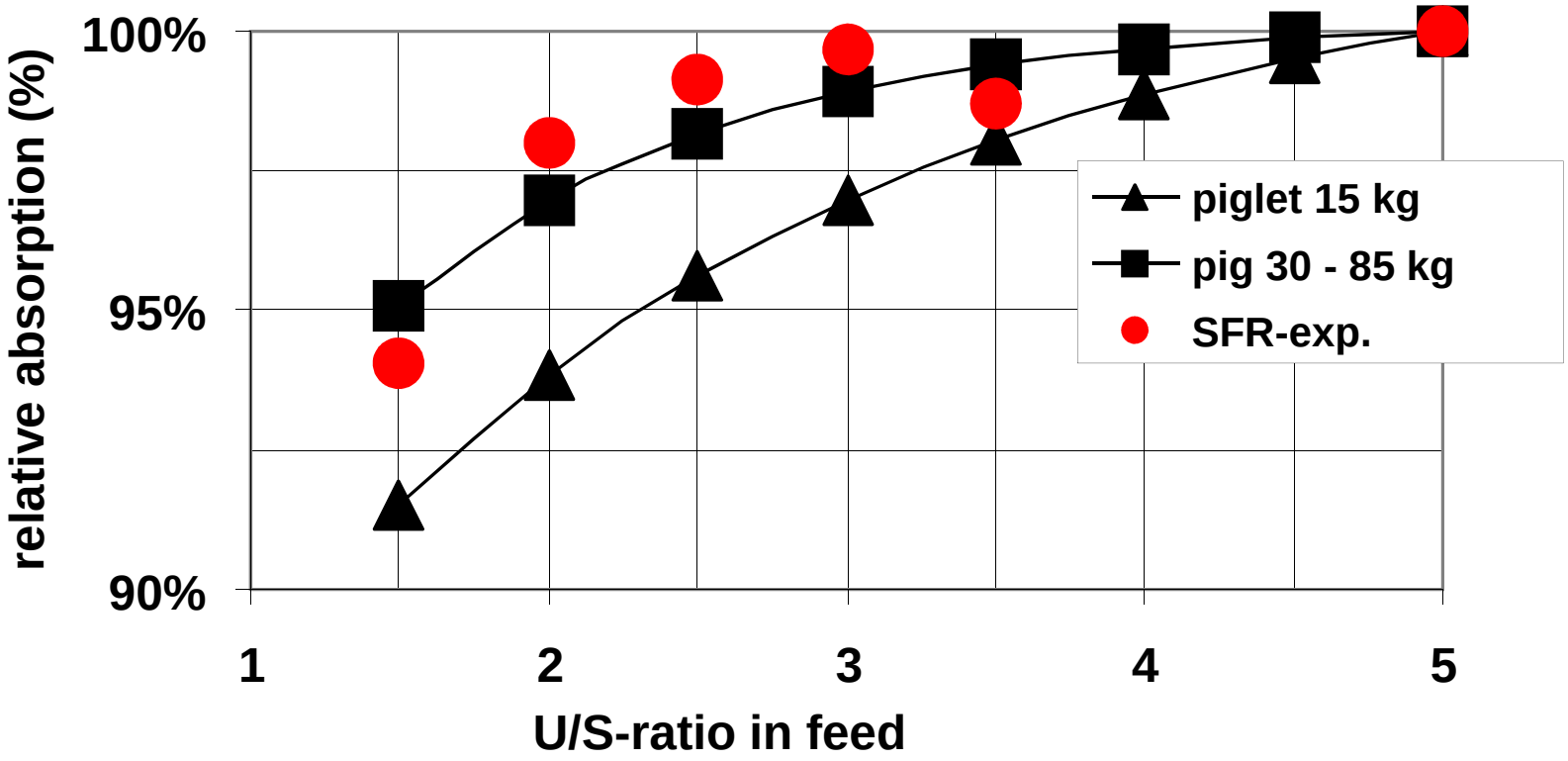


N-ammonia

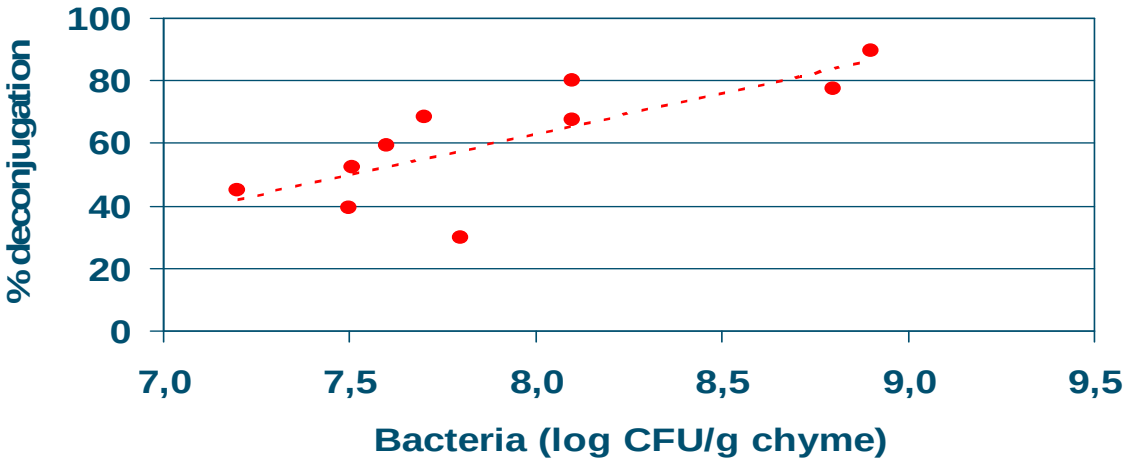
\- gut integrity



Effect of U:S-ratio on fat digestibility (according to Wiseman et. al. and Schothorst experiment)



Bacterial degradation of bile acids



Van der Klis, 1999

- **Overgrowth of bacteria is linked to lower fat digestibility!**

MCFA's- Intestinal health

Treatment	Stomach				Duodenum			
	Total	*Lactobacilli*	*Streptococci*	*E. coli*	Total	*Lactobacilli*	*Streptococci*	*E. coli*
A	7.0^{a}	7.2^{ac}	4.2^{a}	4.6^{a}	6.4^{a}	6.9	1.6^{a}	4.9^{a}
B	7.0^{ac}	7.6^{a}	0.6^{b}	0.8^{bc}	6.1^{a}	6.8	0.0^{a}	4.8^{a}
C	5.9^{b}	6.6^{bc}	5.3^{a}	2.0^{b}	5.6^{b}	5.9	4.7^{b}	1.8^{b}
D	6.9^{ac}	7.3^{a}	5.1^{a}	0.0^{c}	5.9^{a}	6.4	4.7^{b}	1.8^{b}
S.E.M.	0.13	0.13	0.48	0.48	0.13	0.19	0.54	0.51

a,b,c: different superscripts in the same column denote significant differences at least $P < 0.05$.

Dierick et al., 2002

- A: control feed (incl. 2.5% soya oil)
- B: control feed + 2.5% MCFA - C8 and C10 (instead of soya oil)
- C: feed B + lipase
- D: Control feed met 1.5% organic acids

Take home message pre-weaning

Colostrum
The first 24 hours

Milk replacer

Focus on developing microbiota and innate immune system

Focus on having a robust GIT and preparing the piglets for the weaning period

Weaning

Creep feed

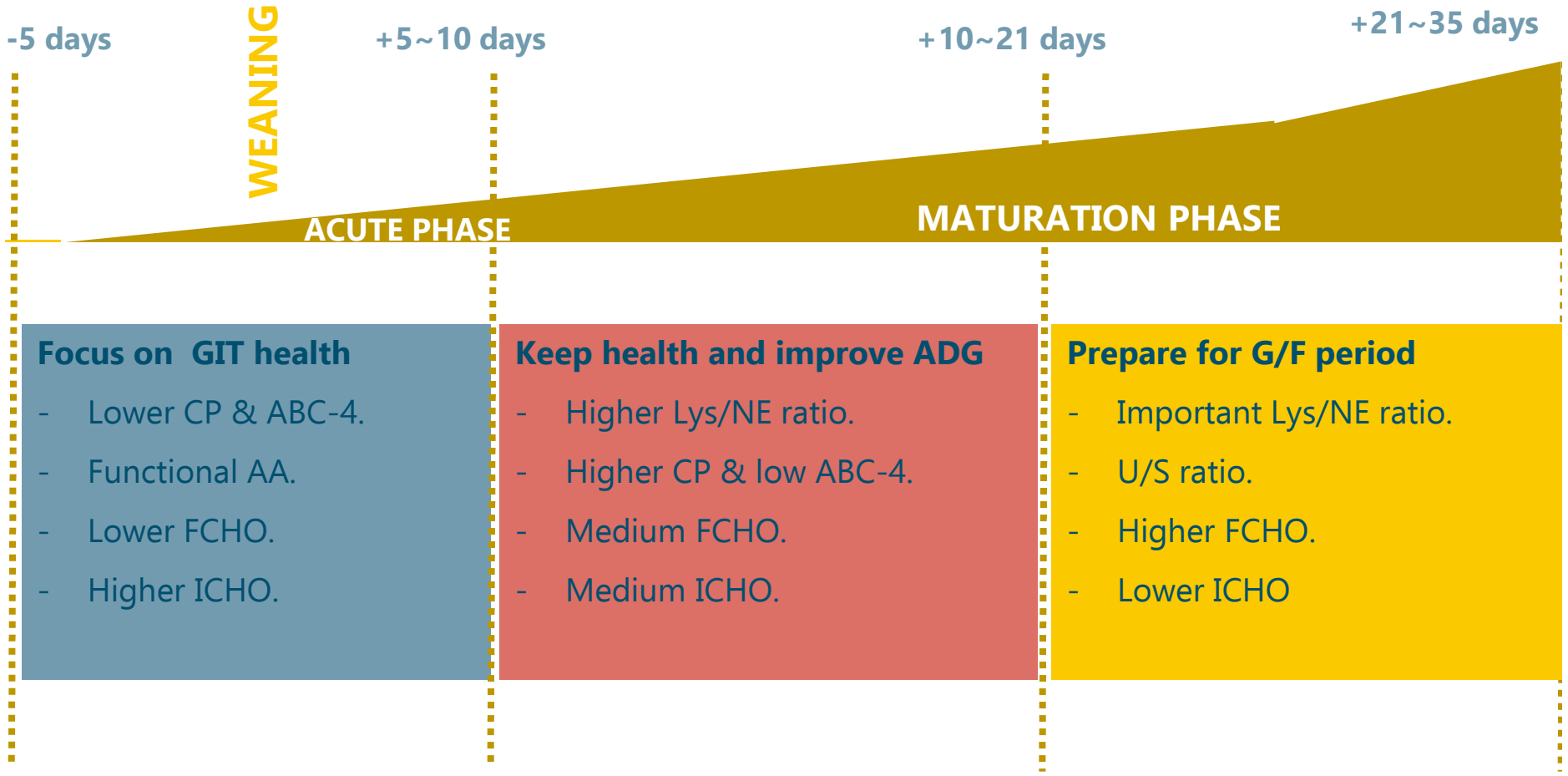
Sow milk

Post weaning

Week 1 | Week 2 | Week 3 | Week 4 | Week 5....

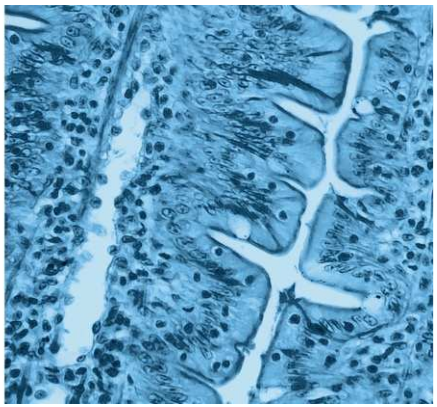
Diet around weaning

Take home message post-weaning



SCHOTHORST FEED RESEARCH





Thank you for your attention

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Knowhow to feed