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Probiotics – Do they have a role in the pig industry?

EAAP Congress Dublin 2007

Outline of presentation

- Gut bacteria – rôles
- Introduction to probiotics
- Mechanisms of action
- Examples from Feed For Pig Health Project
- Large Scale trials of Probiotics (literature)
- Practical considerations of delivering probiotics to pigs
- Conclusions

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An Introduction To Gut Bacteria

10^{13} bacteria in the intestine

500 - 1000 species of bacteria

100 X more genes than in the human genome

- Hydrolytic enzymes (e.g. glycosidases)
- Vitamin production
- Detoxification of harmful substances
- Exclusion of dangerous pathogens (active or passive)
- Reduce ammonia/amine production

Mice with no gut bacteria have **60% less body fat** but **increased** food consumption – Gut bacteria facilitate more efficient use of food.

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Probiotics - History

- “The Prolongation of Life" (London, William Heinemann 1907)
- Bulgarians eating lots of yogurt have longer lives
- Due to modulation of bacterial communities in the colon
- Also proposed removal of colon as a good thing !

Elie Metchnikoff (1845-1916)

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Probiotics – what are they?

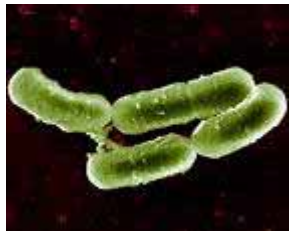
"Live microbial cultures given to animals with the intention of improving health or production parameters."

Bacteria e.g.

Lactic acid bacteria (*e.g. Lactobacillus* spp.)

Bacillus

Enterococcus



Yeast - *Saccharomyces*

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If probiotics work – how do they work?

Mechanisms are varied (probably synergistic):

- Enhance host defences against pathogens – innate and adaptive immune system, improve gut barrier function
- Microbe-microbe interactions
  - ➢ specific biocidal products (bacteriocins) or alteration of environment (lactic acid, local pH) may reduce levels of undesirable bacteria
  - ➢ "competitive exclusion"
  - ➢ enhanced digestibility of feed – healthier animals grow faster, more resistant to disease

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Problems using live organisms (not chemicals)

- Storage/treatment sensitive
- May change with time (gene switching)
- Similar strains may have very significantly different characteristics

Benefits

- **“Natural”**
- **Safe**
- **Multiple benefits (health, nutrition, meat quality??)**

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Isolating/Assessing Potential Probiotics

- Vlasta Demeckova and Peter Brooks (University of Plymouth, UK) have isolated and characterised many lactic acid bacteria from pig faeces. Ideal organisms for fermented liquid feed applications
- Characterised for ability to:
  - ferment pig feed rapidly
  - produce mainly lactate (little acetate)
  - bind to pig gut epithelium
  - aggregate *E. coli*
  - inhibit adhesion of *E. coli* to gut epithelia

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Feed For Pig Health – assessment of probiotics

- Lab-based:
  - Able to kill/inhibit pathogens
  - Interact positively with gut wall and immune system
  - Change gut microbial environment
- Whole animal (small scale):
  - No large negative effects on growth
  - Protect against disease challenge
- On-farm Studies:
  - Effect on performance characteristics
  - Different production stages: pregnancy, lactation, weaning, growing

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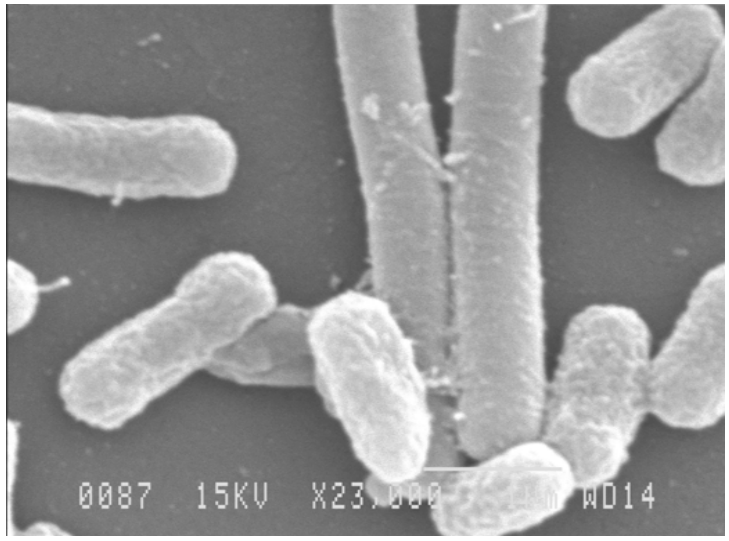
Probiotics – *in vitro* effects on pig pathogens

Ability to kill/inhibit pathogens

in vitro killing of pathogens such as *Salmonella* or *E. coli* can be indicative but *in vivo* situation may be very different – biofilms, co-operation between different gut bacteria.



Lactobacillus aggregating *E. coli*

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Probiotics – *in vitro* effects on pig pathogens

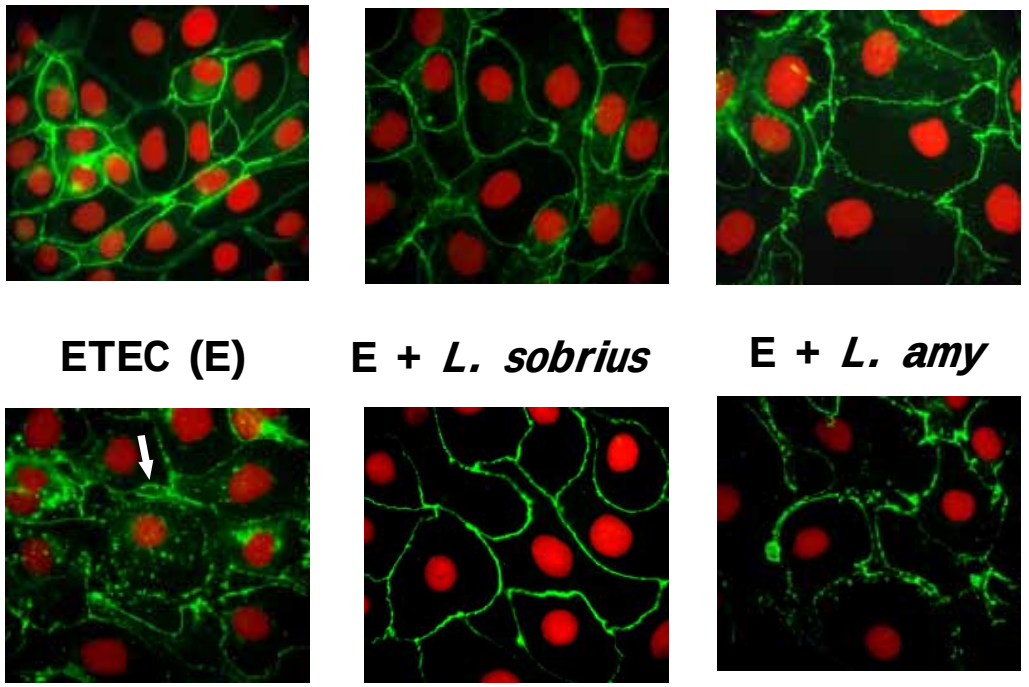
Interaction with pig gut wall

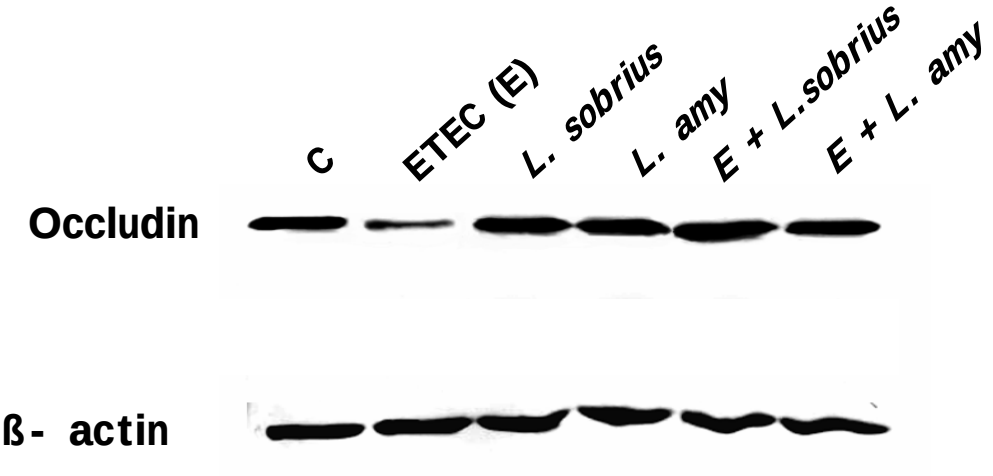
- Cell cultures of gut epithelial cells provide an excellent model system. Pig gut epithelial cell lines are available.
- Enterotoxigenic *E. coli* (ETEC) causes disruption of cell layer integrity (analogous to gut situation). Addition of Lactic Acid Bacteria (LAB) can prevent this process.

Protective effect of *Lactobacillus sobrius*

LABs protect tight junction integrity

Occludin immunofluorescence





Western blot analysis

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Probiotics and post-weaning colibacillosis

Pigs fed *Lactobacillus sobrius* [1] (LAB - 10^{10} bacteria per day) for seven days post-weaning then challenged with ETEC.

	Control (cfu/ml)	**LAB diet** (cfu/ml)
Total Bacteria	**10^{10}**	**5×10^{9}**
L. sobrius	**10^{4}**	**10^{8}***
ETEC	**10^{6}**	**10^{4}***

[1]*L. sobrius* appears to be an important member of the gut community of healthy young pigs!

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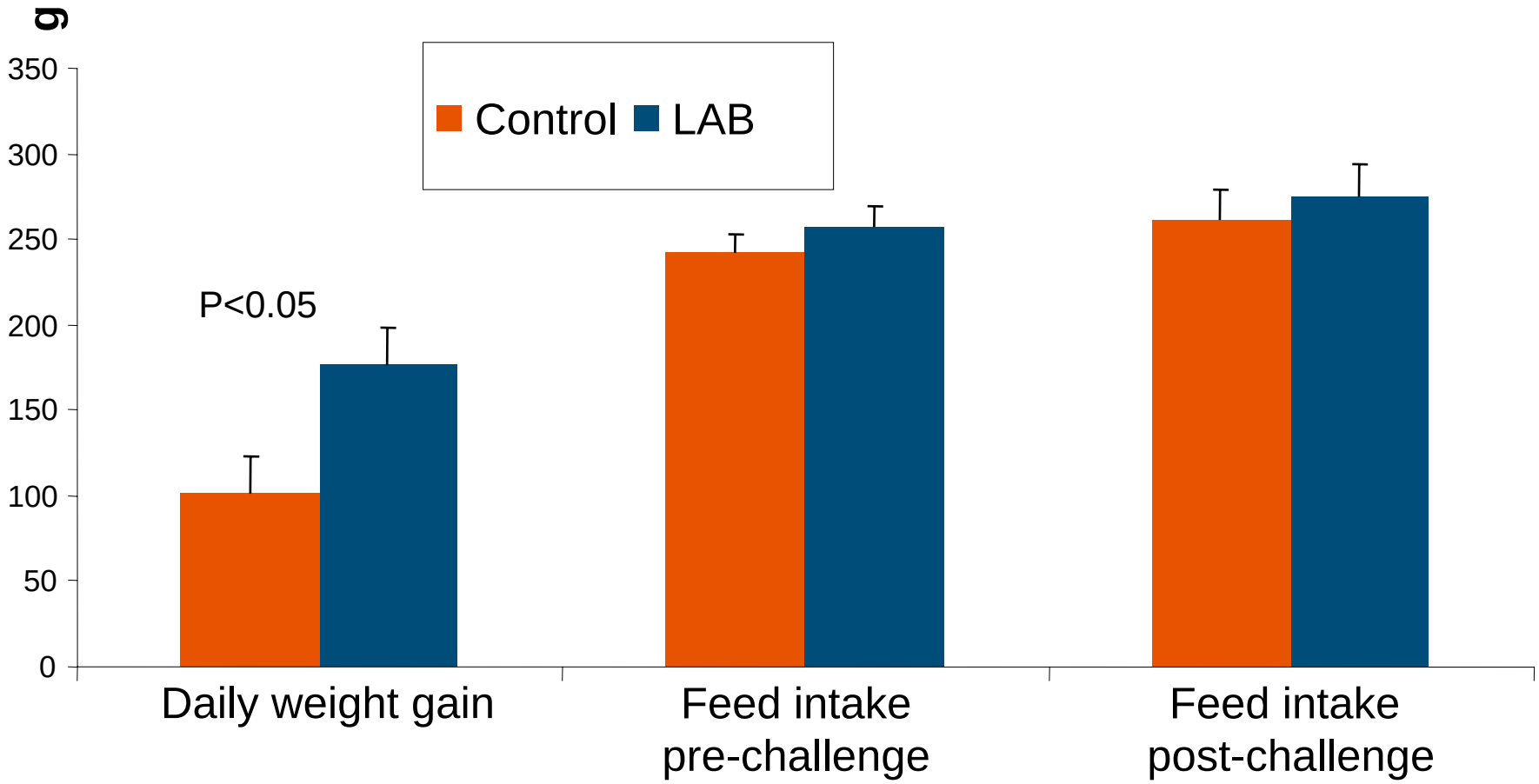
Effect of *L. sobrius* on growth and feed intake of *ETEC* challenged pigs (7 days post-weaning)



Post-weaning growth check reduced

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Fermented liquid feed

- Natural or using a “starter”
- Ferment total mix or component (cereal)
- Good Points
  - Lactic acid
  - Bioavailability
  - Bactericidal (pathogens)
- ? Bad Points
  - Reproducibility
  - “Bad” fermentation (ethanol, aversion)
  - Lysine reduced

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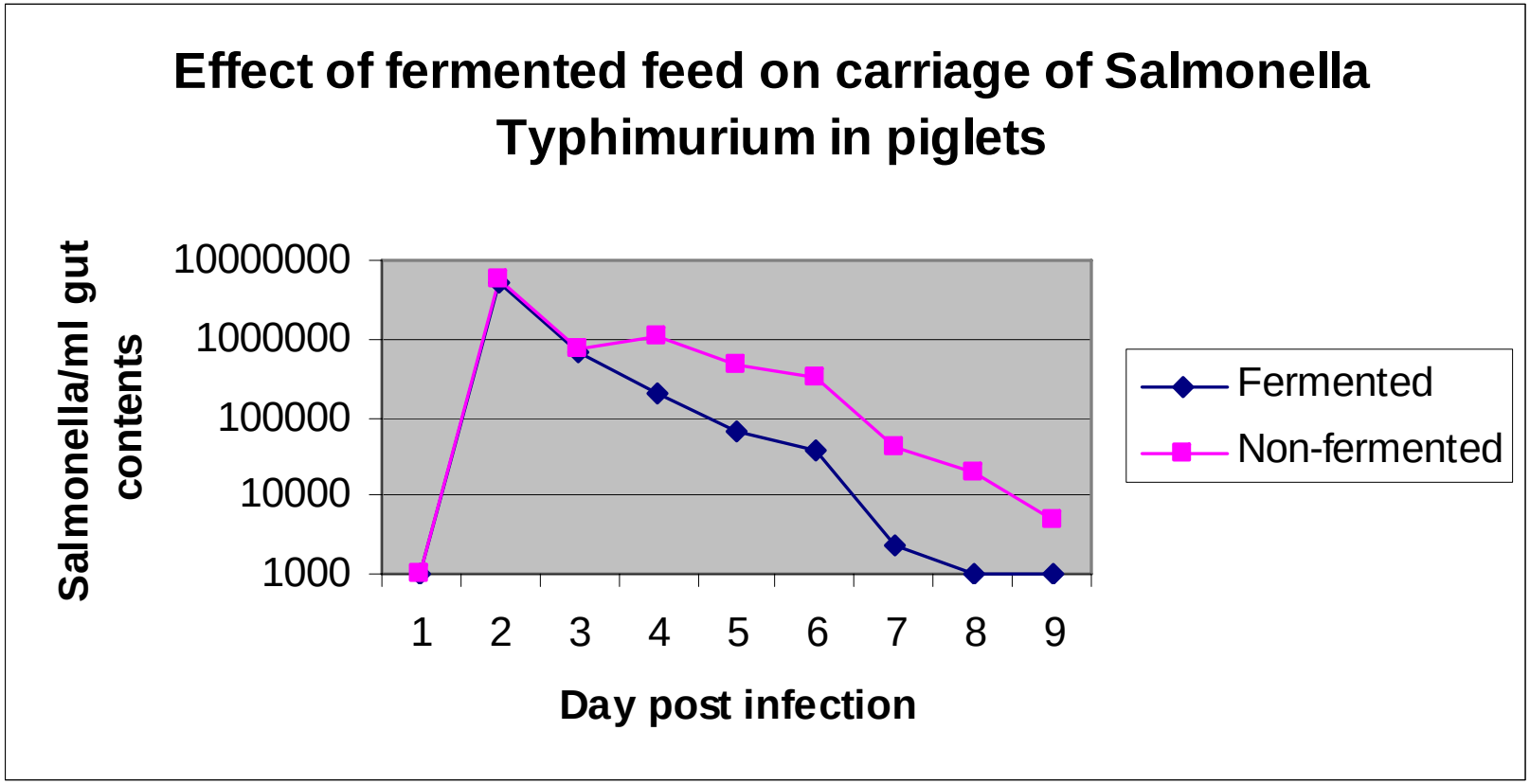
Do probiotics affect *Salmonella* carriage?



Carriage of *Salmonella* reduced in FLF group

Translocation into lymph nodes reduced in FLF group

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Large scale trials – problems of design

Finishing pigs – Fermented vs "control"

- ~1000 pigs kept from 30-100kg
- Liquid diet with cereal fraction fermented in test group
- Fermented with *Pediococcus acidilactici* (commercial starter)
- Control cereal treated under same conditions but no starter
- Feeding effectively *ad libitum*

	pH	Lactate (mM)	LAB/ml
Control	**4.7**	**84**	**$2x10^9$**
Fermented	**4.3 (~3)**	**98 (~200)**	**$3x10^9$ (10^{11})**

NB - Both feeds fermented – (But not much!!)!

http://www.bpex.org/technical/publications/pdf/FinishingPigsTrial_3_Report.pdf

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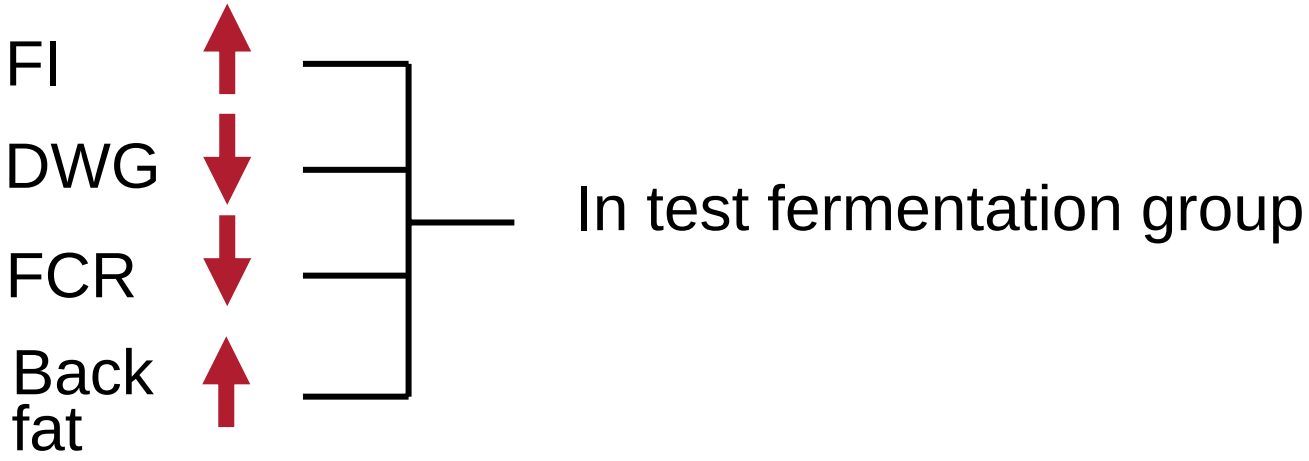
Large Scale Trial – Finishers - Results



BUT ….. BOTH feeds were fermented!

“Control” naturally fermented

“Test” Starter driven

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Large Scale Trial – Finishers - Conclusions

- Does NOT mean that ALL fermented feeds are useless!
- Did not compare non-fermented feed
- One organism (low dose, limited fermentation)
- High health status and welfare environment pigs
- Finishing pigs (what about weaners and farrowing sows?)

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Large Scale Trials – Nursery Pigs*

- Comparing the efficacy of probiotics (10^{12} cfu *Bacillus licheniformis* and *Bacillus subtilis* per tonne of food) with a conventional antibiotic regime (400 ppm neomycin, 1 week, 100ppm neomycin + oxytetracycline, 1 week, 20ppm tylosin 7 weeks) for combating *E. coli* diarrhoea
- ~22,000 piglets
- Study period 20 – 70 days

* Kritas and Morrison (2005) Vet Record 156:447-448

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Large Scale Trials – Nursery Pigs: Results

- Bodyweight, ADG, ADFI and FCR similar in both groups
- Cost of feed per pig and per kg bodyweight gain similar
- Mortality rate and causes similar

Conclusion.

This probiotic mix gives similar results, at no increased cost, to the regime using sub-therapeutic levels of antibiotics. Environmental benefits should encourage further studies

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Large Scale Trial – Farrowing

- 109 gilts
- Test ~10^6 spores of *Bacillus licheniformis* and *B. subtilis* per gramme of feed.

Treat **sows** 14 days prior to farrowing → weaning

Food consumption postpartum ↑

Weight loss postpartum ↓

Piglet diarrhoea ↓ Pre-weaning mortality ↓

Piglet body weight at weaning ↑

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Alexopoulos et al. (2004) J. Animal Phyiol Nutr 88:381-392

Delivery of Probiotics

- Freeze-dried additives
- Heat treated pelletted in feed

- Incorporated into water

- Fermented liquid feed
  - Natural
  - Whole feed or component
  - Starter Batch/Continuous

Conclusions

Choose the right probiotic for right conditions

- A particular probiotic organism may be excellent in a sub-optimal population of pigs but insignificant in a high health status herd
- Probiotics may be excellent in controlling post-weaning diarrhoea but may show minimal effects in growing/farrowing/lactating pigs
- Control of storage/fermentation conditions are critical to ensure reproducibility

THANK YOU!

EU Framework 6

University of Wageningen, Netherlands

INRAN, Rome

University of Bologna, Italy

University of Plymouth, UK

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