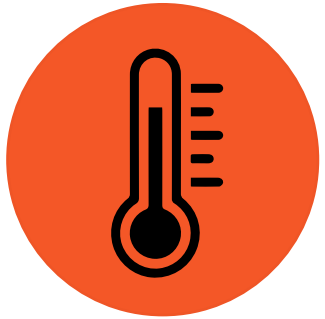
INNOVATION BY engrain™

What Is eMAX™?

- Engrain carries different strains of spore forming *Bacillus spp*. probiotics
- Probiotics are live microorganisms which can confer a health benefit to the animal when administered in appropriate and regular quantities.
- Each strain is constantly evaluated to target specific needs of the poultry and swine industry.

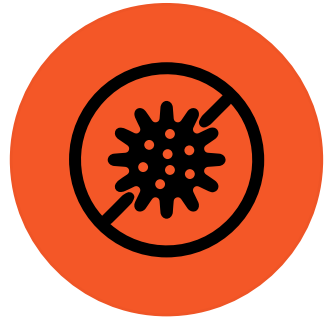
How Is eMAX™ Different?

Engrain's Probiotic Strains:



Easy to store at room temperature

Can be pelletized



Withstand certain concentrations of chlorine and other antimicrobial substances commonly used in farms

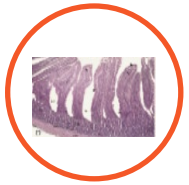
How It Works

- *Bacillus* spores produce micro doses of enzymes that can aid in nutrition
- Each *Bacillus* strain produces its own set of substances that can be beneficial to the animal
- Reducing pathogenic loads can improve the performance and reduce the use of antibiotics

Early stimulation of the immune system

Reduction of common pathogens

Improved intestinal health



Better intestinal morphology

Increases the availability of nutrients

Improvements in growth performance

Bacillus production of antimicrobial substances:

- Subtilosin, sublacin, bacitracin, surfactin, bacilysocin, bacillosin 490, and l8, CAMT2,among others…
- Antimicrobial peptides: polyketides, surfactins, fengycin, fusaricins, iturins, among others…

Reduce pathogens such as *E. coli, Salmonella*, and *Clostridium spp.*

Pathogenic *E. coli* F18 has ben identified as a leading cause of diarrhea and mortality in young swine.

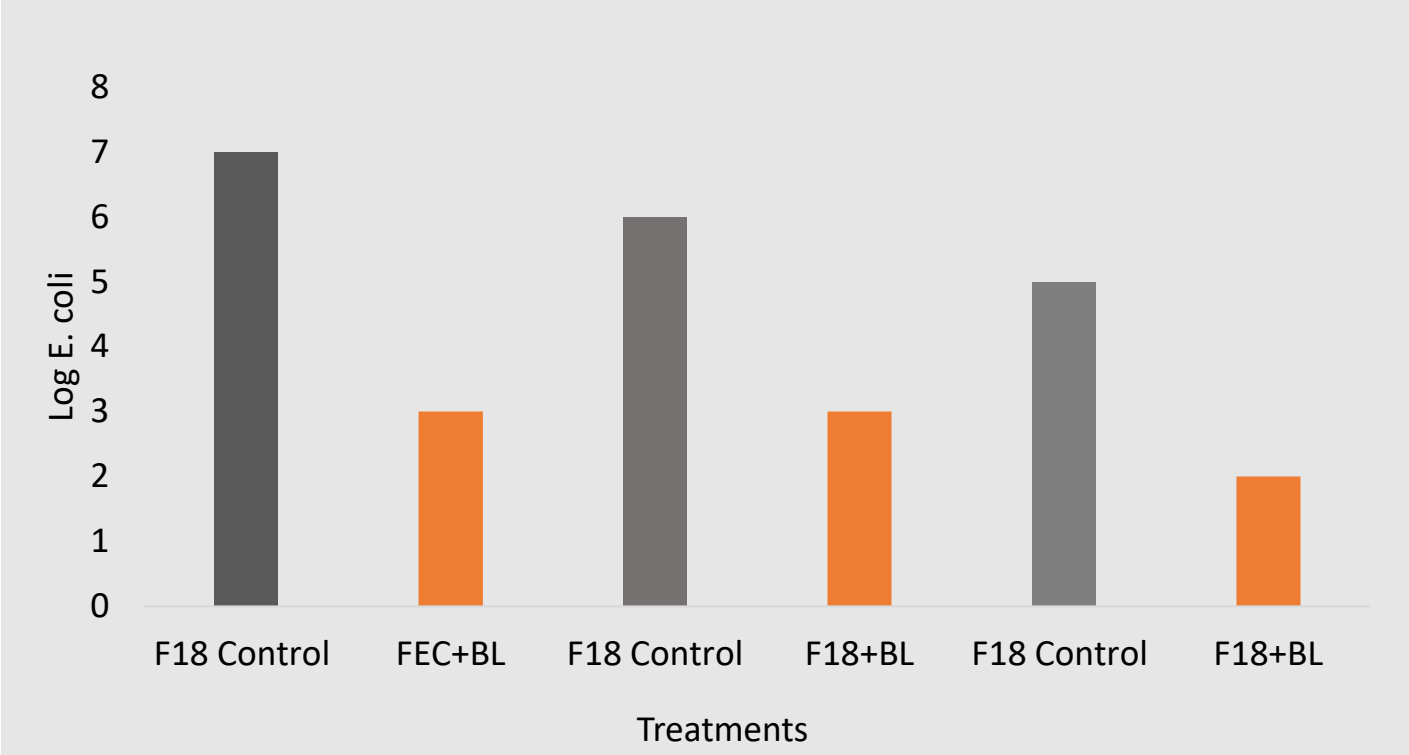
Bacterial strains:
E. coli F18 isolated from infected swine was obtained from Iowa State University- Veterinary and Diagnostic Laboratory - tested positive for LT, Sta, STb, Stx2, Stx2e toxins

Engrain's probiotic *Bacillus* spores

Method: co-incubation with different starting concentrations of *E. coli* F18(7, 6 and 5 log) and 11 logs of Engrain's *Bacillus*.

In vitro competitive exclusion analysis: Bacillus spp. vs E. coli F 18

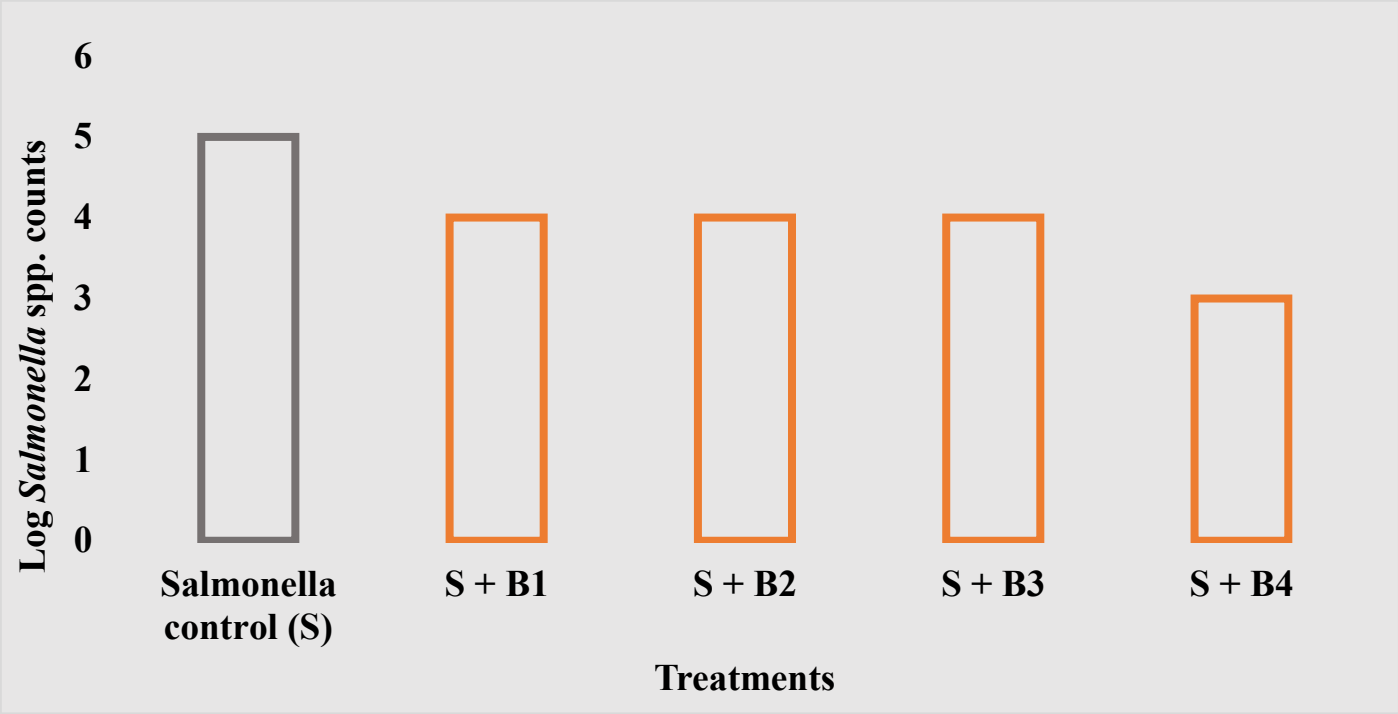
The Bacillus spores inhibited the growth of E. coli F18 by at least 4 logs, preventing the pathogen from reaching infectious concentrations.



FEC control: E. coli F18 alone, evaluated at 3 different starting concentrations (7, 6 and 5 logs)
FEC+ BL: E. coli F18 co-incubated with Engrain's BL probiotic strain

In vitro competitive exclusion analysis: *Bacillus spp. Vs Salmonella spp.*

Engrains Bacillus spores (B) reduced Salmonella (S) by 1-2 logs



Salmonellosis can cause septicemia and/or enterocolitis in pigs and it can also contaminate pork food products and cause human infections.

Bacterial strains:
The strain of *Salmonella* evaluated was obtained from young broiler chicks

Engrain's probiotic *Bacillus* spores

Method: co-incubation with Salmonella at 5 log starting concentration and 11 logs of Engrain's *Bacillus*.

Problem: Farm receives gilts presenting high mortality levels

Problem: *E. coli* F18 infection

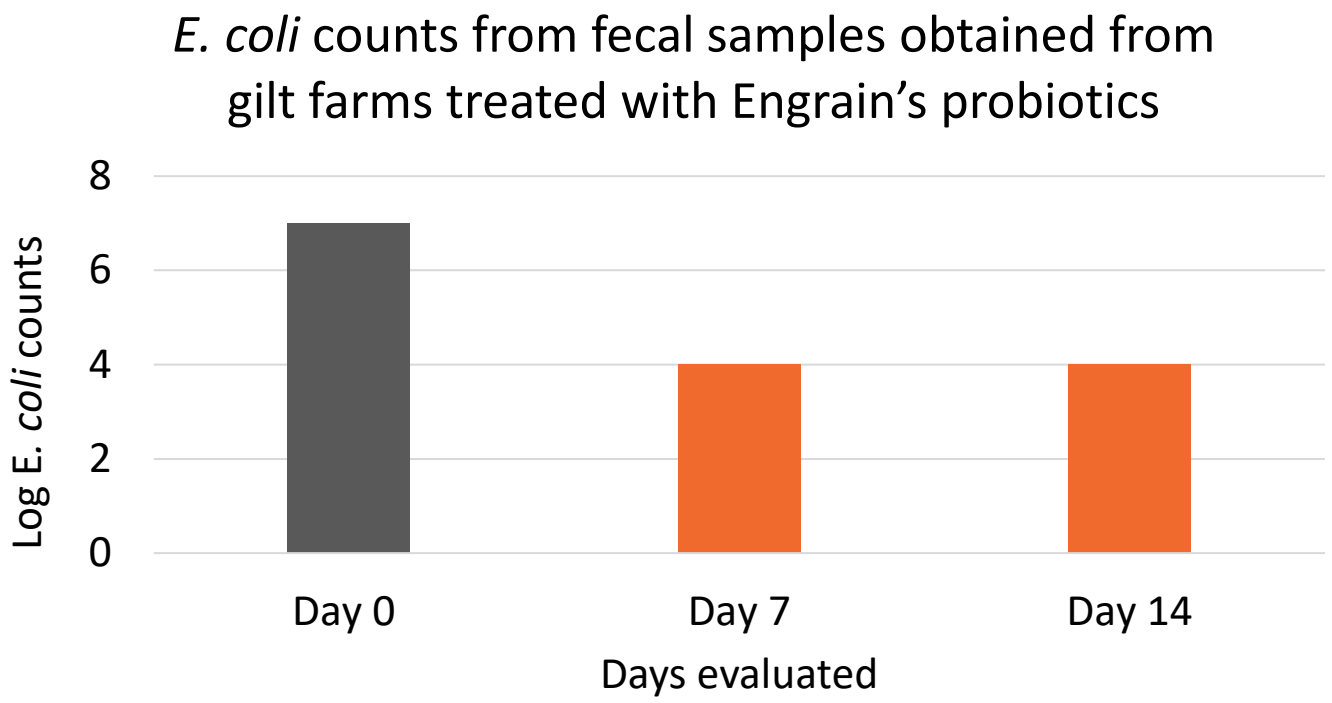
Treatment: Engrain's probiotics, shown to reduce 3 to log of *E. coli* F18 in vitro

Dose: Engrain's probiotics at 50 g/1000 L of water

Day 0: Control (pre-treatment)
D7 and 14: Gilts treated with Engrain's BL

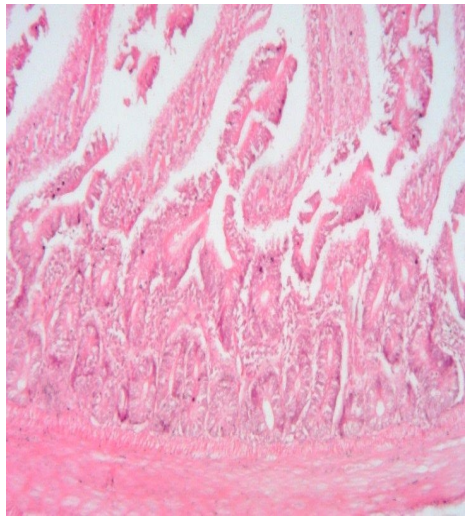
Fecal sample microbiology analysis from young gilts before and after the probiotic treatment

In the farm, mortality was reduced from 16% to 4% after the probiotic treatment.

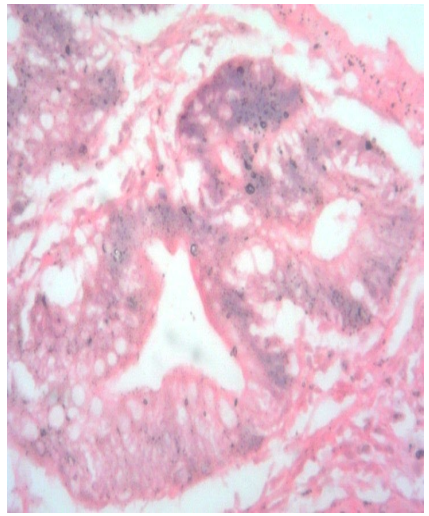


Changes in Intestinal Morphology

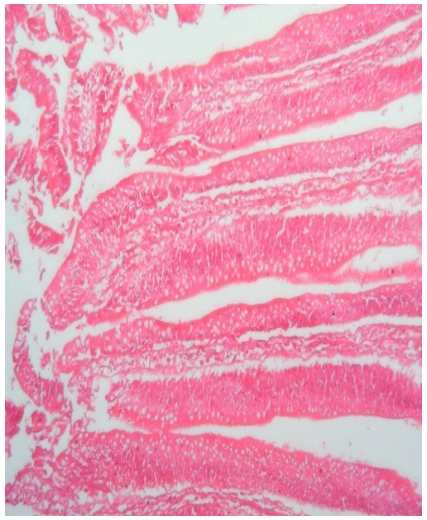
- ✓ This probiotic treatment also improves the morphology of the intestine
- ✓ This change leads to better digestion and nutrient utilization
- ✓ Producers often see reductions in diarrhea in youg pigs which could also lead to a reduction in mortality



Ileum Control
Villus height: 532 µm



Antibiotic Villus height: 877 µm



Engrain probiotics
Villus height: 902 µm

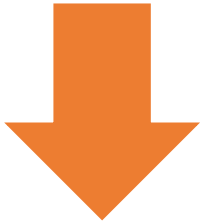
Engrain's Bacillus Based Probiotics can help with:

Intestinal Health
Pathogen control

- Reducing E. coli, Salmonella, Clostridium spp. presence
- Reduce or eliminate the use on antibiotics in the farm
- Feed or water administration
- Recommended dose: 50-100 ppm

Intestinal Morphology

- Increased area of digestion and nutrient absorption
- Improves the moisture content in the manure
- Less moisture in manure reduces insect presence and pathogen proliferation
- Feed or water administration 50-100 ppm



Reducing the Cost of the Diet

- Reduce the use of growth promoters
- Reduces the need for multi enzyme complex
- Allows for ME reductions in the diet: 3-4%
- - Dose: 50-100 ppm
- - Saving: up to $10/MT of feed

ZAMORANO

Experimental Research Trial:

Evaluating the probiotic eMAX in productive performance of pigs

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Experimental period:
August to December of 2022 in Zamorano University swine facility (70 to 168 days).

Diets evaluated:

1. Standard control diet commonly utilized in the research facility
2. Diet with eMAX probiotic at a dose of 100 ppm, and an energy reduction of 4% in all feeding stages evaluated (grower, development, finisher)

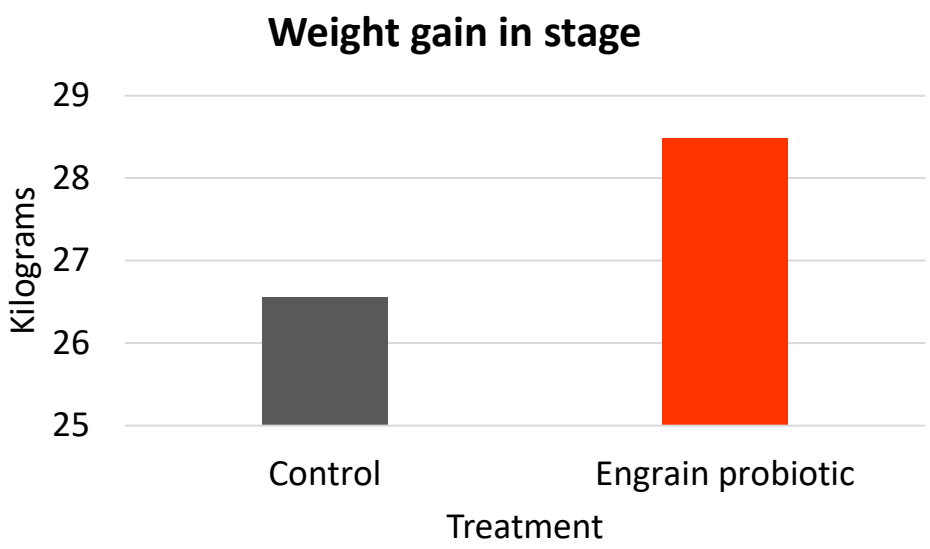
Analysis: 238 pigs from Yorkshire, Landrace, and Duroc breeds were utilized for this trial set in a randomized complete block design. ANOVA Analysis in SAS 2013, $p \leq 0.05$.

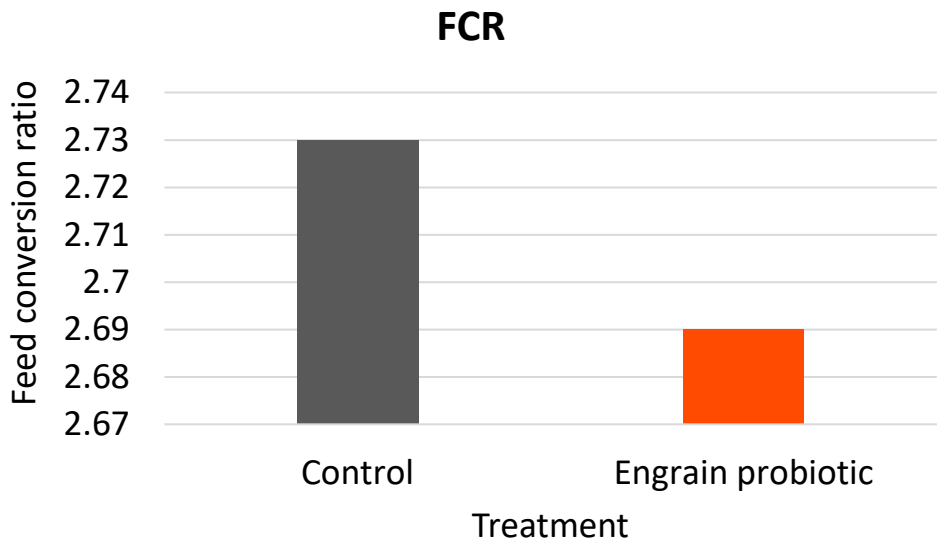
Diet modifications: example of a grower eMAX diet compared to a standard diet (days 70-106)

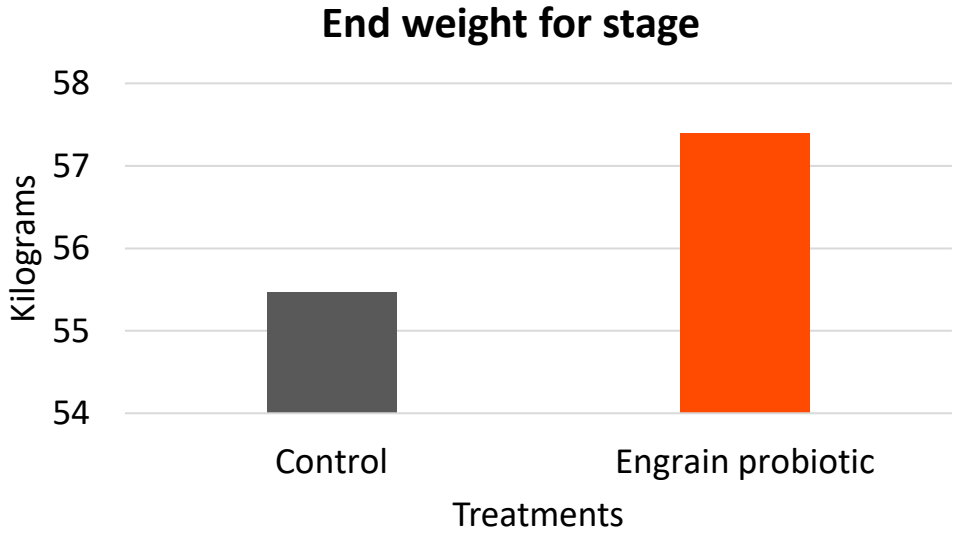
- Diet example for the grower stage (days 70-105), the trial was carried for 3 stages, grower, developer and finisher (70-168 days)
- ME reduction of 4% in all stages: grower, developer and finisher
- Engrain probiotics (eMAX used at 100 ppm in feed.

	Grower diet -Inclusion levels, %	
Ingredients	Control Diet	Engrain's diet
Corn	62.42	59.00
African Palm Oil	2.0	1.0
Wheat bran		
Soybean meal	29.5	30.3
Calcium Carbonate	1.15	1.13
Biophos	0.92	0.94
Lysine	0.16	0.15
Methionine	0.05	0.06
Threonine		
Molasses	3.0	6.61
Salt	0.5	0.5
Vit/mineral premix	0.3	0.3
eMAX®	0	.01
Dietary ME (kcal/kg)	3,300	3,168
Diet cost, $/MT	630	620

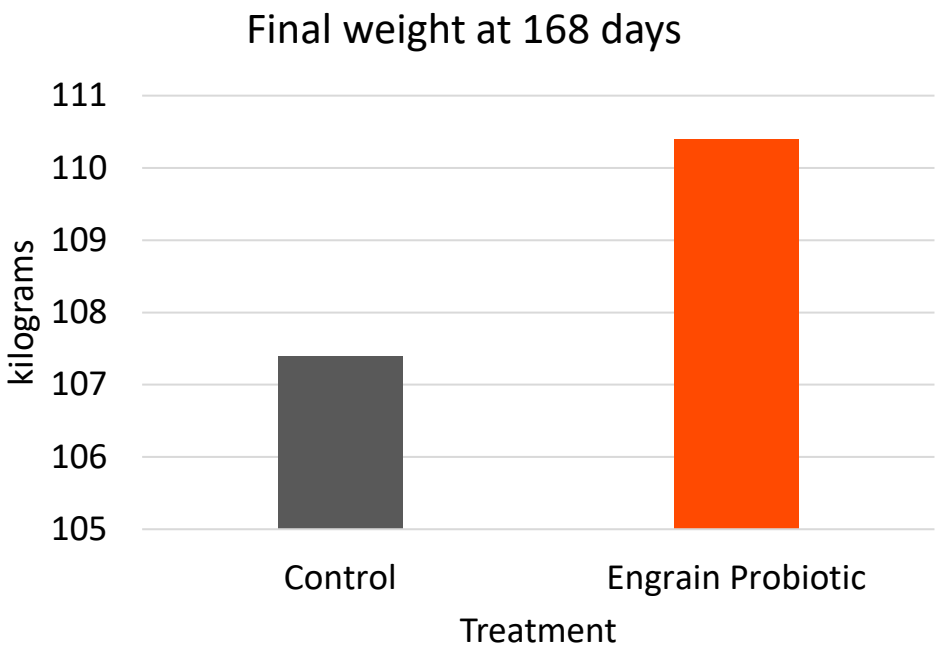
Growth performance results: grower stage example

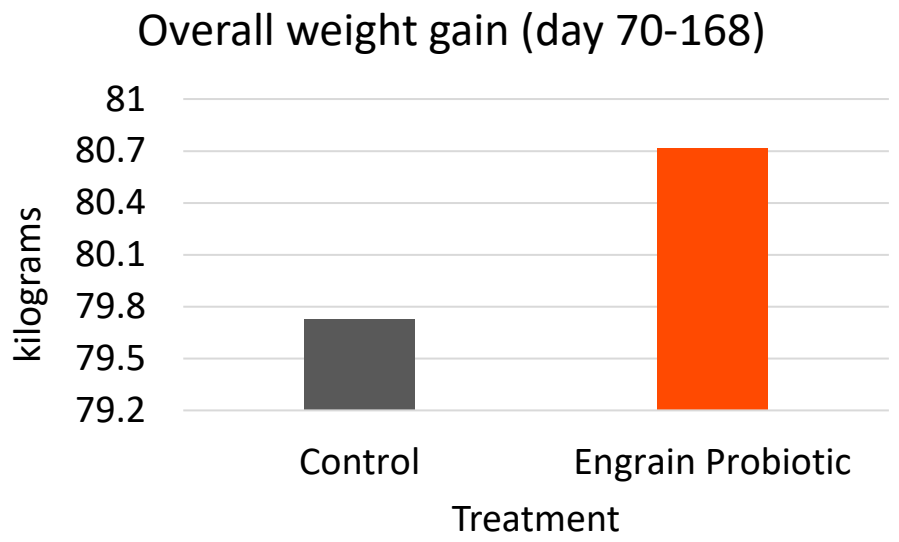


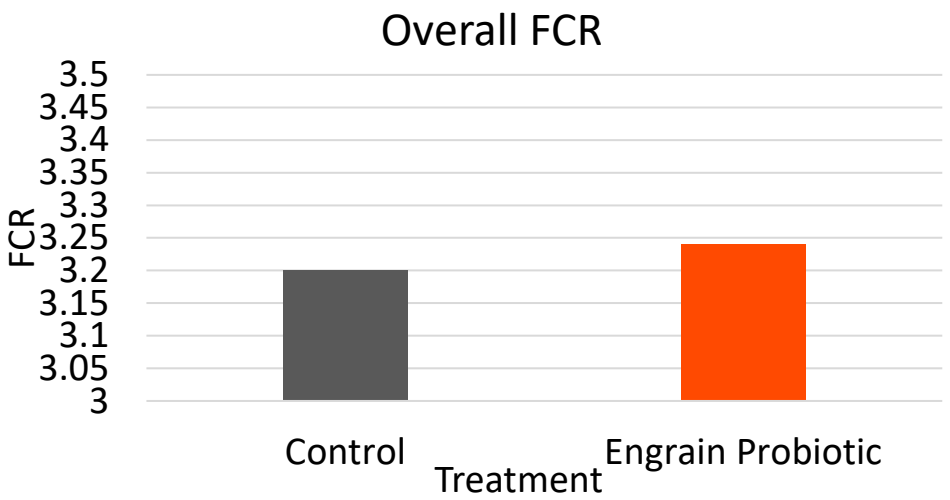




Overall Growth Performance Results







Economic Analysis

Feed costs and gross income for pig carcass sales per treatment evaluated.

	Grower Feed cost, $/MT	Developer Feed Cost, $/MT	Finisher Feed cost, $/MT	Cost of feed consumed $	Carcass Wt. kg	Feed cost/kg of weight gain	Carcass price $/kg	Gross income $	Utility/ feed $
Control	630	610	590	153.87	79.62	1.93	3.17	252.40	98.52
Engrain's probiotic diet	620	590	580	155.73	81.92	1.92	3.17	259.69	103.96

Utility calculated as gross income minus the total feed costs which represents more than 80% of the production cost
Feed cost/kg of weight gain calculated as the total feed cost divided by the weight gained from day 70-168
$: USD

*Prices and costs shown were obtained and calculated at the research facility and the university's own processing plant and store and may vary according to the geographic location, by breed, and ingredient supplier.

Using Engrain's solutions for your farm means...

Providing healthy bacteria to the animal to promote intestinal health, reduce infections, stimulate the immune system.

Intestinal health leads to better nutrient absorption and better feed utilization

Healthy animals grow more efficiently and have a better quality of life

Diets can be optimized to reduce cost and increase weight gain and yields

More meat produced with less resources results in better gross income and higher utility

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