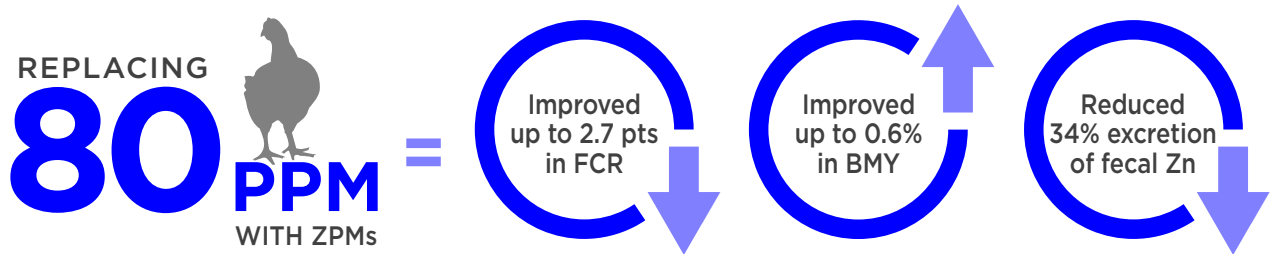


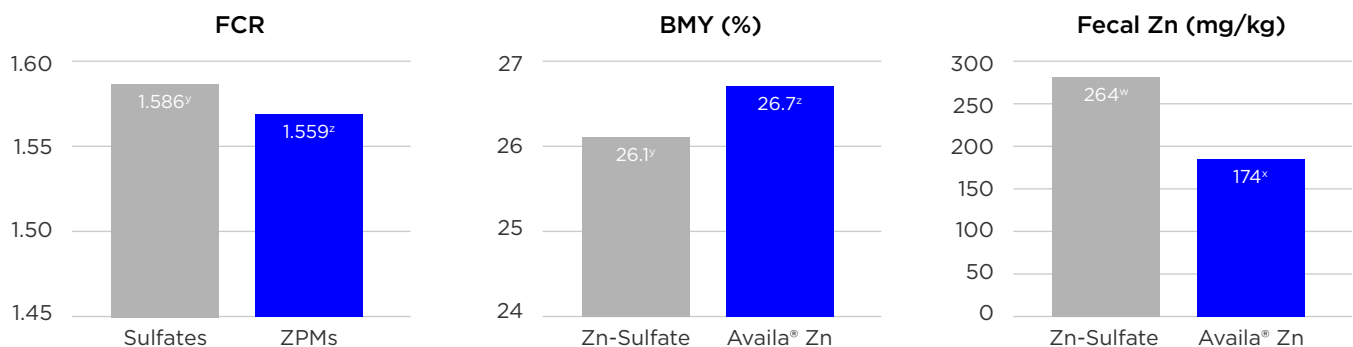


# Poultry Sustainable Solutions

Environmentally sustainable poultry production starts by reducing excess nutrients in the diet, preventing them from being wasted via excretion, while maintaining performance and health status of the flock. High trace mineral inclusion in commercial diets generates interest as a current target for more sustainable animal production. With that objective in mind, several research experiments were conducted to further understand the effects of decreasing total mineral supplementation levels in diets with complete or partial substitution of inorganic minerals with Zinpro Performance Minerals® (ZPMs).



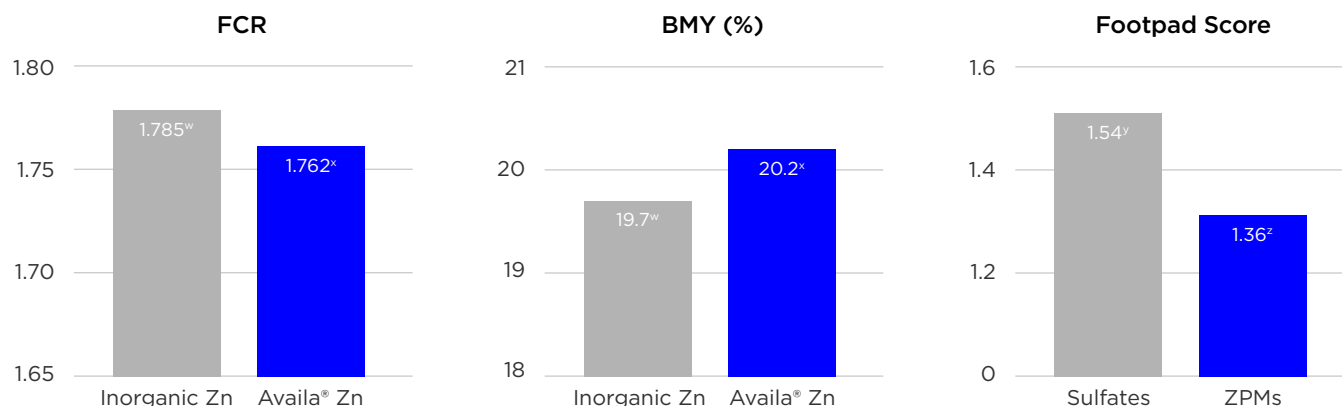
In several studies in broilers, supplementation of 80 ppm of zinc (Zn) as Zn-sulfate (ZnS) was fully replaced by 40 ppm of Zn as Availa® Zn (AvZn), decreasing total mineral supplementation by 50%. By completely replacing ZnS with AvZn in the diet, fecal excretion of Zn was reduced 34% ( $P < 0.001$ ), feed conversion ratio (FCR) was improved up to 0.5 points ( $P < 0.07$ ), carcass yield (CY) was increased by 0.9%, and there was a 0.6% improvement in breast meat yield (BMY,  $P < 0.06$ ) with a carcass hematoma score reduction of 18%. Other equally important parameters showed no differences between treatments: body weight (BW), mortality rate, pododermatitis lesion scores, hock score, tibia weight and strength, tibia ash (T-Ash) and Zn content, leg meat yield, total superoxide dismutase (T-SOD), Zn/Cu-SOD, and total antioxidant capacity (T-AOC). In another study with low levels of inorganic minerals, the supplementation of a mineral premix with 80 ppm ZnS, 80 ppm manganese sulfate (MnS), 14 ppm copper sulfate (CuS), 50 ppm iron sulfate (FeS) and 0.3 ppm sodium selenite (NaSe), was replaced with a ZPM premix with 40 ppm AvZn, 40 ppm Availa® Mn (AvMn), 7 ppm Availa® Cu (AvCu), 25 ppm Availa® Fe (AvFe) and 0.15 ppm Availa® Se (AvSe). By substituting all of the inorganic trace minerals with ZPMs, an improvement of 2.7 points in FCR ( $P < 0.06$ ) was observed. Of similar importance, other measurements showed no differences between treatments: growth performance, carcass parameters, meat drip loss, litter quality and moisture, carcass scratches and bruises, and footpad lesion scores (FPS). Put together, these studies suggest that swapping all of the inorganic trace minerals in a diet with ZPMs can maintain and improve broiler production, and lessen environmental mineral contamination.

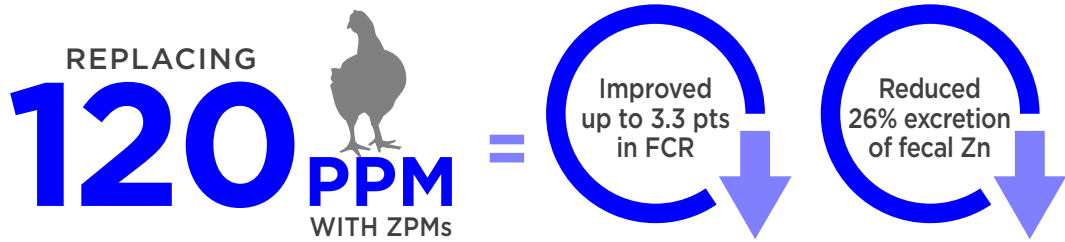




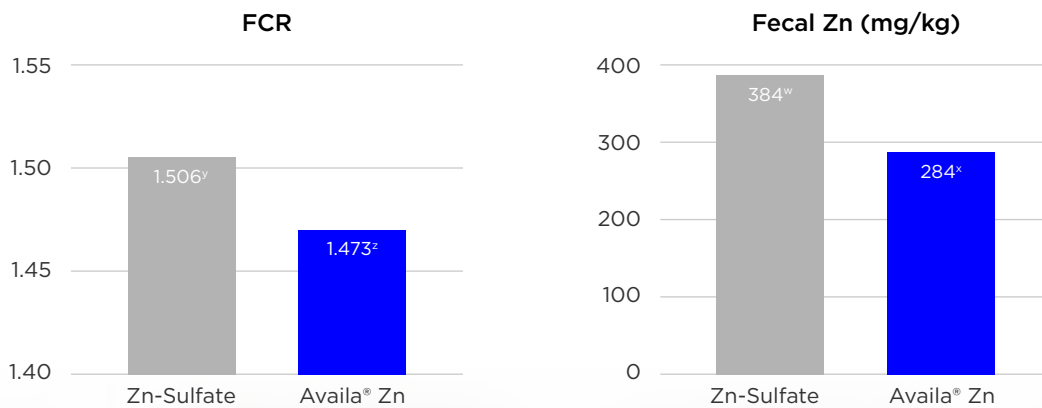
When it comes to substituting increased levels of inorganic minerals with ZPMs in poultry diets, a popular approach is partial replacement, where a decrease in total mineral supplementation is still beneficial. As a few examples, research studies were conducted with broiler diets supplemented with 100 ppm inorganic Zn or a reduced total Zn supplementation with the inclusion of 40 ppm AvZn. This dietary sustainable approach led to an improvement of 2.3 points in FCR ( $P < 0.01$ ) and 0.5% in BMY ( $P < 0.01$ ) for the diets with inclusion of 40 ppm AvZn. In another study, broilers were fed a basal diet supplemented either with 100 ppm ZnS, 100 ppm MnS, 20 ppm CuS, 60 ppm FeS, 0.3 ppm NaSe, or supplemented with 20 ppm ZnS + 40 ppm AvZn, 20 ppm MnS + 40 ppm AvMn, 3 ppm CuS + 7 ppm AvCu, 20 ppm FeS + 20 ppm AvFe, 0.1 ppm NaSe + 0.1 ppm AvSe. In this scenario, a 12% reduction in FPS ( $P < 0.06$ ) was observed in birds fed the ZPM diet. All other metrics, including performance, carcass parameters, litter quality and carcass scratches and bruises had similar results.

Coupled with the results obtained with complete substitution of inorganic minerals with ZPMs, the data suggests that an increase in ZPM supplementation offers more opportunities for less inorganic minerals fed with increased benefits, even if in a partial manner.



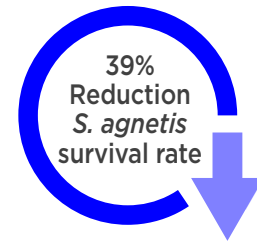
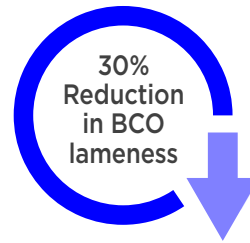


Taking this approach a step further, more studies were conducted with even higher levels of total mineral supplementation. In one study, reducing 120 ppm of ZnS to 40 ppm ZnS plus 40 ppm AvZn, improved 3.3 pts ( $P < 0.07$ ) in FCR and 1.3% in T-Ash ( $P < 0.001$ ), while reducing fecal Zn excretion to the environment by 26% ( $P < 0.001$ ). In another study, with both treatment diets supplemented with 40 ppm AvZn, the reduction of 100 ppm Zn as Zn hydroxychloride in the control treatment, to 40 ppm Zn in the test treatment, resulted in no differences in growth performance and carcass measurements. In a similar study, reducing Cu supplementation from 125 ppm as Cu hydroxychloride to 14 ppm as AvCu, led to no differences in performance and carcass parameters as well. All these studies consistently showed that decreasing inorganic mineral levels in broiler diets when supplementing ZPMs, promotes less environmental mineral shedding while consistently maintaining and/or improving poultry production.

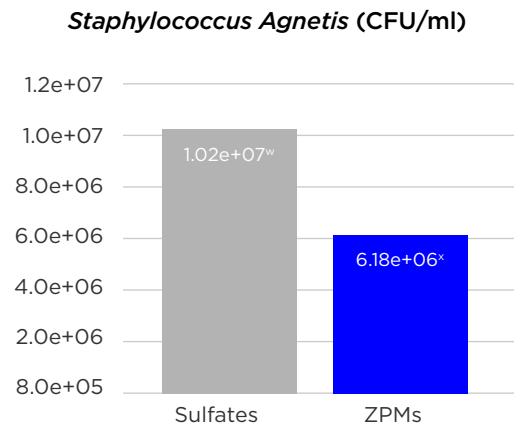
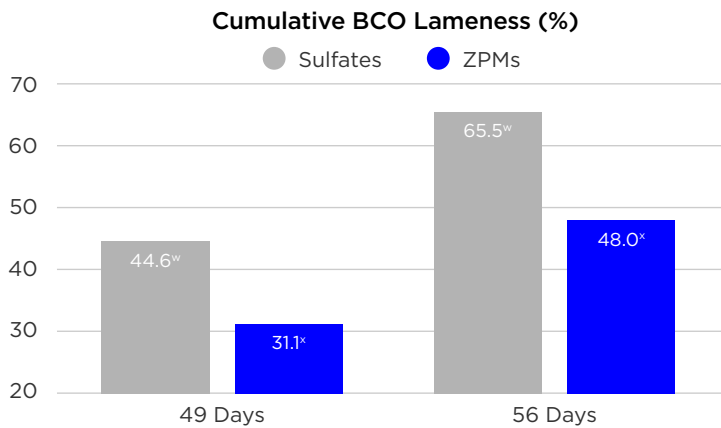


# +Health

(BACTERIAL CHALLENGES)



A sustainable approach in poultry farming, such as reducing the total mineral supplementation level, must be one that works in all kinds of scenarios. In the face of an enteric challenge, replacing inorganic trace minerals with lower levels of organic minerals was able to maintain and/or improve animal's health and welfare in all the following studies. In a *Clostridium perfringens* challenge study, the complete replacement of 80 ppm ZnS with 40 ppm AvZn yielded no differences in intestinal permeability, transepithelial electrical resistance, endotoxin concentration, digestive enzymatic activity, as well as histomorphological parameters such as villi height, crypt depth and its ratio. There were also no differences in tight junction protein expression such as claudin, occludin and mucin-2, which are crucial components of gut epithelial permeability and integrity. In two other consecutive studies, broilers challenged with *Staphylococcus agnetis* (*S. agnetis*), were provided one of two diets: a basal diet supplemented with either 100 ppm ZnS, 100 ppm MnS, 20.5 ppm CuS, or a diet supplemented with 40 ppm ZnS + 40 ppm AvZn, 40 ppm MnS + 40 ppm AvMn, 10 ppm CuS + 7 ppm AvCu. In both studies, there were no differences in performance between treatments however, Bacterial Chondronecrosis with Osteomyelitis (BCO) lameness incidence was reduced receiving the treatment diet by 30% ( $P < 0.05$ ) and 27% ( $P < 0.05$ ) at 49 and 56 days respectively. Furthermore, birds fed ZPMs had an up to 5% reduction in femoral head necrosis and 6% reduction in tibial head necrosis compared to the sulfate group. An improvement of 18% in jejunum and ileum villi height, a higher jejunum occludin protein expression ( $P < 0.05$ ), and a 39% reduced *S. agnetis* survival rate to macrophage activity ( $P < 0.03$ ) was registered in birds supplemented with ZPMs.



## MORE BENEFITS WITH LESS PRODUCT

In the research studies described herein, the consistency in the overall results obtained show that ZPMs are able to provide a reduction in trace mineral supplementation, through substitution of inorganic minerals in the diets, while maintaining or improving growth performance and the health status of the birds. This mineral strategy is proof of how Zinpro contributes to a healthier and more sustainable world, not only from the environmental standpoint, but also by making agriculture more profitable, maintaining food supply, providing healthier and safer food, and supporting agricultural activities.



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