



Optimizing Animal Development with Early Nutrition Report

Introduction

It is well known that the conditions experienced early in life can influence the long-term health of an animal, modulating their development, physiology, behavior, resilience and vulnerability to disease. Critical developmental windows start in gestation and lactation and progress through to early post-natal life. Strategic nutritional solutions at these key stages can positively impact the developmental trajectory of the animals and their lifetime health and performance.

This report outlines key nutritional challenges related to early life nutrition across livestock, poultry and aqua species, and highlights innovative solutions and services that can support young production animals to achieve their full genetic potential.



CHALLENGE 1:

Gestation and Lactation

A developing fetus responds to stimuli or changes in the maternal environment, conveyed either via the placenta in mammals, or directly to the egg in birds. This in turn, can alter the genetic expression of the offspring with possible long-term effects on their health and development. Influences that have the potential to program the fetus – positively or negatively – include nutrition, medication and vaccines, pathogens, toxins and stress.

Upon birth, the main source of nutrition for young swine and ruminants normally comes from the mother's milk, which contains vital nutrients and passive immune factors for their offspring. Both gestation and lactation are energetically expensive processes, meaning the health and nutritional status of the maternal environment is critical.

SOLUTION SPOTLIGHT:**CitriStim, ADM's Proprietary Inactivated Yeast Product**

CitriStim is a truly unique whole-cell inactivated yeast (*Pichia guilliermondii*) product beneficial in the diet for all life stages and classes of animals. CitriStim helps the animal strengthen its defense against various challenges by optimizing gut function, gut integrity and systemic protective responses to sustain animal productivity.

CitriStim supplementation during sow gestation and lactation has been demonstrated to have a beneficial impact on piglet improved resilience, health, and growth to market weight¹⁻⁷.

**SOLUTION SPOTLIGHT:****B-Traxim Organic Trace Minerals**

Minerals such as phosphorus, zinc, copper, manganese and selenium support diverse aspects of maternal health, including fertility, fetal development and lactation. Supplementation with inorganic mineral sources can be inefficient due to mineral antagonisms, competition for absorption and interaction with feed components. Organically bound mineral sources can bypass many of these challenges and improve bioavailability.

ADM has developed B-Traxim 2C, a unique range of organic trace minerals bound to glycine or glycinates, designed to deliver highly bioavailable and homogenous nutrients for optimal animal performance across species.





CHALLENGE 2:

Gastrointestinal (GI) Tract Maturation

The gastrointestinal (GI) tract is the main interface for all nutritional strategies. When functioning optimally, one of the key roles of the gut is to digest food particles and absorb the resulting nutrients. The energetic resources are then allocated to healthy development and robust physiological functioning. Current farming conditions, however, can introduce various GI stressors that may lead to digestive disturbances.

This is especially true for young animals whose guts are not fully mature before weaning. The transition from milk to solid foods, such as grain- and oilseeds-based diets, can present a challenge to the immature digestive system. Alongside other stress factors associated with weaning, such as separation from their mothers and littermates to new social and environmental conditions, a reduction in feed intake may ensue. Reduced nutrients at this critical development window can negatively impact the morphology and function of the intestines, disrupt digestion and absorption, and affect diarrhea, robustness and productivity, with potential implications on long-term impact performance.



SOLUTION SPOTLIGHT:

Nursy Program for Heifers

At birth, calves are monogastric. Their bodies must undergo a series of metabolic changes to transition into a ruminant digestive system, capable of extracting nutrients from fibrous plant materials through fermentation processes in the rumen. During GI development and maturation, fiber content in the diet must be increased gradually to ensure proper digestibility.

Early life intervention with the ideal feed enhances gut development and supports long-term benefits. Producers can encourage intake of solid feeds while calves are still on liquid diets (milk or milk replacers) by providing continuous access to both starter feed and water whilst avoiding traditional forage. This stimulates rumen development and accelerates the weaning period. Early growth is also an important factor in advancing the cow reproductive potential.

ADM's Nursy program optimizes heifer growth by fulfilling their nutritional requirements, fostering early rumen development and supporting gut resilience. Highly palatable milk replacers and starter feeds are designed to work in concert to help achieve the goal of healthy heifers that become productive cows. ADM also offers a holistic Nursy nutritional program to support piglets through weaning, including creep feed, peri-weaning diets and pre-starter diets.



SOLUTION SPOTLIGHT:

TakTik X-IN for Piglets

The challenges associated with weaning piglets are multifaceted, as nutrient intake is decreased, gut development is impaired and nutrient absorption becomes inefficient. As a result, there is a lack of nutrients to support the delicate, immature immune system, and weaning piglets are more susceptible to health challenges, which further impairs the absorption of nutrients from the gut.

TakTik X-IN is a solution containing two distinct and complementary components to support gut function and enhance performance of piglets. The first component is made of the sweet taste enhancer, Sucram, which improves feed intake, increases glucose absorption by the gut, and supports GLP-2 secretion, which is key in the process of gut maturation and development, including the production of glucose transporters to increase intestinal glucose uptake⁸⁻¹¹. The second part consists of the bioactive phytonutrient anethole, which has the potential to improve immune function and intestinal health, as in some experiments it has been shown to mitigate inflammation and enhance the protection of the gut epithelium¹²⁻¹⁴. Improving gut maturation and functionality in piglets can boost intake, weight gain and feed efficiency, ultimately supporting profitability of the animals.



CHALLENGE 3:

Immune Function

Pathogens are an inevitable component of the farm ecosystem and from birth, animals are rapidly exposed to large numbers of them. Central to an animal's defense is the immune system. Comprised of a complex network of cells, tissues, organs and the substances they produce, efficient immune responses can greatly limit potential invaders. Although animals are born with certain innate defenses, the immune system continues to develop over time, adapting to diverse antigenic exposure. This means young animals with relatively immature immune systems are more vulnerable to pathogenic challenges.

To protect neonates during the maturation of their immune systems, maternal antibodies are transferred through the placenta and colostrum in milk. While this does not translate into immunological memory, it can ward off pathogenic threats in young animals until their own immune systems are stronger. This provides a nutritional opportunity to support the resilience and survivability of young animals from birth.

A number of feed additive solutions are designed to support the immune function of young animals, applied either indirectly to the mother, or directly to the offspring. These solutions can mitigate reliance on antibiotic growth promoters (AGP) and minimize risk of antimicrobial resistance (AMR) worldwide.



SOLUTION SPOTLIGHT:

XTRACT, A Plant Extract-Based Feed Additive

ADM's XTRACT line is a combination of microencapsulated active substances found in aromatic plants and spices with demonstrated physiological effects on livestock. Specific formulations, such as XTRACT 6930 and XTRACT Nature, support animals through critical phases, aiding immune function and reducing gut inflammation while improving feed digestibility and nutrient uptake.

Thorough performance analyses of XTRACT 6930 indicate its efficacy in increasing broiler weight, carcass yield and breast weight¹⁵, as well as improved feed conversion ratio (FCR)¹⁶. Enhanced efficiencies in raw material use, FCR and zootechnical performance can help farmers produce more with less, which also contributes to sustainability targets.

SOLUTION SPOTLIGHT:

B-Traxim Organic Trace Minerals

Trace minerals, such as zinc and copper, have been linked to antimicrobial resistance and soil pollution, which are a growing global concern. Recent practice has been to reduce the permissible levels of zinc and copper in feed and stop the use of above-nutritional supplementation, such as the high levels of zinc oxide to control pathogens in pig production, or copper sulfate supplementation for growth promotion. To fulfill nutritional requirements for the animals while reducing supplementation levels and the excretion of trace minerals, organic trace minerals can be used due to their high bioavailability compared to inorganic trace mineral sources. Trace minerals are essential nutrients supporting a variety of metabolic processes, impacting growth performance, reproductive performance and immunity. Not meeting the requirements of these essential nutrients can impact both animal welfare and final product quality.

Organic trace minerals, like ADM's B-Traxim 2C range of glycinate, have shown to help support immunity across species, both by controlling inflammation and supporting specific immune response, as observed in ruminants¹⁷⁻¹⁸ and in shrimp during a trial performed with the Kasetsart University in Thailand. An effective immune response is needed in case of disease but also required to support animal health, welfare and efficient production throughout the full production cycle when facing continuous challenges. Supporting the youngest animals in their development through early nutrition is an efficient way to have a positive impact on all following production phases.



CHALLENGE 4:

Weaning & Palatability

Continual intake of high-quality nutrition is paramount to avoiding the post-weaning production gap. Appetites in weaning animals are often suppressed and need to be stimulated to ensure adequate feed intake for development and growth. Young animals typically prefer sweet tastes, so high-intensity sweeteners provide an effective incentive when switching from liquid diets to solid feed.

Research has identified species-specific differences in palatability, where calves generally show preferences for vanilla-based flavors and piglets favor red berry flavors. To minimize the time to first feeding, producers can motivate their animals by improving ration appeal with customized palatants and sweeteners.



SOLUTION SPOTLIGHT:

Sucram Sweeteners for Piglets

Standard industry practice has traditionally relied on human taste perception to inform animal sweetener formulations. ADM researchers, in collaboration with scientists at the University of Liverpool, are expanding industry knowledge of the function of sweet taste receptors in livestock species. This knowledge informs ADM's Sucram product line, an in-feed sweetening solution designed specifically for swine.

The team developed an *in vitro* heterologous system of swine sweet taste receptors to generate a database of sweet ingredients for swine. This enabled the creation of sweeteners dedicated entirely to pigs, with specific applications for piglets at weaning. Among the many compounds and combinations screened *in vitro*, two stood-out in attaining high levels of synergistic activation of the swine sweet taste receptors. These ingredients served as Sucram's "pig sweet nucleus" that provides the basis for two new saccharin-free products: Sucram Specifeek and Sucram M'I Sweet.

Sucram not only activates the sweet taste receptors T1R2 and T1R3 present on the tongue, thus triggering a sweet taste, but also activates the same receptors on the surface of gut enteroendocrine cells triggering the release of the glucose-like peptide-2 (GLP-2) hormone¹⁹⁻²⁰. This in turn leads to increased absorption of glucose from the intestinal lumen and the hormone is also notably involved in tissue reparation, increasing blood flow to the gut, fostering gut maturation and integrity and the improved digestion and absorption of nutrients.



CHALLENGE 5:

Environmental Conditions

The first days and weeks of an animal's life are marked by heightened sensitivity to fluctuations in their environment, such as temperature, housing conditions and access to clean water. Some species are more at risk when separated from their mother or relocated to a new facility, such as with aquaculture. Nursery-stage stressors that are more pronounced with aquatic species include transportation, transfers, handlings, vaccination, mixing of populations, varying water conditions and temperatures.

Certain environmental challenges can impact all animals, irrespective of age. Heat related stressors constitutes one such challenge, which may become increasingly prevalent with climate change. High ambient temperatures can impact an animal's ability to maintain energetic, thermal, hormonal and mineral balance. In turn, temperatures above the thermal neutral zone can be detrimental to lactation, growth and reproduction across all agriculturally important livestock species as well as aquaculture.

SOLUTION SPOTLIGHT:**AquaTrax & BernAqua Feed**

By focusing on the starter phase nutrition for fish and shrimp, farmers can positively impact their physiology and immunology in subsequent life stages to facilitate their genetic productivity potential. ADM's global brand, BernAqua, provides complete feed for fish and shrimp species in early life stages, from larvae to nursery. The NURSea range has been designed for juvenile marine fish and WEAN Prime is a targeted solution for juvenile shrimp and freshwater fish. BernAqua sources highly digestible raw materials and leverages cold microextrusion processing technology to ensure better feed behavior and stability in water, particle quality and a range of feed sizes adapted to very small animals and intensive farm conditions.

Equipped with only non-specific immune defenses, shrimp have an adaptive immune system and continually face the environmental and health stressors of commercial aquaculture production. ADM's AquaTrax is a unique *Pichia guilliermondii inactivated* yeast-based specialty feed ingredient that can assist in managing periods of high heat through a modulating effect on gut microbiota and immune function. AquaTrax has shown significant effects in the presence of different pathogens, including *Vibrio harveyi*, AHPND-*Vibrio parahaemolyticus* and White Spot Syndrome Virus (WSSV), thus supporting the shrimp's natural response to pathogen challenges and improvements in survival²¹. In addition, shrimp receiving AquaTrax dietary supplementation in typical, nonspecific challenged field conditions have shown growth improvements²¹.



SOLUTION SPOTLIGHT:**FreshUp for Animals Under High Heat Conditions**

FreshUp is a tailored nutrition formulation to help limit the negative impact of high heat conditions on poultry, swine and ruminants. ADM's customized formulation services create synergistic effects of natural and targeted ingredients that are supplemented in the feed meet the animal's daily nutritional needs and help manage heat-related challenges. A blend of plant extracts, organic trace minerals and sweeteners help improve palatability, ease heat dissipation through vasodilation, and minimize effects of gut inflammation and the disruption of intestinal integrity.

**Conclusion**

Health and nutrition are inextricably interlinked. Investment in quality feed during this short but critical period should be carefully considered by producers where supporting early life nutrition is central to achieving optimal animal performance, economic returns and sustainable production outcomes.

ADM is continuously striving to advance its science-based solutions that support three key pillars in animal nutrition, including i) global food security via increased protein production efficiency, ii) health through nutrition, and iii) sustainability through reduced environmental impact. With a diverse global network of cross-functional collaborations, ADM continues to the very best of science and technology to deliver innovative solutions and services that fulfil customers' evolving needs.

References

- ¹ Bass B, Perez V, Yang H, et al. Impact of a whole cell yeast product on sow and litter performance. *Journal of Animal Science* 2012;90:49.
- ² Bass BE, Tsai T-C, Yang H, et al. Influence of a whole yeast product (*Pichia guilliermondii*) fed throughout gestation and lactation on performance and immune parameters of the sow and litter. *Journal of Animal Science* 2019;97:1671-1678.
- ³ Thayer MT, Garcia RM, Duttlinger AW, et al. Feeding a whole-cell inactivated *Pichia guilliermondii* yeast to gestating and lactating sows in a commercial production system. *Journal of Animal Science* 2020;98:99-100.
- ⁴ Thayer MT, Asmus MD, Gourley G, et al. Feeding a whole-cell inactivated *Pichia guilliermondii* yeast to gestating and lactating sows over two consecutive parities. *Journal of Animal Science* 2020;98:97-97.
- ⁵ Thayer M, Jones DB, Asmus MD, et al. Effects of Feeding a Whole-Cell Inactivated *Pichia guilliermondii* Yeast in Sow and/or Pig Diets on Progeny Nursery and Grow-Finish Growth Performance and Carcass Characteristics. *Journal of Animal Science* 2022;100.
- ⁶ Janvier E, Oguey C, Samson A. Dietary supplementation with *Pichia guilliermondii* yeast product during gestation and lactation improves sows' body condition and litter performance. 15th International Symposium on Digestive Physiology of Pigs. Rotterdam, The Netherlands: Animal - Science Proceedings, 2022;209.
- ⁷ Oguey C, Thayer M, Jones DB, et al. Meta-analysis of the effects of inactivated *Pichia guilliermondii* yeast fed to sows on progeny performance before and after weaning. 15th International Symposium on Digestive Physiology of Pigs 2022;210.
- ⁸ Douglas G. Burrin, Barbara Stoll, Xinfu Guan, Liwei Cui, Xiaoyan Chang, Jens J. Holst, Glucagon-Like Peptide 2 Dose-Dependently Activates Intestinal Cell Survival and Proliferation in Neonatal Piglets, *Endocrinology*, Volume 146, Issue 1, 1 January 2005, Pages 22–32, <https://doi.org/10.1210/en.2004-1119>
- ⁹ Juncai Chen, Yan Lei, Yang Zhang, Shiqian He, Lingbin Liu, Xianwen Dong. Beyond sweetness: The high-intensity sweeteners and farm animals. 2020. *Animal Feed Science and Technology*. Volume 267:114571, <https://doi.org/10.1016/j.anifeedsci.2020.114571>.
- ¹⁰ Moran AW, M. Al-Rammahi, C. Zhang, D. Bravo, S. Calsamiglia, S.P. Shirazi-Beechey. Sweet taste receptor expression in ruminant intestine and its activation by artificial sweeteners to regulate glucose absorption. 2014. *Journal of Dairy Science* 97, Issue 8: 4955-4972. <https://doi.org/10.3168/jds.2014-8004>.
- ¹¹ Moran AW, Al-Rammahi MA, Arora DK, et al. Expression of Na⁺/glucose co-transporter 1 (SGLT1) is enhanced by supplementation of the diet of weaning piglets with artificial sweeteners. *British Journal of Nutrition*. 2010;104(5):637-646. doi:10.1017/S0007114510000917
- ¹² Duk Kyung Kim, Hyun S. Lillehoj, Sung Hyen Lee, Seung Ik Jang, Myeong Seon Park, Wongi Min, Erik P. Lillehoj, David Bravo. Immune effects of dietary anethole on *Eimeria acervulina* infection. 2013. *Poultry Science*, Volume 92, Issue 10: 2625-2634, <https://doi.org/10.3382/ps.2013-03092>.
- ¹³ Rosemayre S. Freire, Selene M. Morais, Francisco Eduardo A. Catunda-Junior, Diana C.S.N. Pinheiro. Synthesis and antioxidant, anti-inflammatory and gastroprotector activities of anethole and related compounds. 2005. *Bioorganic & Medicinal Chemistry*, Volume 13, Issue 13: 4353-4358, <https://doi.org/10.1016/j.bmc.2005.03.058>.
- ¹⁴ Wlodarska, M., Willing, B., Bravo, D. et al. Phytonutrient diet supplementation promotes beneficial *Clostridia* species and intestinal mucus secretion resulting in protection against enteric infection. *Sci Rep* 5, 9253 (2015). <https://doi.org/10.1038/srep09253>
- ¹⁵ Oguey C, Poultry Science Meeting 2017
- ¹⁶ Bravo, D., & Ionesco, C. (2008, November). Meta analysis of the effect of a mixture of carvacrol, cinnamaldehyde and capsicum oleoresin in broilers. In *Book of Abstracts for the 10th World Conference on Animal Production* (pp. 150-150). Wageningen Academic.
- ¹⁷ Wall E H, Tran K, Wallinger C, Hogan2 J S and Weiss W P. Mineral-glycinate supplementation improves the systemic immune response to lipopolysaccharide challenge in lactating dairy cows. *Joint Annual Meeting*, 2016.
- ¹⁸ Fry R S, Spears J W, Schlegel P and Durosoy S. Effects of dietary zinc source and level on immune responses and health of cattle. 8. *BOKU-Symposium Tierernahrung* 2009.
- ¹⁹ Shirazi-Beechey SP, Daly K, Al-Rammahi M, Moran AW and D. Bravo, 2014. Role of nutrient-sensing taste 1 receptor (T1R) family members in gastrointestinal chemosensing. *British Journal of Nutrition*. 111 Suppl 1:S8-15.
- ²⁰ Furness, J.B. et al., 2013. The gut as a sensory organ. *Nature Reviews. Gastroenterol. Hepatol*. 10(12):729
- ²¹ ADM (2021) AquaTrax, whole-cell inactivated yeast *P. guilliermondii*, unpublished company research



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