DRIVING PROFITS THROUGH PIGLET QUALITY

SWINE

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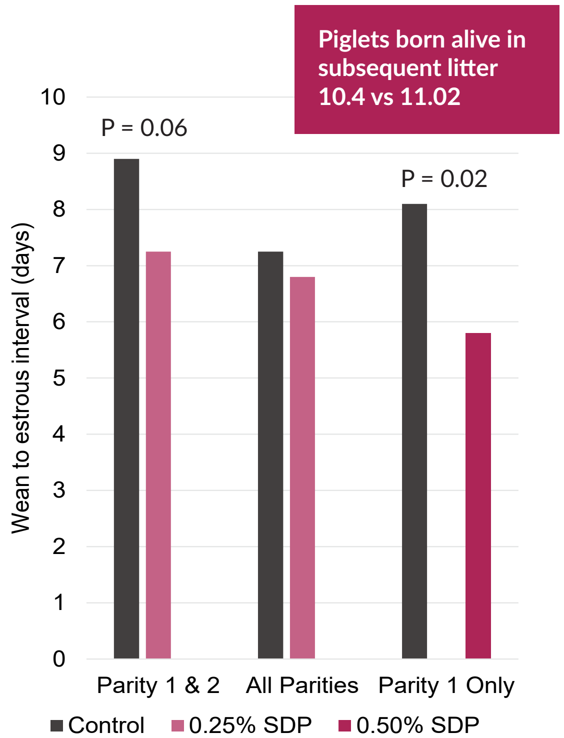
Generally, profitability parameters of swine operations are determined by value generated by kilogram of pork produced per sow lifetime minus the production cost per kilogram of pork. Nutritional aspects to boost sow productivity and the carryover effects on colostrum quality, piglet quality, and weaner quality will be focused in this article.

Throughout the breeding cycle of sows, there are many challenges including physiological challenges, oxidative stress, inflammation, and microflora disruption. After weaning, the sows go through mammary involution which often involves inflammation. After mating, sow diet composition changes, coupled with feed restriction, which leads to microflora disruption. After 70 days of gestation, there is an exponential growth of litter and mammary cells which causes an oxidative stress and could take up to 3 weeks for the sows to recover. Studies show antioxidants e.g. Selenium and Vitamin E supplementation could help to alleviate the negative impact of oxidative stress. After farrowing and during lactation, major metabolic stresses include rapid uterine involution, mammary tissue growth, and high milk output. More importantly, the quality and quantity of follicles for the next cycle is determined early in lactation period. Some nutritional tools can enable the sows to overcome these challenges.

A study by Cao et. al. (2019) showed 500 gm of Total Dietary Fibre (TDF) per day during gilt development promote oocyte development and increase total number of follicles, which could be explained by more Short Chained Fatty Acid (SCFA) produced via hind gut fermentation, which influences the maturation and/or termination of follicles. This dietary fibre recommendation is in line with Danbred genetics for sows in general. Reported by Crenshaw et. al. (2017), use of 0.25% Spray-Dried Porcine Plasma (SDPP) especially in younger sows (parity 1-2) reduced body weight loss by 3 kgs during lactation period. With 0.5% SDPP, especially for sow parity 1, wean-to-estrus interval was significantly reduced by 2 days. Moreover, piglets born alive in the subsequent litter were 0.8 piglet more compared to a control group. Sow retention in parity 2 increased from 80 to 87% with 0.5% SDPP supplemented in the diet. Another study by Crenshaw et. al. (2020) demonstrated long term reproductive benefits in both total born and born alive numbers, which increased in the subsequent litter when sows were fed 0.5 - 2.5% SDPP from 6 days before and 5 days after farrowing in the first farrowing only. Plasma protein has been widely accepted and successfully used in nursery feed for the past 40 years.



Summary from various recent studies demonstrated that 0.5% SDPP supplementation resulted in +0.33 to +0.48 pigs weaned per litter, -0.44 stillborn pigs per litter, and +0.5 pigs born alive in the subsequent litter.

REFERENCE	PLASMA EFFECT ON PROGENY
Campbell et al., 2006	+0.40 Pigs Born Alive and Weaned Per Sow Served
Crenshaw et al., 2007	+0.40 Full Value Pigs Weaned Litter
Crenshaw et al., 2010	+0.33 Full Value Pigs Weaned Per Litter
Van Iersel et al., 2011	+0.48 Pigs Weaned Per Litter
Crenshaw et al., 2021	-0.44 Stillborn Pigs Per Litter
Crenshaw et al., 2021	+0.50 Pigs Born Alive in Subsequent Litter

Various nutritional tools were proposed during transition phase in order to drive profits. Three main areas are minimizing stillbirth rate, maximizing birth weight, minimizing weight variation, and providing best quality colostrum for the piglets. Adequate fibre supplement for 2 weeks before farrowing significantly reduced number of stillborn piglet (-2.2% of total born) and overall mortality (-2.4% of total born) in a Danish study by Feyera et. al. (2017). Similarly, Loisel et. al. (2014) presented that piglets from sows fed a high fibre diet were born quicker, had shorter birth to sucking interval, resulting in higher colostrum intake and better vitality, especially for piglets with low birth weight. Compared to Control group, piglet mortality (24 hrs - 21 days old) was significantly reduced by half in high fibre diet group (14.7% vs. 6.2%, respectively). Due to a strong linear correlation between immunoglobulins G (IgG) concentration in sow colostrum at parturition and in piglet serum at 48-72 hours after birth, it is important that sows provide adequate colostrum with good quality (> 4,700 mg IgG/dl), as piglets with lower than 1,500 mg IgG/dl intake are at greater risk of pre-weaning mortality.

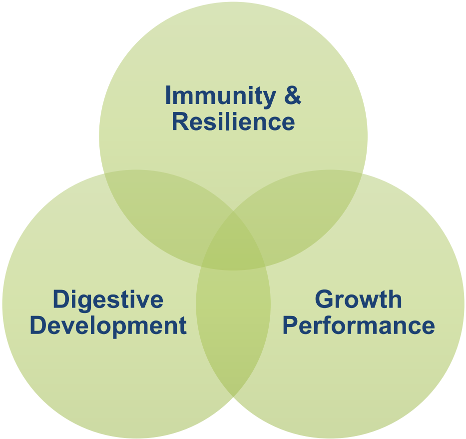
Several nutritional interventions to improve colostrum quality have been well-studied. Some examples are Medium Chain Fatty Acid (MCFA), live yeast, butyrate, yeast fraction, Conjugated Linoleic Acid (CLA), vitamin E, and arginine. Most of which have immuno-modulatory or immuno-stimulatory effects in boosting colostrum IgG which can be delivered via the sow to her piglets. Arginine supplementation at 1% significantly increased sow colostrum IgG concentration, piglet blood oxygen saturation, and pigletaverage birth weight. Arginine acts as vasodilator which allows more evenly distribution of nutrients throughout the placenta, so piglet vitality is subsequently improved (Nuntapaitoon et. al., 2018).

Vitamin E at 150 IU supplemented during lactation enhanced colostrum fat, IgG, and IgA (Wang et. al., 2017). Higher colostrum intake at 150 g within 24 hours resulted in higher weaning weight by 2 kgs at 3-4 weeks of age (Hasan et. al., 2019). Manipulation in fatty acid profile also increased colostrum fat and IgG and piglet average daily gain (ADG) and weaning weight at 21 days of age (Tian et. al., 2017). Higher sow colostrum IgG was observed when sows were fed a higher dose of CLA, resulting in higher piglet serum IgG at weaning and post weaning ADG was improved (Carino et. al., 2009).

A recent study by Crenshaw et. al. (2021) showed a significant improvement in pre- and post-partum serum oxidative status in sows fed diets with 0.5% or 2.5% SDPP for 6 days before and 5 days after farrowing. The level of Glutathione Peroxidase (GPx) was elevated with SDPP supplementation, which means sows were able to respond well against oxidative stress and able to partition more nutrients and immunity to the piglets. When 1% SDPP was fed to the sows from 3 weeks before farrowing and throughout lactation, sows had significantly lower body weight loss, piglets had higher body weight at weaning and at the end of nursery (Kim et al., 2021).

Inflammatory marker (TNF-alpha) in blood from both sows and piglets was significantly lower on day 3 and day 7 of lactation. Stress marker (Cortisol) in piglets was significantly lower on day 3 post-weaning which means SDPP in sow feed offers immune modulatory benefits to both sows and progeny during lactation, along with a carryover effect on pig growth in post weaning period (Kim et. al., 2021).

Nursery Nutrition Opportunities to Drive Profit



During the nursery period, to achieve full potential of piglet growth performance, it is important to focus on providing passive immunity for the piglets and supporting the development of an immature digestive system, especially during 4-7 weeks of age. A recent review paper by Bonetti et. al. (2021) identified 3 major modes of action (Immune modulation, Nutrient utilization, and Pathogen control) for each candidate of ZnO feeding alternatives.

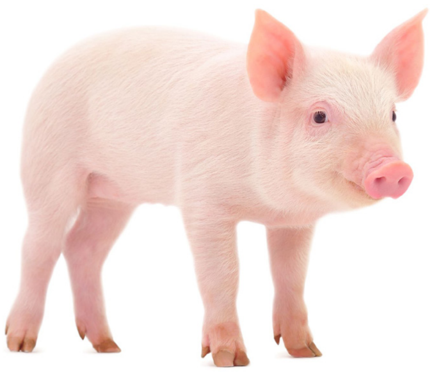
Spray-Dried Plasma (SDP) is one of the ideal candidates as SDP offers all 3 modes of action, especially in providing passive immunity for the piglets. SDP stimulates feed intake and helps to reduce intestinal inflammation which is commonly caused by a drop in feed intake associated with weaning stress. When left uncorrected, inflammation leads to an increase in oxidative stress and production of Nitric Oxide (NO) which is converted to nitrate (NO3) in the intestinal lumen. Increased level of nitrate acts as food source for pathogens e.g. enterotoxigenic Escherichia coli (ETEC) and salmonella, causing an overgrowth of pathogen and a suppression of beneficial bacteria e.g. bifido or lactobacillus, which further worsens the intestine inflammation cycle.

Other ZnO alternatives discussed in this review paper are: Antioxidants (Vitamin C, Vitamin E, and polyphenols) to elevate oxidative stress; Eubiotics with antimicrobial benefits to manipulate microbial load and to balance micro-biome; Prebiotics and Probiotics to support growth of beneficial bacteria; Glutamine as a fuel for fast recovery of damaged intestinal epithelial cells. Other management approaches recommended are creep feeding, delayed weaning age, and foetal imprinting (using the same feed additives in lactating sow diet, which piglets can familiarize with taste and smell. Piglet feed intake is stimulated especially during the transition period).

Evolution of stomach pH: The logic behind the challenge

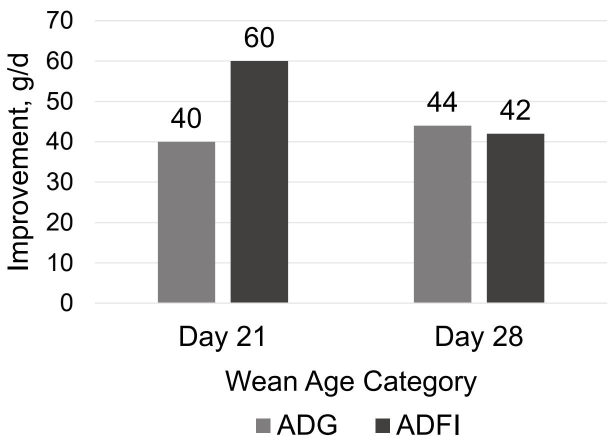
At birth the piglet stomach pH is at 5-6 due to the strong acid buffering capacity of colostrum. This higher pH range is naturally required to allow a broad spectrum of microbes to colonize in the gut and also to allow passive immunity from colostrum to be utilized. From 2 days of age to weaning (3 to 4 weeks duration), stomach pH drops to 4, which is the pH needed for the activation of chymosin which is responsible for clotting and digesting the milk. However, at pH 4, hydrochloric acid (HCl) secretion cells are not developed which prevents a further reduction of pH. By providing creep feed, stomach development is stimulated, and acid and pepsin secretion becomes more active. Right after weaning (4-6 weeks duration), stomach pH is unstable and ranges from 3-5 vs. the ideal pH 2.5. Factors influencing higher pH are lactose withdrawal, change of diet to cereal-based with acid binding capacity, early weaning age, variable and inconsistent feed intake, and poor appetite. Organic acids can be supplied through feed and/or water to reduce stomach pH to 2.5, where pepsinogen efficacy is high (highest at pH 2 and less at pH 4).

In mature pigs with a fully functional digestive system, the pigs are capable of secreting adequate digestive acid to maintain stomach pH between 2 to 3.5. Cranwell in 1985 evaluated the effect of creep feeding on the development of HCl secreting cells and showed a 12% increase in stomach capacity at the end of suckling period. Larger stomach capacity indicated higher appetite and more exposure of the feed to digestive enzymes. Acid (HCl) output increased by 58% and pepsin output by 164% in piglets fed with milk+creep feed, compared to only milk. This data suggested that more SBM and other protein ingredients in the diet can be digested and therefore lower the risk of diarrhea from undigested protein reaching the hind gut.



Another management strategy is intermittent suckling (mother sows were removed for a period to stimulate intake of the piglets) and co-mingling with other familiar piglets. Turpin et. al. (2017) showed a significant increase in average daily feed intake (ADFI) during the last 7 days before weaning in the piglet group subjected to intermittent suckling and co-mingling. Similarly, ADFI, average daily gain (ADG), and feed conversion ratio (FCR) were significantly improved during day 2 to day 8 after weaning in the intermittent suckling and co-mingling treatment group. It is important to note that the co-mingling should be among familiar pigs, instead of non-familiar pigs which could lead to more stress and disease exposure. A meta-analysis (Balan, 2020) of growth performance response of nursery pigs to plasma protein showed 40 and 44 g/d ADG improvement, 60 and 42 g/d ADFI improvement in pigs weaned at 21 or 28 days of age, respectively.

Meta-analysis of growth performance improvements in nursery pigs in the first 14 days post weaning



In newly weaned pigs SDPP was offered at 3% in feed during day 0-13 and 2% day 14-26. SDPP fed piglets had better growth performance (+0.5 kg BW at day 42), lower medication cost (-0.20 US$), higher ileal tight junction protein expression, and greater ileal villus height, both with and without antibiotics (Ruckman et. al., 2020).

	CONTROL	SDPP
Body weight D0	4.93	4.93
Body weight D13	6.17	6.35
Body weight D26	9.60	10.05
Body weight D42	15.69	16.23
Medical treatment	0.979	0.735

Zhang et. al. (2016) fed a diet with 5% SDPP for 28 days and intestinal permeability and inflammatory markers were significantly reduced in SDPP fed piglets. These data indicated that SDPP promoted healthier villi with stronger barrier integrity.

In conclusion, to optimize sow and piglet productivity and efficacy, nutritional tools should be used along with management, genetic, and health aspects. Investing early in sow nutrition ensures piglet quality and growth performance are maximized. **Plasma protein is a functional feed ingredient which can be used to complement and boost the nutritional strategy for sows and piglets.** Meta-analysis and recent studies showed that plasma protein reduced the negative impacts from oxidative stress and inflammation. Plasma protein also enhances gut health and functionality. Overcoming these metabolic and immunological stresses is the key driver that determines piglet production efficiency and overall profitability.

References upon request