Fire Extinguisher™ S

Heat Stress Solution Technology for Swine

Fire Extinguisher S is an innovative product developed by ADM researchers after five years of extensive swine research. Fire Extinguisher S is specifically designed to help ameliorate the negative effects of heat stress, based on ADM researchers' understanding of the underlying physiology of heat stress. Specific ingredients have been scientifically selected to address different aspects of physiological changes associated with heat stress. As a result, Fire Extinguisher S may help enhance blood flow and heat dissipation, overcome osmotic challenge, and support gut health and integrity while supporting the immune system and increasing nutrient intake. When used in conjunction with appropriate feeding and management practices, Fire Extinguisher S may be an effective solution technology for heat-stressed swine.

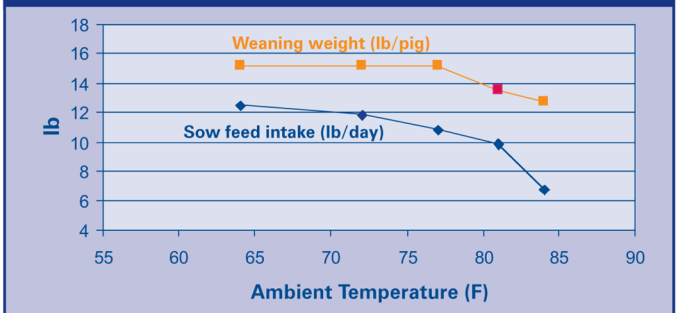
The Physiology of Heat Stress

The thermal environment has direct effects on pigs' energy expenditure and voluntary feed intake and therefore on their performance. The thermoneutral zone, or the comfort zone or zone of thermal comfort, is simply the range of temperatures in which the pig is not cold or hot. Young pigs are very sensitive to cold, whereas older pigs including sows are more sensitive to heat. The thermoneutral zone for lactating sows is approx. 59°F to 68 F. When ambient temperatures are above the upper range of the thermoneutral zone, pigs experience heat stress. When heat stress occurs, thermoregulatory mechanisms are activated. These mechanisms consist of behavioral and metabolic changes that reduce body heat load in an effort to maintain normal body temperature. Common responses to heat stress in swine include decreased feed intake, increased respiration rate, and increased water consumption. These responses in lactating sows contribute to higher maintenance energy expenditure, reduced milk production which reduces litter growth rate, increased sow backfat loss, and compromised subsequent reproductive performance.

Several theories have been proposed to explain the negative effects of heat stress. One theory is that damage to gut integrity plays a critical role in mediating the adverse consequences of heat stress. Animals experiencing heat stress redirect blood flow from the body core to the periphery to facilitate dissipation of body heat to the environment. The increased blood flow to the skin is counter-balanced by reduced blood flow to the gut and other body organs (liver, spleen, pancreas, and mammary glands). The reduction in blood flow to the gut results in insufficient supply of nutrients (energy) and oxygen, which cause imbalanced osmotic pressure and gut cell damage. The barrier function of gut lining may eventually become so compromised that endotoxin, a component of bacteria in the gut, enters the body. The presence of endotoxin induces an exaggerated inflammatory response from the gut immune system, which may precipitate multiple organ failure, compromised performance, and potentially death with severe heat stress.

Heat Stress and Lactating Sow Performance

Figure 1 Effect of Temperature on Sow Feed Intake and Piglet Weaning Weight



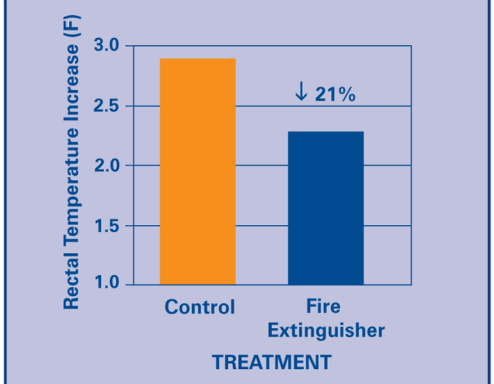
Source: Quiniou and Noblet, 1999.

Numerous university and industry research studies have been published regarding heat stress effect on lactating sow performance. Data published by Quiniou and Noblet (1999) have shown that increasing ambient temperatures from 64°F to 84°F increased sow backfat loss from 2.1 mm to 3.5 mm, increased sow lactation weight loss from 50.6 lb to 77.0 lb, reduced sow 21-day lactation feed intake from 12.5 lb/day to 6.8 lb/day (see Figure 1), and reduced piglet weaning weight from 15.2 lb/pig to 12.8 lb/pig. This study indicated that sow feed intake and litter weaning weight reduction is a curvilinear response to increased ambient temperature. Specifically, greater feed intake and litter weaning weight reduction occurred when temperatures were above 77° F. In addition, piglet growth rate reduction due to heat stress is more pronounced with the advancement of lactation, which may result from a more pronounced milk shortage in later stages of lactation.

Fire Extinguisher S Research

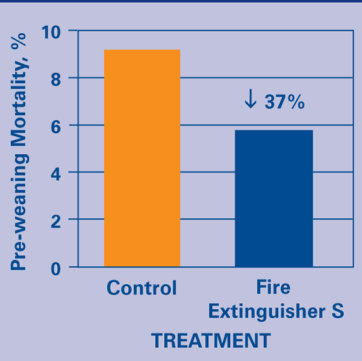
The ADM Fire Extinguisher research project is an initiative across species. Some components were tested individually and in combination across species and are used in both Fire Extinguisher R (ruminant formulation) and Fire Extinguisher S (swine formulation). Major components used in Fire Extinguisher were evaluated in a growing cattle trial (B07501). In this ADM research trial, 16 growing dairy cattle were subjected to heat stress and monitored. Half of these cattle consumed the Fire Extinguisher product while half did not. During heat stress, rectal temperature increase was 21% (0.6°F) less for the cattle consuming Fire Extinguisher than for the control cattle (see Figure 2). Cattle consuming the

Figure 2 Rectal Temperature Increase During Heat Stress



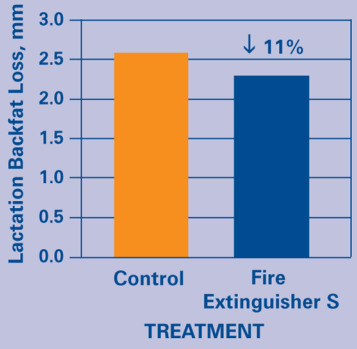
ADM Animal Nutrition Research Trial B07501

Figure 3 Fire Extinguisher S and Pre-weaning Mortality



ADM Animal Nutrition Research Trial S06307

Figure 4 Fire Extinguisher S and Sow Backfat Loss



ADM Animal Nutrition Research Trial S07301; conducted in Mexico.

product also gained an additional 0.27 lb/head/day. This data indicates that Fire Extinguisher helps animals adjust to the added stress of high heat situations by improving their ability to maintain body temperature and lean growth.

ADM Animal Nutrition conducted two commercial sow trials to evaluate efficacy of Fire Extinguisher S. The first sow trial (S06307) used 766 mixed parity sows at an Indiana commercial facility, with 369 sows on control treatment and 397 sows in Fire Extinguisher S treatment. The trial was conducted from May 2006 to September 2006. Sows were moved into farrowing rooms five to seven days before farrowing due dates and were fed experimental diets from the time they were moved into farrowing crates until weaning. Fire Extinguisher S decreased piglet pre-weaning mortality by 37% (from 9.2% for control to 5.8% for Fire Extinguisher S; see Figure 3), which resulted in 0.2 additional pigs per litter (8.85 vs. 8.62) at weaning.

The second sow trial (S07301) was performed in Mexico from February 2007 to November 2007. Nine-hundred twenty-seven sows were used in this commercial sow trial, with 451 sows on control and 476 sows on Fire Extinguisher S. Among the 927 sows, 108 sows had enough time to complete two reproductive cycles. Fire Extinguisher S was fed during gestation and lactation. During the summer, sows fed Fire Extinguisher S had significantly higher feed intake and less backfat loss during lactation than sows fed the control diet. Backfat loss was 11% less for sows fed Fire Extinguisher S (2.30 vs. 2.59 mm; see Figure 4). Lactation feed intake was greater in the second cycle for sows fed Fire Extinguisher S in the previous cycle (16 vs. 14.6 lb/day), suggesting a positive carryover effect of Fire Extinguisher S. This finding may need to be repeated due to limited number of sows completing two reproductive cycles in this trial. In addition, number of sows was 2% more at the end of this trial for sows fed Fire Extinguisher S than for sows fed the control diet. This suggested 2% greater sow retention rate (i.e. 2% less sow culling rate) when Fire Extinguisher S was fed.

Summary

Heat stress has dramatic negative impacts to various life stages of swine. Adverse effects of heat stress may be due to gut integrity damage and compromised immune function. ADM Animal Nutrition research has shown possible benefits of feeding Fire Extinguisher S during hot weather. These benefits include better sow feed intake, less sow backfat loss, reduced piglet pre-weaning mortality, and reduced sow culling rate. Consequently, Fire Extinguisher S may increase swine resilience to heat stress.

Reference available upon request

Management and Nutritional Tips to Minimize Adverse Consequences of Heat Stress

Key management tips:

- Provide clean, fresh, cool water at all times.
- Offer more feed at night when the temperature drops.
- Clean feeder frequently to encourage feed intake.
- Install proper cooling equipment, such as water drip.
- Ensure adequate building ventilation to allow fresh air flow and minimize room humidity. Pigs increase respiration rate to help increase heat loss. Compared to other mammalian species, heat loss via sweating in the pig is ineffective due to limited functional sweat glands.
- Choose proper floor type – concrete vs. plastic; total solid vs. partial slotted vs. total slotted.

Key nutritional tips:

- Increase dietary energy density to compensate for lower feed intake.
- Decrease dietary fiber by using less fibrous byproduct ingredients in diets. High-fiber diets generate more heat during digestion than lower fiber diets.
- Use more synthetic amino acids to reduce dietary crude protein levels. Excessive dietary protein or amino acids generate more heat during digestion and metabolism.
- Consider using feed additives that help increase feed intake, modify gut microbial population and gut integrity and maintain proper cation and anion balance.
- Consider using Fire Extinguisher S to support gut health, heat dissipation, nutrient intake and immune function.

September 2016