Feature Article

Slowing pig growth during COVID-19, models for use in future market fluctuations

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Implications

- COVID-19 resulted in significant challenges for swine production in the United States and globally due to temporary limitations of harvest capacity at swine processing facilities.
- The U.S. swine industry worked collaboratively to discuss, evaluate, and disseminate strategies to reduce the growth rate of pigs in order to avoid pigs growing past a stage where processing facilities could no longer accept them.
- A combination of management and nutritional approaches has been extremely effective in restricting pig growth rate in response to the COVID-19 pandemic—namely feeding reduced protein diets, increasing stocking density, and ambient temperature, among others.

Key words: COVID-19, reduced growth, swine

Introduction

COVID-19 has provided global challenges to almost every industry. Among these challenges were positive cases of COVID-19 in employees at swine processing facilities, leading to temporary, or extended, shutdown of the facilities (Millet et al., 2020). In the United States, processing capacity is closely aligned with the number of pigs produced such that packing facility shutdowns or slowdowns rapidly results in a backlog of pigs needing to be harvested. Thus, there was no place for the pigs to go that were ready for market. Swine processing under federal inspection began to decrease in late March 2020 (Figure 1; USDA, 2020). The lowest weekly harvest occurred from April 27 to May 2, 2020, which represented a decrease of approximately 45% of normal slaughter capacity.

In the late finishing stage, pigs typically gain 800 to 1,000 g/d. Thus, each day they were held resulted in approximately 1-kg heavier pigs. Processors have maximum allowable market weights because their facilities are not able to accommodate extremely heavy pigs. The maximum weight varies by the processor but is typically around 145 to 155 kg in the United States. During the COVID-19 pandemic, an increase in swine carcass weight was observed in response to this reduced harvest capacity (USDA Agricultural Marketing Service, 2020). Producers were quickly faced with a dilemma with few options and none of them good.

One option was to allow pigs to continue to grow, knowing that they would quickly be beyond the maximum allowable weight, not be accepted by the processor (whenever they were able to process pigs again), and have no value. The second option was to euthanize the pigs as they became too heavy, which, besides the economic ramifications and logistical difficulty, carries an enormous emotional toll. The third option was to slow the growth of the pigs with the hope that the processing plants would eventually reopen. This third option became the preferred choice for the majority of the swine industry if the extra finishing space needed to keep the pigs indefinitely was available.

The question then became: how do you slow the growth rate of the pigs? As an industry, considerable research has been conducted to find ways to increase the growth rate of pigs; however, very little research has focused specifically on methods to reduce pig growth rates. This is particularly true for pigs in late finishing. An additional challenge that needed to be overcome was related to facility design. In the United States, facilities have automated feeding and watering systems to allow pigs to have constant access to feed and water to promote growth and are not designed for restricting feed consumption.

Universities, feed companies, the National Pork Board, and others responded to producer needs by providing data-driven recommendations on strategies that producers could consider implementing in their facilities (DeRouchey et al., 2020, Hostetler, 2020; Patience and Greiner, 2020). Iowa State University was one of the first to respond to the industry need. They altered an ongoing study to test some potential options in

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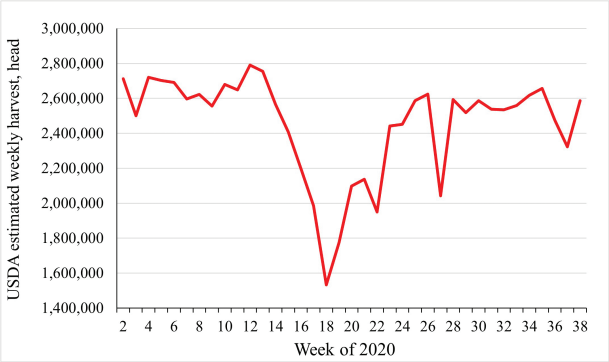

Figure 1. Estimated weekly swine harvest under federal inspection in 2020. Data adapted from USDA Livestock, Poultry, and Grain Market News Division.

individually housed pigs, which gave many the encouragement needed to try fairly drastic diet changes (Gabler et al., 2020). Iowa State University, National Pork Board, and many others hosted webinars to discuss processing capacity, slowing pig growth, and euthanasia options. Producers, veterinarians, nutritionists, and others shared their experiences and thoughts openly. These combined resources were critical to provide essential information for producers.

The exact requirement on how much pig growth needed to be slowed depended on the producer, but immediate and dramatic reduction in growth was required for pigs already close to market weight. The need for slowing down younger pigs was less known because of the huge uncertainty of how soon processing plants would be able to be back online and how long it would take to get through the backlog of pigs. Thus, the application of slow down methods for young pigs was more varied. For many, the response with younger pigs was just a shift from maximizing profit to minimizing loss (shift from formulating for maximum margin over feed and facility cost to formulating for minimal feed cost per unit of gain). For heavy pigs, the need for a dramatic reduction in growth led to the consideration of many options.

Options Considered

Nutrition

Remove growth-promoting feed additives. An obvious first step to lower growth rate was to remove any feed additive included in the diet for growth promotion. These included ingredients such as copper, ionophores, acidifiers, enzymes (other than phytase), and mycotoxin binders. Producers implemented this option, but reductions in growth were only marginal with the removal of these products, especially in the late finishing pig.

Reduce dietary energy. Including high-fiber ingredients in the diet and removing any added fat will lower dietary energy and growth rate (Nitikanchana et al., 2015). When fed high-fiber diets, pigs increase feed intake in an attempt to meet their energy requirement; however, if the fiber concentrations are high enough, the pig cannot physically consume enough feed and, thus, pig growth is reduced (Kyriazakis and Emmans, 1995). The neutral detergent fiber level in the diet needs to exceed 20% to have an appreciable impact on growth rate (Patience and Greiner, 2020). Unfortunately, economical fiber sources were not available and, in many cases, simply not available at all. Ethanol byproducts are often the highest fiber ingredients available in the United States and most ethanol plants were closed during this time period and, thus, their byproducts were not available or cost effective. Thus, this option was not available to many. However, producers that were using added fat in late finishing removed it immediately to lower diet energy and feed cost.

Reducing the dietary electrolyte balance. Including ingredients in the diet that greatly lower the electrolyte balance (negatively charged dietary ions [Cl^-] subtracted from positively charged dietary ions [Na^+, K^+]) makes the diet unpalatable to the pig and is highly effective at reducing feed intake (Patience et al., 1987). The most common ingredient used for this purpose is calcium chloride, but other ingredients can have a similar effect. Although some research exists, predicting the exact response to altered acid–base balance remains difficult (Haydon et al., 1990; Patience and Chaplin, 1997; Holt and Walker, 2011). The use of products to alter acid–base balance can be expensive, greatly increases water usage, and, therefore, carries some risk if water availability is a concern. Some producers may have chosen to use this strategy; however, it was on a limited basis because of the cost and low availability of calcium chloride during the pandemic.

Altered amino acid balance. Reducing the ratios of some amino acids, such as tryptophan, valine, or isoleucine, relative to lysine is known to reduce feed intake and growth rate (Gonçalves et al., 2018; Cemin et al., 2019). The growth rate is particularly impacted if the leucine to lysine ratio is also high in the diet (Cemin et al., 2019). Diets with high leucine concentrations can be easily produced when corn byproducts from ethanol production are available; however, as stated previously, ethanol byproducts were in short supply during the pandemic. Thus, this method had little practical use. Another strategy that was discussed was significantly increasing the addition of specific amino acids to generate a wide excess, most notably DL-methionine, which has been shown to greatly reduce intake and growth when added at very high inclusion levels (Edmonds and Baker, 1987; Edmonds et al., 1987). However, excessive dietary DL-methionine was not widely implemented in the 2020 COVID-19 pandemic.

Low-protein (amino acid) diets. Reducing dietary protein (all amino acids) greatly reduces the growth rate of pigs. Feed intake is not impacted as much; thus, feed efficiency dramatically worsens. Under normal circumstances, this option is not preferred because the cost per unit of gain increases dramatically even though diet cost is reduced with the reduction in the

protein content. The COVID-19 pandemic was not a normal situation. Cost per unit of gain is not a very useful metric when you do not want pigs to gain weight. The cost per day to feed the pig becomes a more important metric. Low-protein diets reduced the daily feed cost per pig. Thus, low-protein, corn-based diets were used by the majority of swine producers. Experiments by Iowa State University showed the effectiveness of this approach at reducing pig growth rate (Gabler et al., 2020). Multiple feed companies conducted similar studies to validate the approach. An experiment was conducted at Kansas State University to evaluate feeding a lysine-restricted diet or a corn-vitamin-trace mineral diet for different periods of time in finishing pigs (Rao et al., 2020b; Figure 2). The lysine-restricted diet was formulated to contain 75% of the lysine concentration in the control diet. This diet reduced pig performance but not to the extent achieved with a corn-vitamin-trace mineral diet, which contained about 25% of the lysine concentration of the control diet. This data, as well as multiple other research trials by swine production systems, allied feed industry, and academia, documented that growth rate could be significantly reduced with manipulation of the diet.

Management

Reducing floor space. Pigs require a minimum amount of space directly related to their body weight (Gonyou et al., 2006). If these space requirements are not met, the growth rate will be reduced. As pigs went beyond their intended market weight, the growth rate was naturally reduced to some extent because pigs started to become limited on space availability. Increasing the number of pigs per pen to limit floor space can also reduce the growth rate. This was done to some extent with younger pigs to allow heavy pigs more time in barns; however, it was not done with heavyweight pigs because of potential welfare concerns.

Increasing barn temperature. Increasing temperature above the thermoneutral zone of the pig results in reduced feed intake and growth rate (Renaudeau et al., 2011). Hot temperatures are a natural consequence in the summer and result in the seasonality of pig growth rate and market weights. The pandemic did not occur in the hottest months of the year and, therefore, decreased ventilation rates would have been required to increase temperatures in the barn. Reducing ventilation to increase temperature carries risk because gasses can increase in the facility posing a health danger. In addition, in order to be effective, barn temperature would need to be increased significantly to have enough impact on feed intake and growth rate. Increased barn temperature may have been implemented by some farmers but not the majority of the industry.

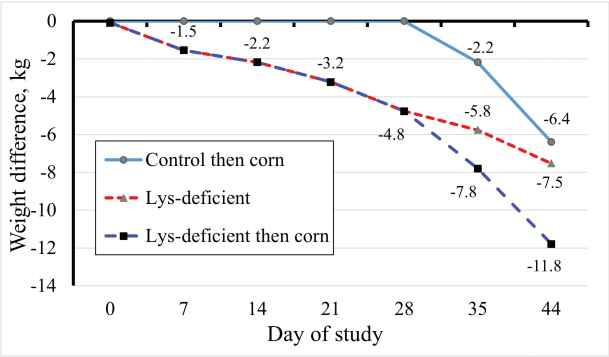

Figure 2. Body weight change relative to control (black horizontal line) when pigs initially 90 kg body weight were fed 1) the control diet for 28 d and then switched to corn-vitamin-trace mineral diet for the final 16 d, 2) fed a lysine-restricted diet for the entire 44 d study, and 3) fed a lysine-restricted diet for the first 28 d of the study followed by a corn-vitamin-trace mineral diet for the final 16 d. The control, lysine-deficient, and corn-vitamin-trace mineral diets contained 0.7%, 0.5%, and 0.18% digestible lysine, respectively. Adapted from Rao et al. (2020b).

Restricting feed access. Restricting access to feed will reduce intake and growth rate and does not result in poorer feed efficiency. Thus, on the surface, this option would appear to be ideal. However, true restriction in feed intake is difficult to accomplish in most finishing barns in the United States because all pigs typically have free access to dry feed in either a mash or pelleted form. Tightening the feeder opening limits feed intake but, by itself, does not greatly reduce pig growth. Reducing feed access to a greater extent by blocking access to one or more of the spaces in a multi-space feeder or allowing pigs to have access to feed for only certain hours of the day or every other day was considered by some producers to reduce feed intake, but worries about increased pig-to-pig aggression limited its application. A few producers allowed pigs from neighboring pens (e.g., across an aisle) to share a single feeder in one of the pens instead of having access to the feeders in both pens. However, these methods would also increase pig-to-pig aggression and require changes in barn management and were not widely implemented.

Restricting water access. A pig's water intake is directly related to feed intake (Patience, 2012). Thus, reducing water access will reduce feed intake. However, limiting water access for pigs is risky because water shortage can lead to salt toxicity. Because pig barns have water systems with a limited number of water devices that are shared by pigs, providing access to water for only certain hours of the day would lead to fighting whenever the water became available. Thus, this option was not used by producers and in general is not recommended due to the potential negative impacts on animal welfare.

Producer application and lessons learned. COVID-19 left many swine producers with limited options. They were faced with either mass euthanasia of pigs or finding a way to slow the growth rate immediately. Producers pivoted quickly to adapt to the crisis. Diets with reduced amino acids were adopted as the easiest nutritional strategies to implement what would have an immediate impact on reducing the growth rate. Because a dramatic reduction in growth rate was required, pigs that were at or near market weight were placed on a lowered protein diet containing only corn, vitamins, and minerals. The "corn" diet met all of the vitamin and mineral requirements of the pig but was below amino acid requirements for rapid growth. The vitamins and minerals were maintained in

the diet because it was unknown how long the diet would need to be fed and a deficiency in these nutrients that may impact the health or welfare of the pigs was not desired. The "corn" diet was fed in mash form by most producers. The diet slowed the growth rate by 50% or more from normal levels. Reducing the protein sources reduced the cost of the diet such that feed cost per pig was reduced on a daily basis compared to feeding a normal diet, although the impact was minor and did little to offset the major financial impact that COVID-19 had on pig farmers. For pigs that were not near market weight, less dramatic reductions in amino acid concentrations were used depending on the farm and their marketing prospects.

The corn diet was fed for anywhere from 1 to 8 wk, but was fed for 3 to 4 wk for the majority of situations. As would be expected, pigs fed this type of diet had more backfat and less muscle than if they would have been fed a normal diet. However, coupled with strategies like tightened feeder adjustment, it was effective at holding the majority of pigs long enough for them to reach normal processing channels. A concern expressed by producers was that the amino acid-deficient diet would increase aggression and vices. Fortunately, vices and aggression were not reported by anybody that fed this diet in mash form; however, anecdotal reports indicated some vice problems when the corn diet was fed in pelleted form.

Some pigs that were fed the corn diet were switched back to a typical finishing diet prior to marketing as processing space became available. These pigs exhibited compensatory gain greatly improving growth rate and feed efficiency when switched to normal diets (Gabler et al., 2020; Rao et al., 2020a; Figure 3).

The COVID-19 pandemic caused tremendous financial loss and emotional stress for many people around the globe. The crisis also brought out the best in people in the swine industry. Genuine care and concern for pig farmers and the welfare of the pigs under their care resulted in collaboration between universities, feed companies, other allied industry suppliers, and the National Pork Board resulting in data-driven solutions to lessen the impact of the crisis. Whether the strategies used will be the model for future market fluctuations remains to be seen, but the cooperation and communication within the industry can serve as an example of people coming together to help each other in a time of need.

Conflict of interest statement. None declared.

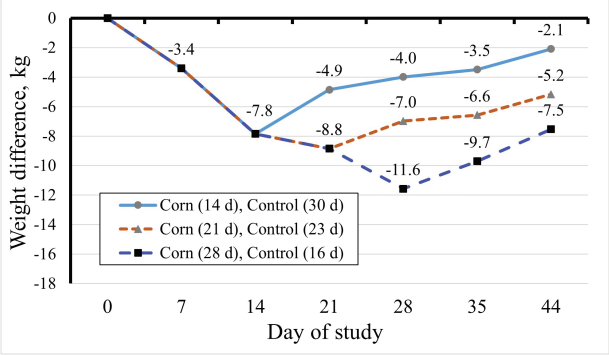

Figure 3. Body weight change relative to control (black horizontal line) when pigs initially 89 kg body weight were fed 1) the corn-vitamin-trace mineral diet for 14 d and then switched to control diet for 30 d, 2) the corn-vitamin-trace mineral diet for 21 d and then switched to control diet for 23 d, and 3) the corn-vitamin-trace mineral diet for 28 d and then switched to control diet for 16 d. The control and corn-vitamin-trace mineral diets contained 0.7% and 0.18% digestible lysine, respectively. Adapted from Rao et al. (2020a).

Potential Strategies to Reduce the Growth Rate of Pigs in Response to Reduction in Processing Facility Capacity

Nutritional

- Remove all growth-promoting feed additives
- Reduce dietary energy
- Reduce dietary electrolyte balance
- Altered amino acid balance (branch chain amino acids, excessive DL-methionine)
- Deficiency of amino acids (widely used during 2020 COVID-19 pandemic)

Management

- Reducing floor space
- Increasing barn temperature
- Restricting feed access
- Reduced water access (not recommended)

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