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Improving on-farm mixing efficiency

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Abstract

Particle size reduction has a great impact on efficiency of feed utilization. Decreasing particle size improves digestibility of nutrients by increasing surface area and allowing for greater interaction with digestive enzymes. In addition, particle size reduction can influence how uniformly feed is mixed and potential for segregation of ingredients. Mixing equipment and times also need to be evaluated to ensure feed uniformity. Very often suggested mixing times underestimate the amount of time necessary to thoroughly mix feed. Items such as worn paddles or ribbons, ribbon or paddle speed, and overfilling mixers increase the time necessary for adequate feed mixing and uniformity. The consequences of undermixed feed will be observed in poorer feed conversion. This will be most evident in younger or limit-fed pigs. A mixing efficiency test is a simple procedure to check if your feed is adequately mixed and, therefore, should be used as an indicator of feed quality control.; Swine Day, Manhattan, KS, November 15, 1990

Keywords

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IMPROVING ON-FARM MIXING EFFICIENCY

Bob Goodband

Summary

Particle size reduction has a great impact on efficiency of feed utilization. Decreasing particle size improves digestibility of nutrients by increasing surface area and allowing for greater interaction with digestive enzymes. In addition, particle size reduction can influence how uniformly feed is mixed and potential for segregation of ingredients. Mixing equipment and times also need to be evaluated to ensure feed uniformity. Very often suggested mixing times underestimate the amount of time necessary to thoroughly mix feed. Items such as worn paddles or ribbons, ribbon or paddle speed, and overfilling mixers increase the time necessary for adequate feed mixing and uniformity. The consequences of undermixed feed will be observed in poorer feed conversion. This will be most evident in younger or limit-fed pigs. A mixing efficiency test is a simple procedure to check if your feed is adequately mixed and, therefore, should be used as an indicator of feed quality control.

(Key Words: Diet, Process, Swine.)

Introduction

Because cereal grains are the primary energy sources in swine diets, producers must be concerned not only about the composition of the grain but also how it is processed. Feed costs represent 65 to 75% the cost of production for a swine operation; therefore, feed utilization will be a critical factor in determining profitability. Very often, minor changes in feed processing, i.e., particle size reduction or uniformly mixing feed, can improve whole-herd feed conversion from 3 to 8%. As producers take on more of the responsibility of mixing their own feed, quality control measures might go unchecked. Particle size and mixing efficiency are two simple tests that are often overlooked.

Discussion

A survey of particle size analysis of feed samples over the past 5 years indicates that the majority of producers are possibly losing 3 to 8% of their feed utilization costs because of coarsely ground feed. Of the over 1,500 samples analyzed, only 20% of those samples fall within the 700 to 800 micron particle size recommended for swine feeds (Table 1). If there are whole kernels in the diet, then this is an indicator that the feed isn't ground fine enough. It should be noted, however, that grinding too fine, below this recommended range, increases the potential for gastric ulcers, bridging of feeders, dustiness, and energy costs of grinding feed. The following paper, Feed Mills for On-Farm Feed Manufacturing, discusses some of the aspects of particle size reduction and key management decisions to maintain optimum particle size reduction.

Mixing efficiency is another term for feed uniformity or how thoroughly a batch of feed is mixed. The testing procedure involves taking at least 10 individual samples from a single batch of feed and analyzing each sample for salt content. Salt is used for the analysis because it is relatively easy and inexpensive to test. If the variation in salt content between the 10 samples is greater than 10%, then the feed has not been mixed properly. Several factors may affect mixing efficiency. The following are brief descriptions of how each of them affects feed uniformity.

Feed Mixers. Different types of mixers require different amounts of time to thoroughly mix feed. Horizontal mixers with either paddles or ribbons typically require about 5 to 10 min. to get below the recommended 10% coefficient of variation (Figure 1). Rotating drum or "cement" mixers also have been shown to be effective in adequately mixing feed and typically require 5 to 10 min. mixing time. Vertical mixers usually will require approximately 15 min. for optimum feed uniformity. Generally, single-screw vertical mixers require longer mixing times than twin-screw mixers; however, there appears to be a great deal of variation in mixing time of vertical mixers. Portable grinder mixers fall into the same category as single-screw vertical mixers and require at least 15 min to adequately mix a batch of feed. However, usual mixing time of these mixers is the length of time required to get to the feeder or to grind the grain portion of the diet.

A common misconception is that overmixing or unmixing can occur if feed is mixed too long. There is little information to support this concept; therefore, there is little chance for problems to occur if feed is mixed slightly longer than recommended.

Particle Size. Particle size and density can increase the amount of time necessary to thoroughly mix feed. In addition, they may also increase the potential for particle segregation. A recent study evaluated the effects of different particle sizes of either corn- or milo-based diets on mixing efficiency. Each grain was ground through a hammer mill or a roller mill to produce either fine or coarse particle sizes. They were then mixed with soybean meal, vitamins, and minerals in a 1-ton, horizontal, double ribbon mixer for either .5, 1.5, or 3.0 min. At each time increment, samples were collected and mixing efficiency was determined. Results indicate that as particle size increased, the diet needed to be mixed longer to get below the 10% variation level (Table 2). Although mixers and mixing times may vary, it may be safe to assume that with other types of mixers, coarsely ground feed ingredients may require slightly longer mixing times. Other factors such as particle shape, density, hygroscopicity, adhesiveness, and susceptibility to electrostatic charges may influence feed uniformity.

In addition to slightly longer mixing times, increased particle size may also increase the potential for segregation. Although difficult to measure, potential for segregation by trucking and feed handling equipment may be increased with coarsely ground feeds.

Over-filling the Mixer. Very often to save time, producers try to mix more feed than a mixer is designed to handle. This common practice seriously limits the action of the mixer by creating "dead zones". As a result, adequate feed mixing may not take place, even if the mixer is allowed to run for extended periods of time (Figure 2). Paddles should emerge 2 to 3 in. above the level of the feed in a horizontal mixer, whereas vertical mixers should have at least 8 to 12 in. between the top of the screw housing and the top of the mixing chamber.

Worn Equipment. Worn paddles, ribbons, and screws also contribute to increased mixing times (Figure 3). In addition, ribbon or paddle build-up from adding fats or oils and milk products also can interfere with mixing action (Figure 4). Wear on screws and their housing in vertical mixers will reduce mixing action. Because most of the wear will occur at the bottom of the mixer, this will limit the amount of feed that can be lifted. A rule of thumb is that if the diameter of the screw is reduced by 1/2 in., then you should increase mixing time by 5 min.

Mixer RPM. Low revolutions per minute will limit mixing action in both horizontal and vertical mixers (Figure 5). Horizontal mixers should be turning at 30 to 40 RPM, whereas single-screw vertical mixers operate in the 200 to 300 RPM range.

In conclusion, mixing times will vary based on the type of equipment used and its condition. Many other factors, such as particle size, over-fill, worn paddles and screws, build-up of fats and oils, and low operating speeds, can increase the amount of time needed to thoroughly mix a batch of feed. A mixing efficiency test is a simple and effective means of establishing whether your mixer is producing a uniform product.

Table 1. Summary of On-Farm Particle Size Reduction[a]

	Particle size, microns					
	400-599	600-799	800-999	1,000-1,299	1,300-1,999	>2,000
Percentage of samples	3.2	20.3	41.2	28.1	6.5	.7

[a]Analysis of 1,578 samples collected between 1986 and 1990.

Table 2. Effect of Particle Size on Mixing Efficiency[a]

	Mixing time, min[b]		
Particle size, microns	.5	1.5	3.0
<699	35.1[c]	8.3	8.8
700 to 899	43.1	10.3	8.7
>900	50.1	14.3	11.6

[a]Adapted from Martin, 1983.
[b]Samples were mixed in a 1-ton, horizontal double ribbon mixer.
[c]Coefficient of variation below 10% indicates adequately mixed feed.

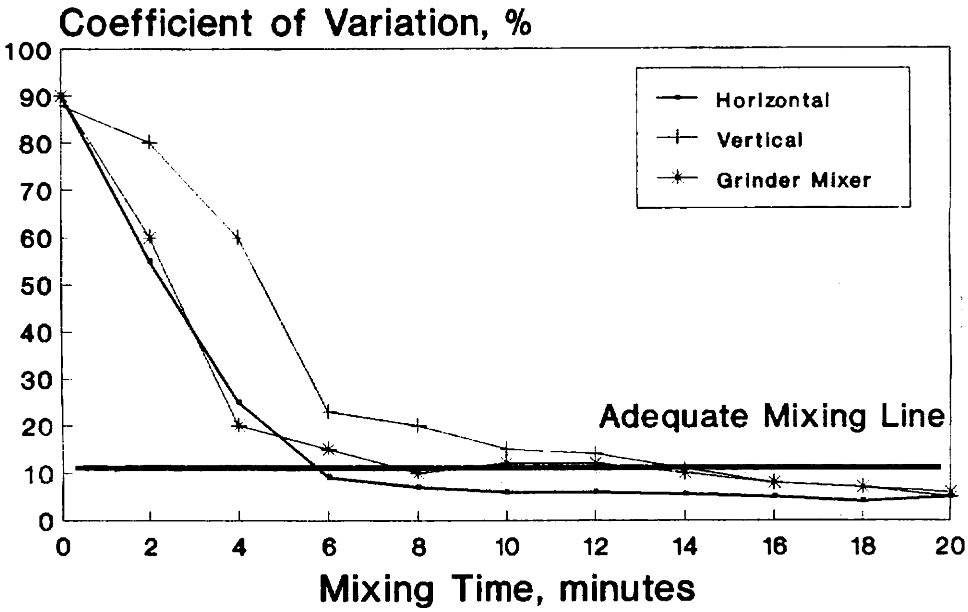

Figure 1. Effect of mixer type on time required to adequately mix feed.

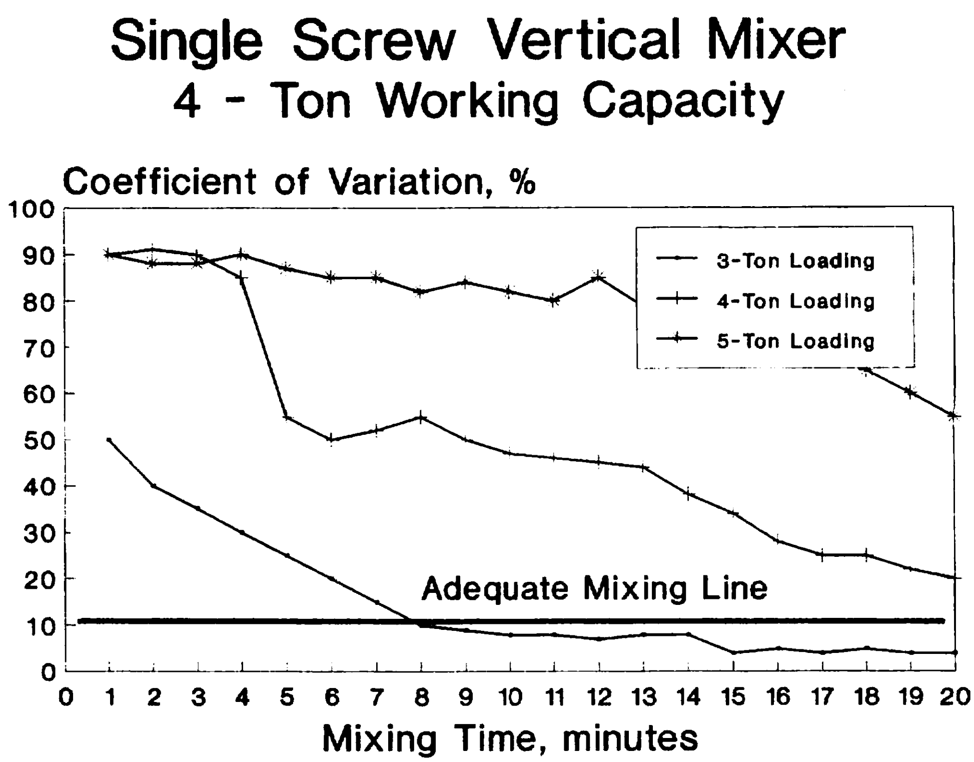

Figure 2. Effect of over-filling a mixer on mixing efficiency.

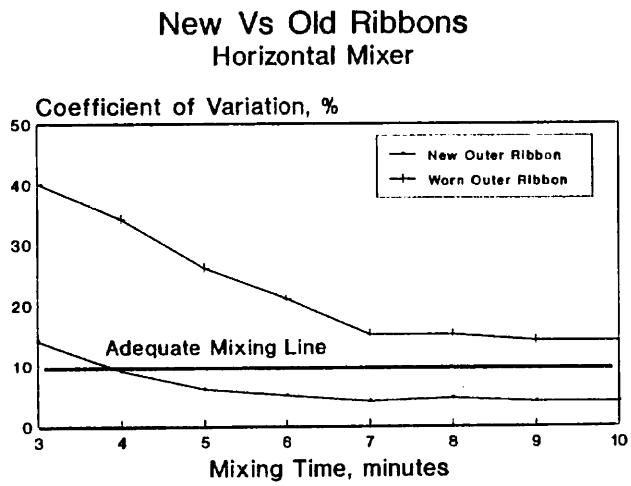

Figure 3. Effect of a wear on mixing efficiency of a single-screw mixer.

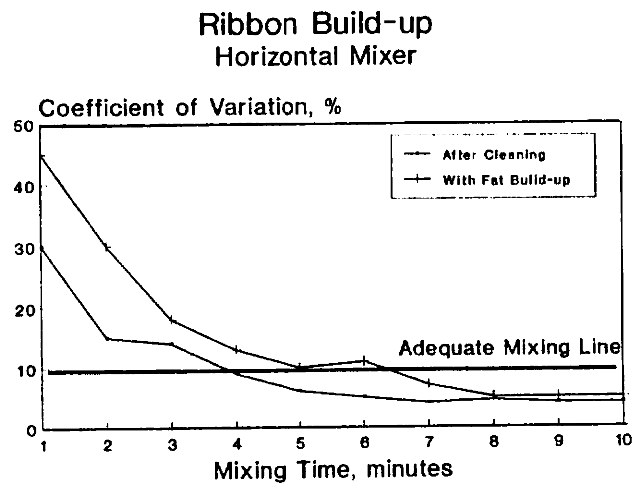

Figure 4. Effect of ribbon build-up on mixing efficiency.

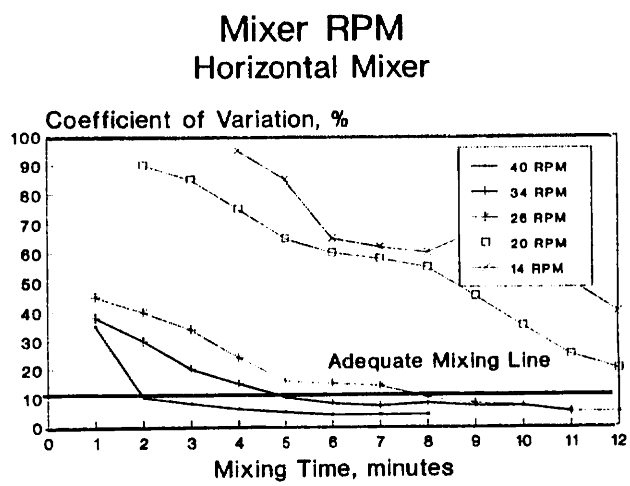

Figure 5. Effect of mixer RPM on mixing efficiency.