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Using mixer efficiency testing to evaluate feed segregation in feed lines

Abstract

An experiment was conducted to evaluate potential diet segregation in feed lines by measuring coefficient of variation (CV) and mean salt concentration. The facility was a 1500-head gestation barn with nine feed lines, transected by a central feed line that conveyed feed from one of two bulk bins. QuantabÂ® chloride titrators were used to analyze the chloride concentration (salt) from samples collected at pre-determined feed line locations at various distances from the bulk bins. Thirty samples were collected from three feed lines (row 1, 5, and 9), ten samples were collected from drop boxes close to the central feed line (location 1), ten samples were collected from a central location within the row (location 2), and ten samples were collected from the furthest end of the feed line (location 3). Samples of approximately 50 g were collected directly from the feed drop. The sample collection procedure was repeated four times. After the first two sample collections, a bin agitator was added to the bulk bin. There was a feed line Ã— distance (within the feed line) Ã— agitator interaction (P > 0.02) observed for CV. The addition of the bin agitator improved the CV in feed line 1 and 5, with no improvement observed in feed line 9. The CV observed before the addition of the agitator averaged 17.6, 18.6, and 14.3% for feed lines 1, 5, and 9, respectively, and the CV observed after the addition of the agitator averaged 13.6, 16, and 14% for feed line 1, 5, and 9 respectively. Within all feed lines (rows), distance CV was higher at locations 1 (17.3%) and 3 (17.6%), compared with CV at location 2 (15.6%) before the addition of the agitator, but was lower at locations 1 (14.3%) and 3 (13.0%), compared with CV at location 2 (15.6%) after the addition of the agitator. There was a mean-salt concentration effect (P<0.0001) observed for feed line. Feed lines 1 and 5 were similar in mean salt concentration, whereas feed line 9 consistently had the highest salt concentration. There was little to no feed segregation observed.; Swine Day, 2004, Kansas State University, Manhattan, KS, 2004

Keywords

Swine day, 2004; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 940; Kansas Agricultural Experiment Station contribution ; no. 05-113-S; Feed segregation; Mixer efficiency; Pigs; Swine

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USING MIXER EFFICIENCY TESTING TO EVALUATE FEED SEGREGATION IN FEED LINES

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Summary

An experiment was conducted to evaluate potential diet segregation in feed lines by measuring coefficient of variation (CV) and mean salt concentration. The facility was a 1500-head gestation barn with nine feed lines, transected by a central feed line that conveyed feed from one of two bulk bins. Quantab® chloride titrators were used to analyze the chloride concentration (salt) from samples collected at pre-determined feed line locations at various distances from the bulk bins. Thirty samples were collected from three feed lines (row 1, 5, and 9), ten samples were collected from drop boxes close to the central feed line (location 1), ten samples were collected from a central location within the row (location 2), and ten samples were collected from the furthest end of the feed line (location 3). Samples of approximately 50 g were collected directly from the feed drop. The sample collection procedure was repeated four times. After the first two sample collections, a bin agitator was added to the bulk bin. There was a feed line × distance (within the feed line) × agitator interaction ($P > 0.02$) observed for CV. The addition of the bin agitator improved the CV in feed line 1 and 5, with no improvement observed in feed line 9. The CV observed before the addition of the agitator averaged 17.6, 18.6, and 14.3% for feed lines1, 5, and 9, respectively, and the CV observed after the addition of the agitator averaged 13.6, 16, and 14% for feed line 1, 5, and 9 respectively. Within all feed lines (rows), distance CV was higher at locations 1 (17.3%) and 3 (17.6%), compared with CV at location 2 (15.6%) before the addition of the agitator, but was lower at locations 1 (14.3%) and 3 (13.0%), compared with CV at location 2 (15.6%) after the addition of the agitator. There was a mean-salt concentration effect ($P<0.0001$) observed for feed line. Feed lines 1 and 5 were similar in mean salt concentration, whereas feed line 9 consistently had the highest salt concentration. There was little to no feed segregation observed.

(Key Words: Feed Segregation, Mixer Efficiency, Pigs.)

Introduction

It is ideal to supply animals with the correct ingredient ratios (Ca:P), vitamins, and minerals to maximize production and efficiency. There is sometimes a concern in facilities with long feed lines that feed segregation may be taking place. Coefficient of variation (CV) is often used in the determination of mixer efficiency, and our objective was to use the concept

[1]Food Animal Health and Management Center.

of mixer-efficiency testing to help determine feed segregation in feed lines. A CV of ≤10% for mixer efficiency is considered excellent, a CV of 10 to 15% is an indicator of good mixing, a CV of 15 to 20% is fair, and a CV of 20% or greater indicates insufficient mixing and warrants attention. These CV values were used to determine feed segregation in feed lines, with a smaller CV value indicating less segregation. The most common test for determining CV in mixer efficiency is chloride Quantab® titrators (Environmental Testing Services, Elkhart, IN), which was the analytical method used in our experiment to determine CV for feed segregation in feed lines.

Procedures

The experiment was conducted at a 1500-head gestation barn with nine feed lines, transected by a central feed line conveying feed from one of two bulk bins to feed lines, filling drop boxes. Thirty samples were collected from drop boxes in three feed lines (row 1, 5, and 9) with ten samples collected (from ten adjacent feed drops) at each of the three pre-determined locations (Figure 1). The locations were close to the central feed line (location 1), a central location within the feed line (location 2), and the farthest point from the central feed line (location 3). Samples of approximately 50 g were collected directly from the feed drop. Four sets of samples were collected, two sets before the addition of a feed agitator to the bulk bin and two sets after the addition of the agitator. Ten samples were also collected from the mixer and from the truck as it was unloading the feed into the empty bulk bin before each set of sample collections from the gestation-barn drop boxes. Coefficients of variation were determined with Quantab® chloride titrators, and CV was used to determine feed segregation. For each 10 adjacent samples there was one CV value generated, with three CV values per feed line (row). Ten grams of the collected sample was weighed into a 120-mL sample cup. Ninety ml of 100°C distilled water was poured into the 120-mL sample cup. The sample was stirred for 30 s, let stand for 60 s, and stirred for an additional 30 s. A folded, circular, fast-flow 12.5-cm filter paper (Quantitative Q8) was placed into the 120-ml sample container, and the Quantab® chloride titrator was placed inside of the filter paper. The solution was allowed to completely saturate the wick of the titrator. The reaction was completed when the yellow wick turned completely black. The titrator was removed from the solution, read, and recorded. Coefficient of variation was calculated. All data was analyzed by using PROC MIXED in SAS 8.1.

Results and Discussion

The average CV and mean salt concentration for the samples collected from the mixer were 14% and 0.60, respectively, for the first two sets and 8% and 0.58, respectively, for the second two sample sets. The average CV and salt concentrations for the samples collected as feed was unloading into the bulk bin were 10% and 0.70, respectively, for the first two sample sets and 11% and 0.72, respectively, for the two sets of samples collected after the addition of the agitator. These values indicate a uniformly mixed feed.

There was a feed line × distance (within the feed line) × agitator interaction ($P>0.02$) observed for CV. The addition of the agitator improved the CV in feed lines 1 and 5, with no improvement observed in feed line 9 (Table 1). The CV observed before the addition of the agitator averaged 17.6, 18.6, and 14.3% for feed lines 1, 5, and 9, respectively, and the CV observed after the addition of the agitator averaged 13.6, 16, and 14% for feed lines 1, 5, and 9, respectively. Distance CV was higher at locations 1 (17.3%) and 3 (17.6%), compared with the CV at the center location 2 (15.6%) before the addition of the agitator, but was lower at locations 1 (14.3%) and 3 (13.0%), compared with the CV at the center location 2 (15.6%) after the addition of the agitator. Mean salt concentration was greater ($P<0.0001$) for feed line 9 than for feed lines 1 and 5, which were similar in mean salt concentration (Table 2).

Feed segregation could be a potential problem, especially when feed is being transported long distances from bulk bins in feed lines. Segregation is variable within each system, and some systems could experience more segregation than other systems, based on system maintenance and feed ingredients used. Using the mixer-efficiency testing method, we were able to evaluate the salt concentration of the diet at locations throughout the barn. We used the CV value to determine if segregation of feed ingredients was occurring in the feed lines. If the CV values were consistent throughout the feed lines there would be no segregation occurring, but if changes occurred, then it is possible that some segregation was occurring. The CV results generated were fairly consistent, but they did have some variability. The addition of the agitator did decrease the CV value slightly, from a mean of 16.6 $\pm$ 1.8 to 14.5 $\pm$ 1.3. Both of the previously listed values are more than the ideal CV value of 10%, but are between 10 and 20%. A CV between 10 and 20% would probably produce results in performance and efficiency similar to a CV of 10%, but the possibility of reducing performance increases as CV is increased. A CV of 20 or more would have a greater probability of affecting animal performance and would need to be addressed.

The mixer-efficiency testing procedure is simple to perform and generates results that are easily interpreted. The procedure could be used to help determine feed-segregation issues within feeding systems.

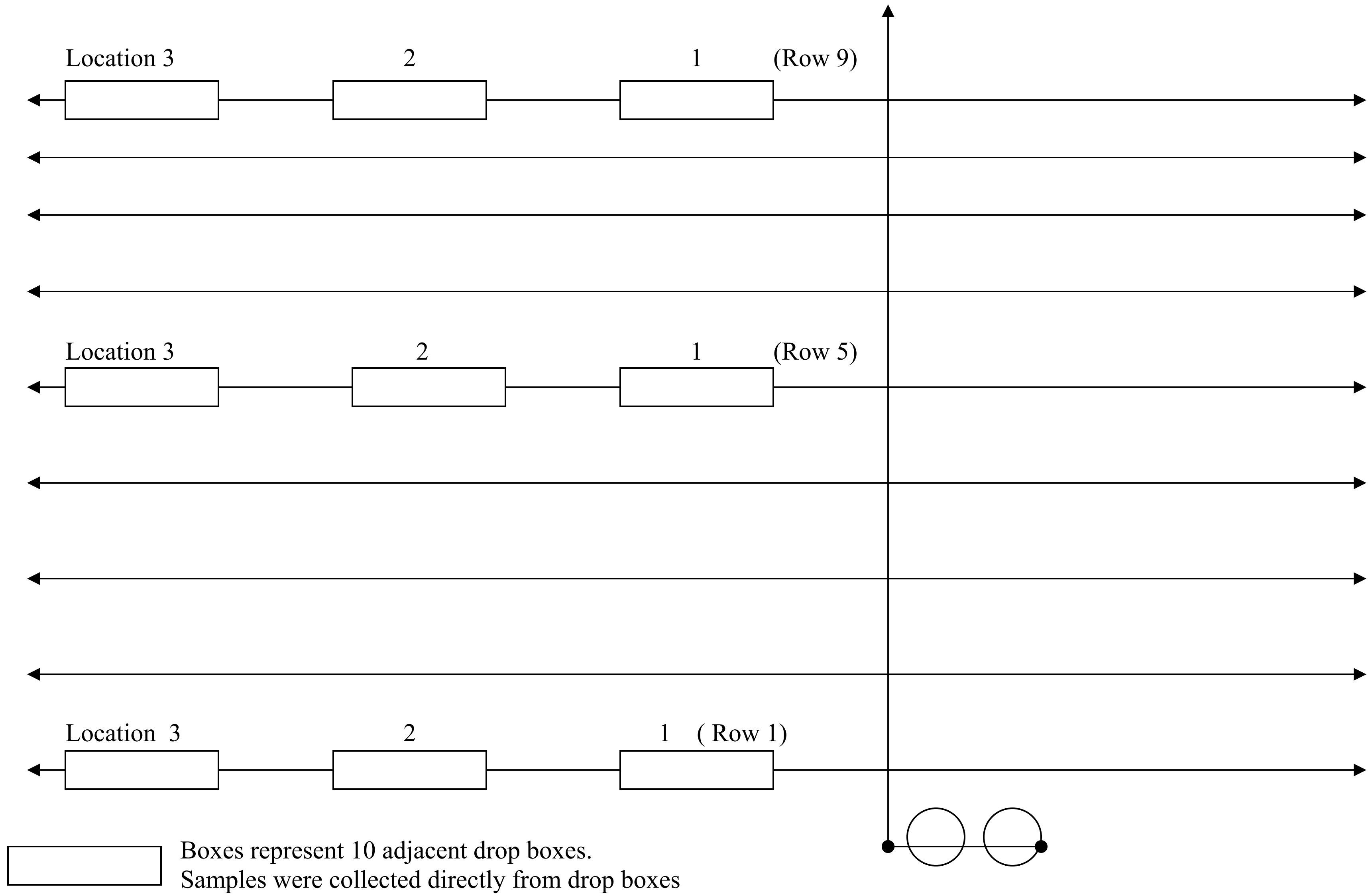

Figure 1. Diagram of Feed Line and Sample Collection Locations, the Facility is a 1500-Head Gestation Barn with 9 Feed lines Transected by a Central Feed Line that Conveyed Feed to the Feed Lines from One of Two Bulk Bins.

Table 1. Coefficient of Variation, %[a]

	Location, distance[b]					
	Before Agitator[c]			After Agitator		
	1[c]	2	3	1	2	3
Feed line 1[d]	22	13	18	14	15	12
Feed line 5	14	17	25	16	18	14
Feed line 9	16	17	10	13	16	13

[a]Coefficient of Variation values were generated from the average of two sets of ten samples collected from adjacent feed drops.
[b]Location 1 – closest set of ten samples to the center feed line; location 2 – ten samples collected from the center location in the feed line; location 3 – the farthest set of ten samples collected form the center feed line.
[c]Two sets of samples (90 samples total, 30 from each feed line, and ten from each distance within the feed line) were collected before the addition of the agitator, and an additional two sets were collected after the agitator was added to the bulk bin.
[d]Feed line 1- closest feed line to the bulk bin; feed line 5 – center feed line; feed line 9 – farthest feed line from the bulk bin.

Table 2. Mean Salt Concentration, %[a]

	Location, distance[b]					
	Before Agitator[c]			After Agitator		
	1	2	3	1	2	3
Feed line 1[d]	0.49	0.48	0.49	0.58	0.52	0.52
Feed line 5	0.51	0.48	0.43	0.40	0.45	0.57
Feed line 9	0.65	0.72	0.67	0.67	0.73	0.73

[a]Mean of salt concentration values were generated form the average of two sets of ten samples collected from adjacent feed drops.
[b]Location 1 – closest set of ten samples to the center feed line; location 2 – ten samples collected from the center location in the feed line; location 3 – the farthest set of ten samples collected form the center feed line.
[c]Two sets of samples (90 samples total, 30 from each feed line, and ten from each distance within the feed line) were collected before the addition of the agitator, and an additional two sets were collected after the agitator was added to the bulk bin.
[d]Feed line 1- closest feed line to the bulk bin; feed line 5 – center feed line; feed line 9 – farthest feed line from the bulk bin.