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Duane E. Reece

Walter W. Stroup

University of Nebraska-Lincoln, wstroup1@unl.edu

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Conducting Pig Feed Trials on the Farm

Duane E. Reese, Extension Swine Spec
Walter W. Stroup, Professor, Biome

Nebraska Cooperative
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E.C. (Nebraska Cooperative
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We suggest that pork producers adopt a "best cost" feeding program tailored to the operation and based on sound nutritional principles. Feed cost per pound of gain is a major item separating high and low profit pork producers. University and feed industry personnel provide information to help producers develop an appropriate feeding program; however, sometimes that information is deemed inadequate. Often a feed trial is conducted on the farm to determine which feed is "best."

Caution! A feed trial will require undivided attention.

A careless approach will produce misleading results. Even a carefully conducted trial that does not use sound statistical principles may produce misleading results. Furthermore, money may be wasted if the results are deceptive. The key to conducting a meaningful trial is to 1) minimize differences in pig performance that could be caused by factors other than the feed and 2) provide some basis for concluding the results are reputable and thus valid for use.

The purpose of this NebGuide is to provide fundamental information that must be understood before attempting to conduct a feed trial. The concepts and procedures described here are valid for most situations involving a comparison of two feeds. Any trial involving more than two feeds raises issues that are beyond the scope of this NebGuide. Those issues are covered in university statistics courses on design and analysis of experiments.

The most practical feed trials for producers to conduct are those involving growing pigs (weaning to about 50 lb and (or) 50 lb to market). Feed trials involving the breeding herd are often not feasible for producers to conduct because adequate replication is difficult to achieve (For example, to accurately detect a one-half pig/litter difference between sow feeds, 388 sows are needed/feed type.)

To illustrate some points assume a producer wants to compare two nursery feeds. One feed is the control (the one currently used) and the other one is the test feed.

Weigh Pigs and Feed. A reliable set of scales to weigh pigs and feed is essential. Estimating pig weight by sight and feed use by volume is unreliable and therefore unacceptable.

Use the same set of scales for the duration of the trial. Be sure they are calibrated before each use.

If feed is handled in bags and their weight is uniform (<2% weight variation between bags of feed), record the number of bags used during the trial. At the end of the trial subtract the weight of feed remaining in the feeders to determine feed use.

Ideally, pigs should be weighed individually at the beginning and end of the trial. Data can be adjusted in the event a pig dies during the trial if individual pig weights are collected.

Have Adequate Replication. Replication means observing at least two pens of pigs per feed type. Suppose only two pens of pigs were available to conduct the feed trial. Results showed that pigs fed the test feed out-performed those fed the control. Should we conclude that the test feed is superior? No. We cannot be certain that the difference in pig performance was due to the feed. It could have been due to other factors, for example a malfunctioning waterer in the control pen or chance variation.

Having only one pen of pigs per feed type in a trial may cause misleading results. Replication is important to minimize mistakes and to ensure correct conclusions are made. In other words, each feed type must be provided in more than one pen of pigs (Figure 1). Otherwise the trial is not valid.

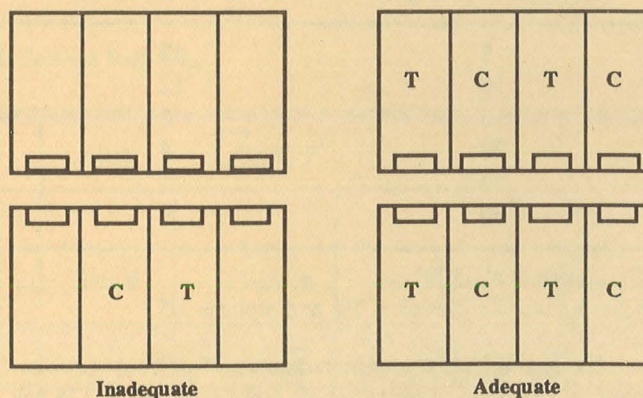


Figure 1. Example of inadequate and adequate replication of control (C) and test (T) feeds.



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To aid in the understanding of the importance of replication, obtain five people and one coin. Assume the following: (1) heads denote the test feed, (2) tails indicate the control feed, (3) the decision on which feed is best will be based on the ratio of heads-to-tails after flipping the coin 10 times, and (4) the control and test feeds are identical.

Ask each person to flip the coin 10 times and record the number of heads and tails. How many people recorded five heads and five tails indicating there is no difference between the feeds? It is unlikely that everyone did. Some individuals likely recorded more heads than tails; others recorded more tails than heads. Thus, some individuals were provided misleading information because of chance variation. Averaging the results should reveal that about five heads and five tails were obtained which indicates the feeds are similar. All trials have some element of chance variation in them. Replication reduces errors caused by chance variation.

How does chance get involved in a feed trial? If we have 20 pigs and randomly assign 10 to each pen, much like the coin flip we expect to get an equal sample in each pen. But like the coin flip, it seldom comes out the way we expect. However, if we have several pens, than on the average, pigs assigned to each feed type should be very similar. Thus, it is more likely that differences we observe result from *real* differences between feed types and not merely from luck.

Table I provides guidelines for the number of pens per feed type required to detect a difference between two feeds with a reasonable degree of confidence. These guidelines allow producers to be 95 percent accurate when making conclusions about two feeds and they are applicable when more than five but fewer than 30 pigs are housed per pen.

Table I. Required number of pens per feed type for starter and grower-finisher feed trials^{ab}

Percent improvement in daily gain or feed/gain	Number pens/feed type
5	43
10	12
15	6
20	4
25	3
30	3

^aBerndston et al., 1991.

^bCoefficient of variation = 7% and alpha = .05.

For example, if you wish to detect a 15 percent improvement in daily gain of nursery pigs (approximately 0.1 lb per day), plan to have a total of six pens per feed type in the trial (Table I). Fewer pens will decrease your ability to accurately detect a 15 percent difference between two feeds. Smaller improvements in performance may be economical but to be sure you chose the correct feed to accomplish this improvement, more replication is necessary.

If the number of pens per feed type requirements cannot be met at one time, repeat the trial over time using successive

groups of pigs. Be sure to have the same number of pens available for each feed type during each time period. Also reassign feed types to pens before repeating the trial (see *Select Proper Pens*).

Two pens sharing the same feeder do not constitute two pens for feed trial purposes — they must be considered as one pen.

Select Proper Pens. All pens in the trial must be the same size and have identical equipment (floors, feeders, waterers, etc.). Also, pen location within a building should not be allowed to influence the outcome of the trial. Otherwise one feed type may appear superior simply because the pigs consuming it were in pens that provided a better environment.

Blocking is a good technique to ensure that a comparison between two feeds is fair and accurate as possible. Adjacent pens, each having a separate feeder, constitutes a block of pens. Provide the control and test feed within each block of pens.

For example, assume we have eight pens available to compare control and test feeds.

1. Divide adjacent pens into blocks of two pens each (Figure 2a).
2. Cut two small pieces of paper and write "C" on one and "T" on another.
3. Fold the pieces of paper, mix, and draw one.
4. The first slip of paper drawn reveals the feed to be provided in Pen 1 Block A. The feed type not chosen would be provided in Pen 2 Block A. Replace the drawn slip and repeat the procedure until all eight pens have been assigned a feed (Figure 2b).

It is often convenient to use pens along one side of an alley for one feed and pens across the alley for the other feed. This arrangement is valid only after establishing that the pigs perform the same on both sides of the alley. Because it requires extensive research to prove that pigs perform similarly on both sides of an alley, we suggest that the feeds be assigned to blocks of pens as described above.

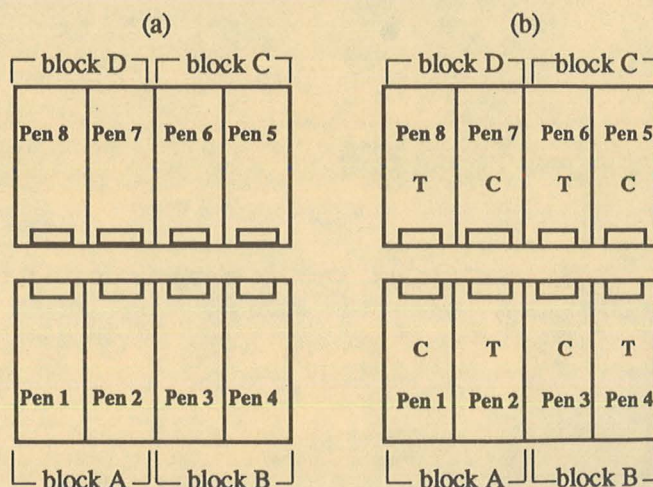


Figure 2. Assignment of control (C) and test (T) feeds to pens.

Minimize Pig Weight, Ancestry, and Sex Effects. Pigs perform differently because of their weight, ancestry, and sex. These effects must be equalized across all feed types in the trial. Ear notch or tag pigs to preserve their identify before assigning pigs to pens.

The simplest way to minimize these effects when comparing two feed types is to identify two pigs from the same litter of similar weight and sex. Put one in a pen where the control feed is offered and the other in the pen offering the test feed. Choose two additional pigs from the same litter of similar weight and sex and place them in another pair of two pens. Continue choosing pigs from that litter until no more pigs are available. Repeat this process with other litters until pens offering the control and test feeds have the same number of pigs of the same sex ratio and similar live weights.

The number of barrows does not need to be the same as the number of gilts in a given pen. However, the ratio of barrows to gilts and the total number of pigs must be the same in each pen.

Initial pig weight is considered similar between pens offering the control and test feeds when the difference between control and test feed pig weights is less than 5 percent of the average weight of all pigs in the trial. For example, after assigning pigs to pens it is determined the average initial weight of pigs to be fed the control and test feeds is 14.7 lb and 15.3 lb, respectively. The average weight of all pigs in the trial is 15 lb. Thus, the difference in average initial weight between pigs to be fed control and test feeds is 4 percent of the average weight of all pigs in the trial (see below).

$$15.3 \text{ lb} - 14.7 \text{ lb} = 0.6 \text{ lb}$$

$$(0.6 \text{ lb} \div 15 \text{ lb}) \times 100 = 4\%$$

If the difference between control and test feed pig weight is greater than 5 percent of the average weight of all pigs, then pigs need to be relocated to reduce the average initial weight difference between feed types. In addition, it is important to

minimize weight variation within pens.

After the pigs are assigned to pens by weight and sex check each pen for common ancestry. If there are three or more pigs from the same litter assigned to a given pen, exchange pigs of similar weight so not more than two pigs from the same litter remain in a given pen.

Select Suitable Test Animals. Sometimes pigs die before the trial is completed. Carefully screening the animals before they are used in the trial will help reduce this problem.

If a pig dies during the trial, data collected from the dead pig's pen must be adjusted. To adjust on-test pen weight, subtract the dead pig's on-test weight from the pen total. Adjust pen feed intake data by determining average daily feed intake per pig for the period the dead pig was alive. Multiply by .75 to estimate daily feed intake for the dead pig. Calculate total feed consumed by the dead pig since the onset of the trial and subtract from the total feed consumed by the pigs in the pen. The quantity of feed remaining in the feeder the day the pig died must be determined.

All pigs in a trial should share common backgrounds. For example, they should receive the same feed and vaccinations during the pretrial period.

Test Feeds Concurrently. Pigs fed the control and test feeds must begin the trial the same day. At the end of the trial, weigh the pigs and the feed remaining in all feeders.

Determine the Duration of the Trial. Conduct nursery feed trials for a predetermined time period (three to five weeks). Growing-finishing feed trials should be terminated when the pigs attain a predetermined weight (240–250 lb).

Tabulate Results and Draw Conclusions. Calculate average daily gain, daily feed intake, feed efficiency and feed cost per pound of gain for each pen in the trial. Determine the average performance for the control and test feed groups (Table II).

Table II. Example results from a feed trial

Feed: <i>Control</i>					Feed: <i>Test</i>			
Block	Pen #	Daily Gain, lb	Feed/Gain	Feed cost/lb gain, ¢	Pen #	Daily Gain, lb	Feed/Gain	Feed cost/lb gain, ¢
<i>A</i>	<i>1</i>	<i>.68</i>	<i>2.08</i>	<i>25</i>	<i>2</i>	<i>.69</i>	<i>1.86</i>	<i>20</i>
<i>B</i>	<i>3</i>	<i>.76</i>	<i>1.85</i>	<i>20</i>	<i>4</i>	<i>.73</i>	<i>1.89</i>	<i>21</i>
<i>C</i>	<i>5</i>	<i>.73</i>	<i>1.96</i>	<i>21</i>	<i>6</i>	<i>.81</i>	<i>1.75</i>	<i>17</i>
<i>D</i>	<i>7</i>	<i>.68</i>	<i>2.10</i>	<i>26</i>	<i>8</i>	<i>.83</i>	<i>1.74</i>	<i>17</i>
Average		<i>.71</i>	<i>2.00</i>	<i>23</i>	Average	<i>.77</i>	<i>1.81</i>	<i>19</i>

People often review data like that in *Table II* and conclude the test feed is superior to the control. Such conclusions are based on no knowledge of the odds that the differences in performance are actually due to the feed.

A procedure for analyzing data to help make valid conclusions is presented in *Table III*. The daily gain data in *Table II* will be used to demonstrate the procedure. A pocket calculator with a square root function key ($\sqrt{}$) is required.

Table III. Worksheet for statistical evaluation of feed trial data

IDENTIFY RESPONSE VARIABLE:

Daily Gain, Daily Feed Intake, Feed/Gain, Feed Cost/lb Gain

1. For each block of observations complete the following table. IMPORTANT: Determine values for column 3 by subtracting values in column 1 from column 2.

Block	Column 1 Average of pens containing control feed	Column 2 Average of pens containing test feed	Column 3 Difference	Column 4 Square of difference
A	.68	.69	.01	.0001
B	.76	.73	-.03	.0009
C	.73	.81	.08	.0064
D	.68	.83	.15	.0225
Total:			.21	.0299

2. Enter the number of blocks

2. 4

3. Subtract (1) from line 2

3. 3

4. Enter the total for column 3

4. .21

5. Enter the total for column 4

5. .0299

6. Divide line 4 by line 2

6. .0525

Line 6 is the average difference between control and test feeds.

7. Calculate the square of line 4.

7. .0441

8. Divide line 7 by line 2.

8. .0110

9. Subtract line 8 from line 5.

9. .0189

10. Divide line 9 by line 3.

10. .0063

11. Divide line 10 by line 2.

11. .0016

12. Enter the square root ($\sqrt{\quad}$) of line 11.

12. 0.397

Line 12 is the "standard error of the difference."

13. Divide line 6 by line 12. (Note: Ignore any negative sign when performing calculation for line 13.)

13. 1.322

14. Refer to line 2 and choose the appropriate value from the table below.

14. 3.182

# Blocks (line 2)	Value
2	12.706
3	4.303
4	3.182
5	2.776
6	2.571
7	2.447
8	2.365
9	2.306
10	2.262
11	2.228
12	2.201

15. Please check:

() Line 13 is larger than line 14.

Conclusion: Performance of pigs fed control and test feeds is different.

(☒) Line 14 is larger than line 13.

Conclusion: Performance of pigs fed control and test feeds is not different.

Because line 14 (3.182) is larger than line 13 (1.322), growth rates of .71 and .77 lb/day are not different. Thus, it is appropriate to conclude that the test feed offers no advantage in terms of daily gain over the control feed in this trial. Although .77 is a larger number than .71 the chance that they are different because of differences between the feeds is poor. Had line 13 been larger than line 14 it is appropriate to conclude that the test feed is superior to the control feed. The same procedure should be applied to daily feed intake, feed efficiency and feed cost per pound of gain data before overall conclusions are drawn.

The numerical difference observed in daily gain (.77 vs .71 lb/day) may be economically important for a pork pro-

ducer. However, until additional trials are conducted using the same feeds a producer cannot be 95 percent accurate that switching to the test feed would improve performance.

It is important to remember that trial results may be valid only for a short time. Feed manufacturers change their formulas, thus the feeds tested may be available for a limited time.

The computations used in Table III can be programmed into a computer. Then a statistical analysis of data can be made conveniently.

Feed trials may prove valuable in choosing a feeding strategy for specific farm conditions. The recommendations presented here will provide producers better information. A blank worksheet for data analysis is provided in Table IV.

Table IV. Worksheet for statistical evaluation of feed trial data

IDENTIFY RESPONSE VARIABLE:

Daily Gain, Daily Feed Intake, Feed/Gain, Feed Cost/lb Gain

1. For each block of observations complete the following table. IMPORTANT: Determine values for column 3 by subtracting values in column 1 from column 2.

[illegible]

2. Enter the number of blocks 2. _____
3. Subtract (1) from line 2 3. _____
4. Enter the total for column 3 4. _____
5. Enter the total for column 4 5. _____

6. Divide line 4 by line 2

6. _____

Line 6 is the average difference between control and test feeds.

7. Calculate the square of line 4.

7. _____

8. Divide line 7 by line 2.

8. _____

9. Subtract line 8 from line 5.

9. _____

10. Divide line 9 by line 3.

10. _____

11. Divide line 10 by line 2.

11. _____

12. Enter the square root ($\sqrt{}$) of line 11.

12. _____

Line 12 is the "standard error of the difference."

13. Divide line 6 by line 12. (*Note: Ignore any negative sign when performing calculation for line 13.*)

13. _____

14. Refer to line 2 and choose the appropriate value from the table below.

14. _____

# Blocks (line 2)	Value
2	12.706
3	4.303
4	3.182
5	2.776
6	2.571
7	2.447
8	2.365
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15. Please check:

() Line 13 is larger than line 14.

Conclusion: Performance of pigs fed control and test feeds is different.

() Line 14 is larger than line 13.

Conclusion: Performance of pigs fed control and test feeds is not different.

Checklist for Evaluating Feed Trial Results

Results from farm feed trials are presented in sales meetings and promotional materials often with few details about how the trials were conducted. Before feed trial results are accepted and applied, inquire about some basic principles of good experimental design and procedures. A checklist is provided below to assist in evaluating feed trial results. "Yes" responses suggest that sound experimental procedures were applied and the trial results are probably valid.

- 1) Was more than one pen of pigs fed each feed type? *(Note: Two pens sharing the same feeder constitutes one pen.)*
_____ yes _____ no _____ don't know
- 2) If yes, how many pens/fed type? _____
- 3) Was the number of pigs/pen, feeder type, floor space/pig, feeder and waterer space/pig the same in each pen?
_____ yes _____ no _____ don't know
- 4) Were steps taken to reduce the chance that pen location in the room or building influenced the results?
_____ yes _____ no _____ don't know
- 5) If yes, describe these steps.
- 6) Was the difference in average initial pig weights between feed types less than 5 percent of the average weight of all pigs in the trial?
_____ yes _____ no _____ don't know
- 7) Was the ratio of barrows to gilts the same in each pen?
_____ yes _____ no _____ don't know
- 8) What is the standard error of the difference between the feeds evaluated? *(Note: If the average difference between feeds (line 6, Table III) is less than two times the standard error of the difference (line 12, Table III), the results being evaluated are probably not reproducible on a given farm.)*