RESEARCHREPORT

ANIMAL WELFARE

Title: Effect of Feeding System Failures on Grow-Finish Performance and Welfare - **NPB #04- 179**

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Abstract: Out-of-feed events are a growing industry problem as production systems struggle with feed delivery to remote sites, feed flow issues from bulk feed storage devices and equipment failures in facilities. Two experiments were conducted to examine the impact of repeated out-of-feed events on grow-finish pig performance and welfare. In Exp. 1, pigs were out-of-feed for a 20 hr period either never or on 1 random day each week for a 16 week trial. In a 2x2 factorial design, diets were either 1266 or 1019 microns in addition to never or weekly out-of-feed. Repeated out-of-feed events reduced daily gain for the first 8 weeks of the experiment by 0.15 lb/d, with no effect the second 8 weeks. Overall, weekly out-of-feed events reduced daily gain 0.07 lb/d compared to never being out of feed. There was no effect of out-of-feed events on feed conversion efficiency or pig welfare as measured by bi-weekly skin lesion and tail-biting scores. Reducing the diet particle size 250 microns improved feed conversion efficiency by 3.1% for the entire grow-finish period, and there was no interaction between particle size and out-of-feed events.

In Exp. 2, pigs were out-of-feed for 20 hr 0x, 1x, 2x or 3x times every 2 week period on random days. Similar to Exp. 1, increasing the number of out-of-feed events resulted in a decrease in daily gain for the first 8 weeks. However, in the second 8 weeks of the experiment, there was no effect of any out-of-feed treatment on daily gain, daily feed or feed conversion. Overall, there was a linear decrease in daily gain with increasing out-of-feed events with no effect on feed conversion. Similar to the first experiment, there was no impact of out-of-feed events on pig welfare as measured by bi-weekly skin lesion and tail-biting scores.

Introduction: In theory, bulk bins and automated feed delivery systems assure an uninterrupted flow of feed to feeder in swine grow-finish facilities. In practice, growing-finishing pigs have varying disruptions in feed availability, some of which may have very serious consequences. While every swine grow-finish facility has occasional disruptions due to mechanical failures in the feed delivery system, there are additional disruptions due to human errors associated with delivering feed to the bulk bin and feed bridging associated with feed removal from the bin. Out-of-feed events are a known cause of ulcers in pigs and are suspected of being associated with increased incidence of

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hemorrhagic bowel syndrome and ileitis. It has been speculated that each 20 to 24 hour out-of-feed event results in an increase in variation in growth within a population of pigs and results in a reduction in daily gain.

Pork producers routinely mill ingredients in swine diets to have a particle size of 700 to 900 microns since the finer particle size results in better feed conversion efficiency. Recent results from Kansas State University suggest that as particle size decreases, and the amount of fat added increases in corn-based diets, the angle of repose (an estimate of likelihood of bridging) increases. Data suggests a 1-1.5% improvement in feed conversion efficiency for each 100 micron reduction in particle size from 1000 to 500 microns. The current University of Nebraska recommendation is to process complete diets to an average particle size of 650 to 750 microns for all grains except wheat.

Objectives:

1) To compare the effect of weekly interruption of feed availability versus feed particle size on pig growth, performance and welfare.

2) To compare the impact of interruption of feed availability 0, 8, 16 or 24 times during the grow-finish period on pig growth, performance and welfare.

Materials and Methods: The research was conducted at the University of Nebraska's Haskell Ag Lab at Concord. The research facility was a fully slatted, naturally ventilated wean-to-finish unit with 16 pens (8 ft x 14 ft). Each pen had 1 2-hole Farmweld wean-to-finish feeder and 1 Drik-o-Mat wean-to-finish cup drinker. There were 15 pigs per pen at weaning (7.5 ft^2/pig) and pen size was not reduced in the event of pig death or removal.

On the day of weaning (14-21 d of age), the pigs were transported approximately 200 miles. At arrival, they were ear tagged, individually weighed and assigned to pens on the basis of arrival weight such that all pens had similar mean weights and within pen coefficients of variation for weight. The experimental treatments began 6 weeks after weaning in Exp. 1 and 5 weeks after weaning in Exp. 2. Only barrows were used in these experiments to minimize the random out-of-feed events associated with gilts urinating in a feed trough and plugging a feeder for an unknown length of time.

The out-of-feed events consisted of closing the feeder delivery device completely at noon and reopening the device at 8:00 a.m. the following morning which resulted in a 20 hour period when no feed was available to a pen of pigs. Pigs were weighed every other week, and on the week of weighing the feeders were never closed on Thursday evening so that pig weights on Friday morning were not confounded with an out-of-feed event. Diet samples were collected on each weigh day and submitted for particle size analysis at the conclusion of each experiment.

Corn-soybean meal based diets were formulated with corn ground in a full-screen hammer mill. Diets containing 40 g/t tylosin were switched to the next lysine sequence on the basis of the average weight of all pigs in the facility. Lysine levels were 1.15% from 40-80 lb, 0.99% from 80-135, 0.77% from 130 to 195, and 0.62% from 195 to slaughter. Diets contained 3% added fat from 45 to 135 lb BW and 1.5% added fat thereafter.

Skin lesions (i.e. lesions that were pink/bleeding), tail biting, and lameness were observed on every weigh day and independently scored by two observers. Lesions were ranked on a 0 to 4 scale with 0 being no fresh lesions observed and 4 being many (12+ small or 6+ large) lesions. Tail biting was ranked on a 0 to 4 scale with 0 being no tail biting and 4 being a large, deep and open wound. Lameness was ranked on a 0 to 2 scale with 0 being no lameness and 2 being complete inability to place weight on one or more limbs.

Pigs were vaccinated for erysipelas, M. hyo and ileitis prior to the start of the out-of-feed events. All pigs that died were examined by a veterinarian for cause of death.

All pigs were scanned using realtime ultrasound for 10^{th} rib backfat depth and loin muscle area on weeks 4, 8, 12 and 16. The same 3 randomly selected pigs per pen were bled on week 0, 4, 8, 12 and 16 via vena puncture and frozen plasma samples were submitted to the non-ruminant nutrition laboratory at the University of Nebraska for assay of plasma urea nitrogen, non-esterified fatty acids and plasma glucose. Bleeding occurred beginning at 6:30 a.m. on the morning feeders were scheduled to be opened following shut-down the previous day.

The pen of pigs was the experimental unit for all observations.

Experiment 1. The experimental treatments in a 2 x 2 factorial arrangement of treatments were:

1) Out-of-feed never or once per week,
2) Coarse or medium complete diet particle size.

The day of the week that the out-of-feed event began was randomly selected each week from Monday thru Friday.

All pigs that weighed greater than 205 lbs were slaughtered at Tyson Foods Madison, NE, four days after final weights were taken on day 109 of the experiment. Pigs were tattooed by pen and pen average carcass data for back fat, loin muscle depth and percent lean was provided by Tyson Foods.

Experiment 2. Experimental treatments were out-of-feed events on a random day within each 2 week period. Pigs were out-of-feed for 0, 1, 2 or 3 times every 2 week period. The out-of-feed events were randomly assigned to days (Monday through Friday each week) within each 2 week period. There was at least one day of feed availability between multiple out-of-feed occurrences in every two week period.

Results:

Experiment 1

The only interactions ($P<0.1$) between feed particle size and out-of-feed events was starting weight and carcass lean percent. Thus, the main effects of the experimental treatments on pig performance are presented in Table 1.

Random, weekly 20-hr out-of-feed events resulted in a 0.077 lb/d reduction in daily gain ($P<0.008$) compared to pigs which were never out-of-feed. Weekly out-of-feed events reduced daily feed overall 0.195 lb/day ($P<0.023$) but had no effect on feed conversion.

The pigs adapted to the random weekly out-of-feed event. For the first 53 days of the experiment, daily gain was reduced 0.150 lb/d compared to 0.009 lb/day for the subsequent 56 day period for the out-of-feed versus never pigs. Similarly, daily feed was reduced 0.291 lb/d for the first 53 day period and only 0.101 lb/d for the subsequent period. There was no difference in feed conversion between the out-of-feed and never treatments for either period. Figures 1 and 2 document the declining impact of the out-of-feed events on daily gain and daily feed intake as the trial progressed.

Because of the overall reduction in daily gain, out-of-feed pigs were lighter at slaughter, had lower hot carcass weights, carcass fat depth and carcass loin depth compared to the never pigs. There was no effect of out-of-feed events on carcass lean percent.

Particle size for the medium treatment was coarser than expected, even though ground corn was pre-sampled at the commercial mill for both particle sizes with the intent of having coarse and fine particle size diets. The coarse diet averaged 1266 microns (2.16 SD) and the medium diet averaged 1019 microns (1.61 SD) for the entire trial. However, for the first 8 weeks, the coarse and medium diets were 1224 microns (2.4 SD) and 929 microns (1.7 SD). For the second 8 week period, the corresponding particle sizes were 1307 microns (1.9 SD) for the coarse diet and 1109 microns (1.6 SD) for the medium diet.

The response to differences in diet particle size agrees with previously published results. There was no effect of particle size on daily gain. However, pigs fed the coarse diets ate more feed for the final 56 day period compared to pigs fed the medium ground diets. Pigs fed the coarse diets had poorer feed conversion efficiencies for both the 53 day initial and 56 day final period. This resulted in a 0.091 lb of feed per lb of gain improvement in overall feed conversion efficiency for the pigs fed the coarse versus medium diet ($P<0.001$), an improvement of 3.1%.

Feed was delivered in bulk for this experiment and augered into a weigh cart for delivery to individual feeders. While not quantified, there were considerably fewer bridging problems with feed removal from the bulk storage bins for the coarse versus medium diets.

Because of the small numbers involved, it was not possible to detect a significant difference between treatments for the number of pigs that died, were removed or weighed less than or equal to 205 lbs at the end of the experiment. However, pigs fed the medium diets and pigs experiencing weekly random out-of-feed events had numerically higher numbers of deaths and lightweight pigs at the end of the experiment. Two pigs were removed from the experiment for severe tail biting injury with one on the medium/out-of-feed treatment combination and the other on the medium/never out-of-feed treatment combination.

There was no effect ($P > 0.1$) of any experimental treatment on skin lesions scores (Table 2). There was also no effect ($P > 0.1$) of out-of-feed events on tail biting. However, pigs fed the medium diet had an increase in severity of tail biting score compared to the coarse pigs ($P=0.012$).

Experiment 2.

Similar to the first experiment, increasing the number of out-of-feed events every 2 week period resulted in a linear ($P=0.003$) decrease in daily gain for the first 8 weeks of the experiment (Table 3). However, there was no effect of out-of-feed events on daily gain ($P>0.1$) for the second 8 week grow-finish period. The significant linear response for the first 8 week period, when combined with the lack of response for the second 8 week period resulted in a linear ($P=0.030$) decrease in overall daily gain. However, the majority of this linear decrease was due to the 1.89 lb/d daily gain for the 3x treatment compared to the 1.96 lb/d daily gain for the 0x and 1x treatments.

Daily feed followed the daily gain pattern. For the first 8 week period, increasing the number of out-of-feed events resulted in a linear ($P=0.011$) decrease in daily feed intake. For the second 8 week period, there was no effect of treatment ($P>0.1$) on daily feed. Overall, there was a trend for a linear ($P=0.111$) decrease in daily feed intake with increasing out-of-feed events.

Similar to Experiment 1, there was no effect of treatment on average skin lesions scores ($P>0.1$; Table 4). There was a trend ($P=0.108$) for pigs on the 3x treatment to have a higher tail biting score compared to the other treatments. There were no lame pigs in this experiment so there was no effect of treatment on lameness.

Although not included in Table 3, there was no effect of treatment (P>0.1) on backfat depth at any of the time points. There was a quadratic effect of treatment (P=0.028) on loin muscle area at 16 weeks (5.74, 5.52, 5.64 and 5.94 in^2 for the 0x, 1x, 2x and 3x treatments respectively).

Discussion: Out-of-feed events are an ongoing concern in most production systems. However, these data suggest that pigs adapt to out-of-feed events. In both experiments, out-of-feed events during the first 8 week period resulted in a decrease in daily feed intake and decrease in daily gain. However, there was effect of out-of-feed events on daily feed intake or daily gain during the second 8 week period.

However, it is not possible to determine if this adaptation is a function of pig size or repeated exposure to out-of-feed events. That is, does the adaptation to repeated 20 hour out-of-feed events occur because the pig has a larger body mass, and as a consequence a larger capacity for feed when feed is made available, or does it occur because the pig alters it's eating behavior in response to repeated out-of-feed events?

These experiments were designed to examine the impact of repeated out-of-feed events during the entire grow-finish phase of production on pig performance and welfare. They do not allow one to speculate on the impact of sporadic out-of-feed events that occur only in late finishing. Nor do they allow one to speculate on the impact of out-of-feed events that occur only in the grower phase. In the above experiments, while there was no negative impact of out-of-feed events on performance for the second 8 week period, the continuation of out-of-feed events prevented the determination of whether the pig would have compensatory growth during the late finishing period if out-of-feed events ceased.

A 20 hour time period was chosen as the out-of-feed interval based on the theory that if the animal care giver (owner, contract grower or employee) observed pigs one time daily, this would be a reasonable maximum length of time for repeated out-of-feed events to occur. It is not appropriate to extrapolate these results to repeated out-of-feed events that are for shorter duration, such as 5 or 10 hours. Nor is it possible to speculate as to the impact of out-of-feed events that vary in duration. For example, does the pig adapt similar to the adaptation in the above experiments if the length of out-of-feed events varies from 4 hours to 20 hours in a random manner?

Lay Interpretation: Results of these 2 experiments document the impact of repeated out-of-feed events on grower-finisher pig performance. Repeated out-of-feed events that are 20 hours long results in a decrease in daily gain. While the pig appears to adjust to repeated out-of-feed events during the finishing phase, the adjustment doesn't always result in overall performance being equal to pigs which never experience a 20-hr out-of-feed event. While pig welfare associated with fighting when feed availability returns is a concern, there was no difference in pig lesion scores between treatments in either experiment. There was a tendency for an increase in tail biting score for pigs fed the medium vs coarse ground diets in Experiment 1 and for pigs on the 3x every 2 weeks out-of-feed treatment in Experiment 2.

While out-of-feed events resulted in a decrease in daily gain, there was no impact on feed conversion efficiency. As expected, pigs fed the medium ground diets had no difference in daily gain, but had a 3.1% improvement in feed conversion efficiency compared to pigs fed the coarsely ground diets. In production units that must sell pigs by a certain date, these data will allow producers to examine whether the improvement in feed conversion efficiency from finely ground diets overcomes the loss in weight gain from out-of-feed events due to increased bridging often associated with finely ground diets.

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Table 1. Impact of experimental treatments on pig performance, Experiment 1

Item	Out of feed[a]		Particle size[b]		SE	P values		
	Never	Weekly	Coarse	Medium		OOF	PSOOF	x PS
No. pens	8	8	8	8				
Pig wt, lb								
On test	53.2	51.3	52.3	52.2	0.7	0.074	0.941	0.031
d 53	155.2	145.3	150.9	149.6	1.7	0.001	0.613	0.197
d 109	261.8	251.5	257.6	255.7	2.3	0.007	0.559	0.274
Coefficient of variation of pig weight within pen, %								
On test	17.4	16.1	16.3	17.3	1.6	0.891	0.099	0.301
d 53	10.7	10.9	10.3	11.3	1.0	0.881	0.513	0.997
d 109	8.1	8.2	7.5	8.8	0.7	0.881	0.230	0.475
Daily gain, lb								
On test – d 53	1.924	1.774	1.860	1.838	0.022	<0.001	0.482	0.638
d 53 – d 109	1.903	1.894	1.905	1.891	0.019	0.746	0.612	0.246
Overall	1.913	1.836	1.883	1.866	0.017	0.008	0.515	0.651
Daily feed, lb								
On test-d 53	4.421	4.130	4.344	4.208	0.056	0.003	0.113	0.552
d 53-d 109	6.566	6.465	6.674	6.358	0.058	0.240	0.002	0.525
Overall	5.524	5.329	5.541	5.311	0.053	0.023	0.010	0.497
Feed:gain								
On test d 53	2.298	2.328	2.335	2.290	0.013	0.133	0.032	0.601
d 53-d109	3.448	3.413	3.501	3.359	0.022	0.291	0.001	0.700
Overall	2.888	2.901	2.940	2.849	0.016	0.545	0.001	0.612

Carcass data, Tyson Fresh Meats, Madison, NE								
Carcass wt., lb	206.3	197.5	201.6	202.1	1.7	0.004	0.839	0.173
Fat depth, in.	1.02	0.97	0.98	1.00	0.02	0.146	0.518	0.114
Loin depth, in	2.75	2.67	2.72	2.70	0.02	0.023	0.553	0.306
Lean, %	53.5	53.5	53.6	53.4	0.1	1.000	0.257	0.021
Pigs dead, no.[c]	2	4	2	4				
removed, no.	1	1	0	2				
< 205 lb, no.	2	4	2	4				

[a]Never = never out-of-feed; Weekly = 20 hr out-of feed on a random day each week.
[b]Coarse = average 1266 microns; Medium = average 1019 microns.
[c]Chi Square analysis; P > 0.1 for all comparisons.

Table 2. Impact of experimental treatments on skin lesions and tail biting score (0 to 4 scale), Experiment 1

	Out of feed[a]		Particle size[b]		P value[c]	
Item	Never	Weekly	Coarse	Medium	OOF	PS
Average skin lesion score	0.29	0.26	0.27	0.27	0.351	0.808
Average tail biting score	0.03	0.02	0.01	0.05	0.301	0.012

[a]Never = never out-of-feed; Weekly = 20 hr out-of feed on a random day each week.
[b]Coarse = average 1266 microns; Medium = average 1019 microns.
[c]Friedman Chi Squared test on ranked pen means.

Table 3. Impact of experimental treatments on pig performance. Experiment 2

	Treatment[a]					Treatment	Orthogonal Contrasts		
Item	0	1	2	3	SE	P-Value	Linear	Quadratic	Cubic
No. pens	4	4	4	4					
Pig wt, lb									
On test	39.2	39.8	41.0	39.2	0.8	0.378	0.765	0.154	0.344
d 56	142.7	141.7	140.1	132.1	2.6	0.050	0.014	0.193	0.621
d 112	257.9	259.2	259.0	251.0	2.6	0.134	0.097	0.097	0.597
Coefficient of variation of pig weight within pen, %									
On test	21.4	17.6	19.0	21.6	2.7	0.678	0.881	0.257	0.744
d 56	14.2	12.6	14.3	16.9	2.1	0.554	0.311	0.338	0.791
d 112	11.9	9.8	10.8	12.5	1.7	0.710	0.730	0.298	0.758
Daily gain, lb									
On test - d 56	1.85	1.82	1.77	1.66	0.04	0.018	0.003	0.286	0.824
d 56 - d 112	2.06	2.10	2.12	2.12	0.03	0.496	0.149	0.545	0.986
Overall	1.96	1.96	1.95	1.89	0.02	0.076	0.030	0.133	0.682
Daily feed, lb									
On test - d 56	4.12	4.08	3.98	3.70	0.10	0.049	0.011	0.245	0.802
d 56 - d 112	7.04	6.88	7.07	6.97	0.11	0.609	0.972	0.760	0.205
Overall	5.58	5.48	5.53	5.34	0.09	0.300	0.111	0.615	0.368
Feed:gain									
On test - d 56	2.23	2.24	2.25	2.23	0.02	0.912	0.924	0.527	0.776
d 56 - d 112	3.45	3.32	3.37	3.31	0.04	0.165	0.095	0.402	0.180
Overall	2.86	2.80	2.84	2.82	0.02	0.408	0.510	0.380	0.199

[a] Number of times pens were out-of-feed for a 20 hr period on a random day every 2 week period.

Table 4. Impact of experimental treatments on skin lesions and tail biting score (0 to 4 scale), Experiment 2

Item	Treatment[a] 0x	1x	2x	3x	P value[b]
Average skin lesion score	0.38	0.42	0.44	0.34	0.422
Average tail biting score	0.02	0.00	0.01	0.05	0.108

[a]Number of out-of-feed events on a random day every 2 week period.
[b]Friedman Chi Squared test on ranked pen mean

Figure 1. Reduction in daily gain due to weekly OOF events, Exp. 1.

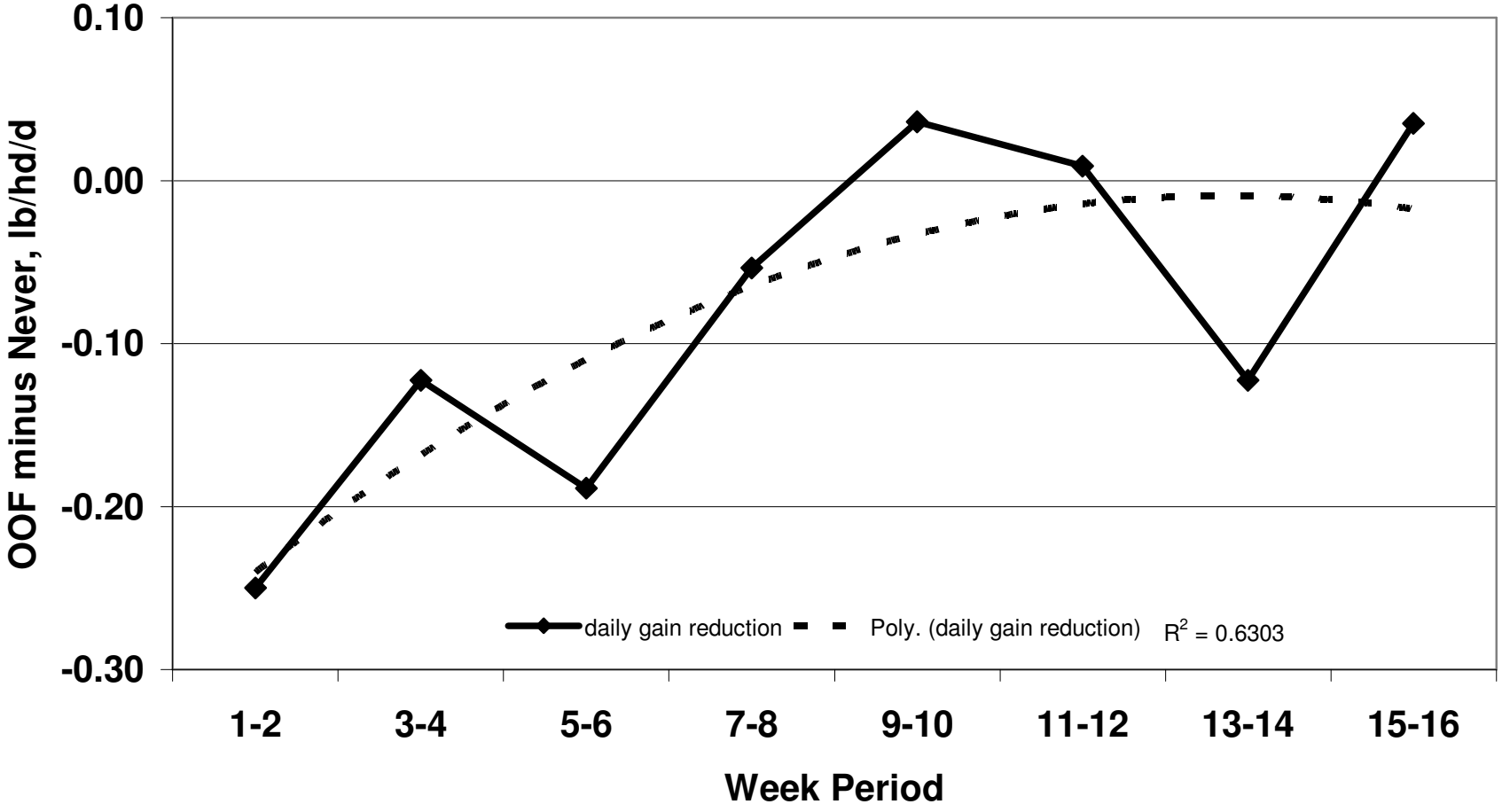

Figure 2. Reduction in daily feed due to weekly OOF events, Exp. 1.