EFFECTS OF PEN SIZE ON THE IMPLANT RESPONSE OF FEEDLOT CATTLE

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ABSTRACT

Sixty nine large pen research trials conducted by Bos Technica Research Services, Inc. involving approximately 103,500 cattle were used to determine number of pens/treatment and number of animals/pen needed to detect statistical differences (Power=.80 and P<.05) in average daily gain, dry matter intake and dry matter feed conversion with pen as the experimental unit. Power curve statistics demonstrated increasing replication (pens/treatment) and/or pen size (animals/pen) increased the ability to detect (P<.05) smaller treatment differences. A historical data base provided by Koers-Turgeon Consulting Service, Inc. involving 47.85 million feedlot cattle, based on a monthly occupancy rate of 683,573 animals, demonstrated anomalies existing in large pen feedlots. Different conclusions were drawn from research results depending on whether or not anomalies, such as, death loss, buller incidence and railer incidence were accounted for in performance calculations. Anomalies measured in large pen studies, rarely occurring or reported in small pen studies, influence implant response and data interpretation. The need for reimplanting cattle should be re-evaluated and alternatives sought out to eliminate it from the industry without sacrificing performance or carcass merit. Researchers should report performance data showing, both with and without, anomalies whenever measured and spend more pre-trial time determining the number of animals and pens needed to demonstrate treatment differences (P<.05).

INTRODUCTION

Applying small pen research data to large pen feedlots is often taken at face value. Anomalies such as death loss, buller incidence, railer incidence and vaginal prolapses rarely exist in small pen studies containing less than 50 animals/pen; yet, they are feedlot reality. How these might influence the implant response in terms of animal performance and carcass characteristics is not well documented in the scientific literature. Most research data are reported with deads and rejects out of the calculations demonstrating only performance of live cattle marketed with the pen. The feedlot industry calculates close-outs deads in and deads out. Feedlot managers recognize performance differences in close-outs basis deads in or deads out. The scientific community should follow suit to advance our knowledge of implant products and programs. Numerous studies exist where treatment differences were not significant (P>.05) even though large numerical differences were apparent. This is especially true for carcass measurements. The purpose of this presentation was to: (1) evaluate the effect of pen size (animals/pen) and pens/treatment on implant response and (2) determine the impact of reimplanting on anomalies measured in large pens.

MATERIALS AND METHODS

Power Curve Data. Sixty nine research trials conducted by Bos Technica Research Services, Inc., Salina, Kansas were used to generate power curves for average daily gain, dry matter feed intake and dry matter feed conversion (Cochran and Cox, 1957; Eskridge,1996). The trials consisted of pens containing 50 to 100 animals/pen with approximately 20 pens per trial. Approximately 103,500 head of research cattle were represented in the live performance measurements. Power curve statistics for percent choice was derived from six trials involving approximately 9000 cattle. The research trials consisted of finishing studies comparing feed additive and/or implant treatments over an approximate 150 day feeding period. Pen was the experimental unit. Coefficients of variation commonly ran 1-3% for the live performance measurements in these trials.

Death Loss Data. A six year historical data base (Koers-Turgeon Consulting Service, Inc., 1991-1996) was used to evaluate death loss, buller, vaginal prolapse and railer incidences in commercial feed yards. The data base covered a time frame of January 1991-October 1996. Forty-seven million eight hundred fifty thousand and one hundred thirteen cattle representing 34.55 million steers and 13.30 million heifers were involved. Monthly occupancy rate was 683,573 animals.

Death loss causes were categorized as Total, Respiratory, Digestive and Other. Monthly death loss and railer incidence was calculated as a percent of the monthly occupancy rate. Therefore, a close-out value could be determined by simply multiplying the monthly rate times the months in a feeding period.

Buller incidence was reported as a percent of the monthly steer population. Vaginal prolapses were reported as a percent of the monthly heifer population.

Performance Data. Two implant trials (Bos Technica Research Services, Inc.) were pooled and used to demonstrate the differences in animal performance depending whether or not death loss and railer incidence was taken into account in the performance calculations. The combined results of trials 1 and 2 consisted of 1074 steers weighing initially 652 lbs. The cattle were on feed 168 days. A total of 12 pens were used with 6 pens/treatment. The two implant program treatments were : (1) A single trenbolone acetate implant given day 1 and (2) An estrogen implant given day 1 followed by a trenbolone acetate implant given day 78. The single implant treatment cattle (trenbolone acetate, day 1) were not re-handled when the treatment 2 cattle were reimplanted. Pen was the experimental unit for all both. Initial animal weights were full weights taken the first day of the trial. Single day final pen weights were adjusted for a 4%shrink.

Performance results were calculated two different ways. The first method was with deads and railers/rejects out of the data base. This is consistent with a vast majority of the reported literature demonstrating the performance of cattle that lived and marketed with the pen come close-out time. Feed for dead/railer cattle was accounted for by deducting the average intake of the pen for every day that animal was on test. Feed for hospital days was accounted for as 50% of the home pens intake for each day an animal was in the hospital. Average daily gain was determined as the difference in average animal weights at the start and end of the trial divided by the number of days on feed.

The second method of calculation was that most representative of feedyard close-outs which include all deads and railers in performance numbers. In this case, average daily gain was determined by taking the difference of total cattle pounds in versus total cattle pounds marketed divided by total head days. This method of calculation is rarely reported in scientific journals or feeder day reports; yet, it is the most commonly used method in the feedlot industry.

RESULTS AND DISCUSSION

Power curve statistics pre-determine the number of replications needed for a given pen size (animals/pen) to measure a detectable treatment difference. Power curves were generated with power = .80 and $P < .05$ (Table 1, Figures 1, 2, and 3). That is, an 80% probability existed of detecting a difference at $P < .05$. Increasing the number of replications/treatment for a given pen size clearly results in the ability to detect ($P < .05$) smaller differences. Interestingly, this was not a linear function; but rather, a quadratic one (Figure 1).

Not only does increasing the number of replications/treatment for a given pen size result in the ability to detect smaller treatment differences, but also, increasing the number of animals within a pen for a given number of replications/treatment (Table 1, Figures 2, 3). For example, a .40 lb/hd/d treatment difference in average daily gain is expected to be different ($P < .05$) with 4 pens/treatment in10 head pens (Table 1). This is a 13% difference in average daily gain for cattle gaining 3.0 lb/hd/d. Few published implant studies show such a large treatment difference, let alone a significant difference ($P < .05$) in rate of gain, unless comparisons were made to non-implanted negative control cattle. The detectable average daily gain difference, however, improves to .12 lb/hd/d with 100 head pens and 4 pens/treatment. This represents a 4% gain difference for cattle gaining 3.0 lb/hd/d. A 3-5% gain difference among different implant treatments is more commonly reported. No wonder so many published trials fail to report significant differences ($P < .05$). They simply lacked the statistical power, in terms of animals/ pen and/or pens/treatment, at the trial's inception.

Table 1. Effect of pen size (head/pen) and replication (pens/treatment) on detecting a difference ($P < .05$, Power = .80) in average daily gain, dry matter intake, dry matter feed conversion and percent choice.

		Head / Pen			
Detectable difference	Pens / Treatment	10	50	100	600
Average daily gain, lb/hd	2	.90	.40	.28	.11
	4	.40	.15	.12	.05
	6	.30	.13	.10	.04
Dry matter intake, lb/hd	2	3.8	1.7	1.2	.5
	4	1.7	.8	.5	.2
	6	1.3	.6	.4	.15
Feed conversion	2	1.40	.64	.45	.18
	4	.60	.28	.20	.08
	6	.45	.20	.15	.06
Percent Choice	2	72	32	23	9
	4	32	14	10	4
	6	24	11	8	3

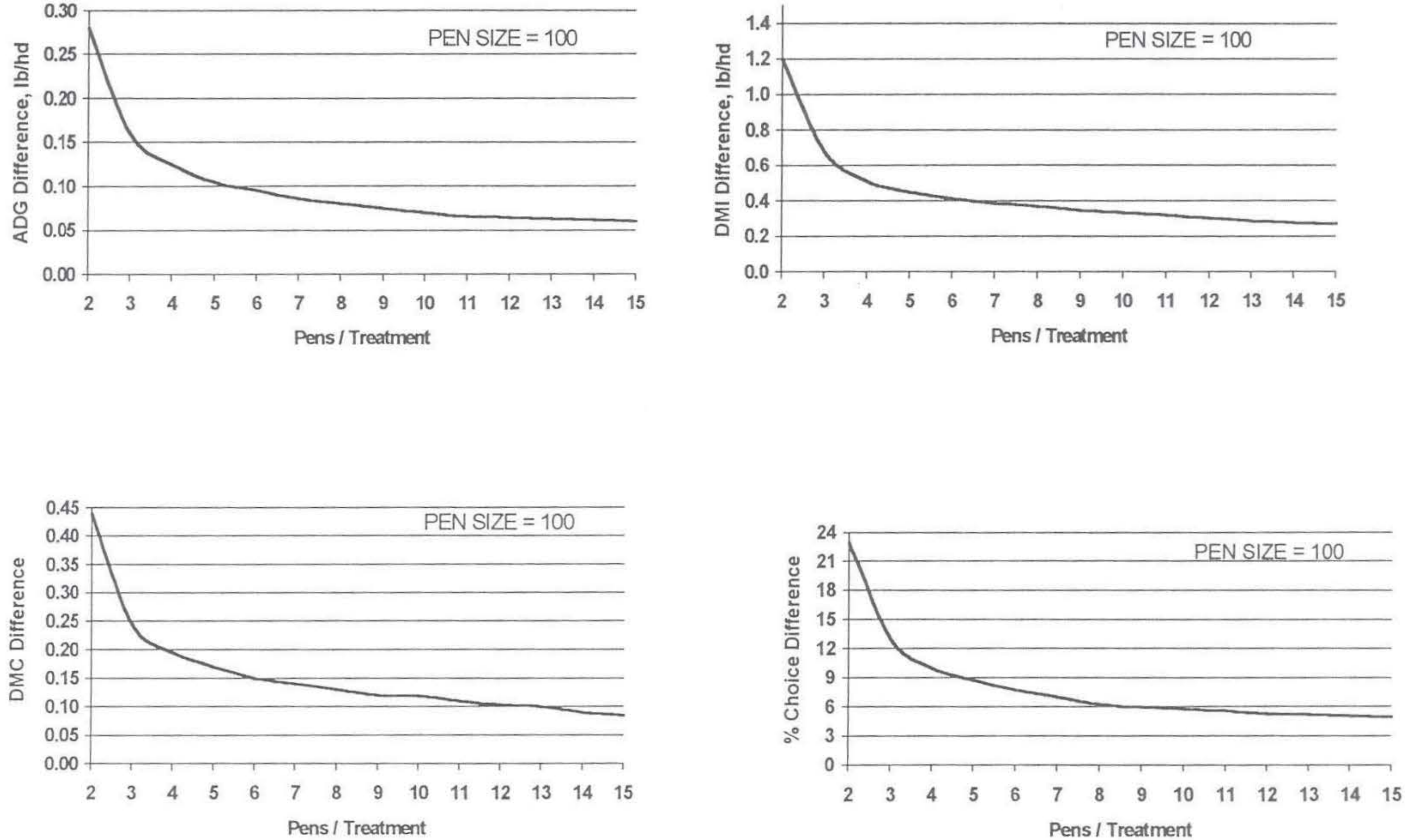

Figure 1. Effect of replication (pens/treatment) on detecting a difference ($P < .05$, Power = .80) in average daily gain (ADG), dry matter intake (DMI), dry matter feed conversion (DMC), and percent choice for a pen size of 100 head.

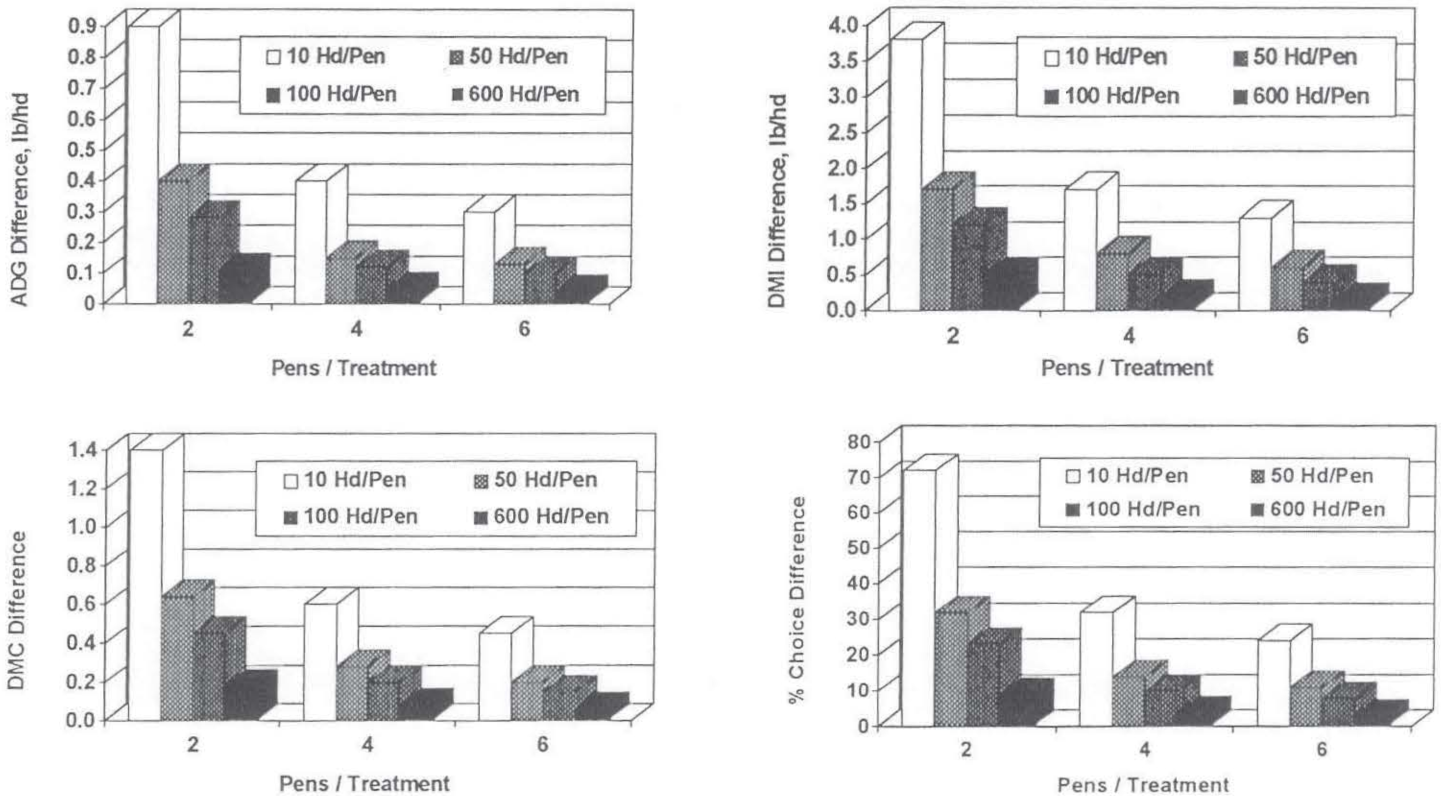

Figure 2. Effect of pen size (head/pen) and replication (pens/treatment) on detecting a difference ($P<.05$, Power = .80) in average daily gain (ADG), dry matter intake (DMI), dry matter feed conversion (DMC), and percent choice.

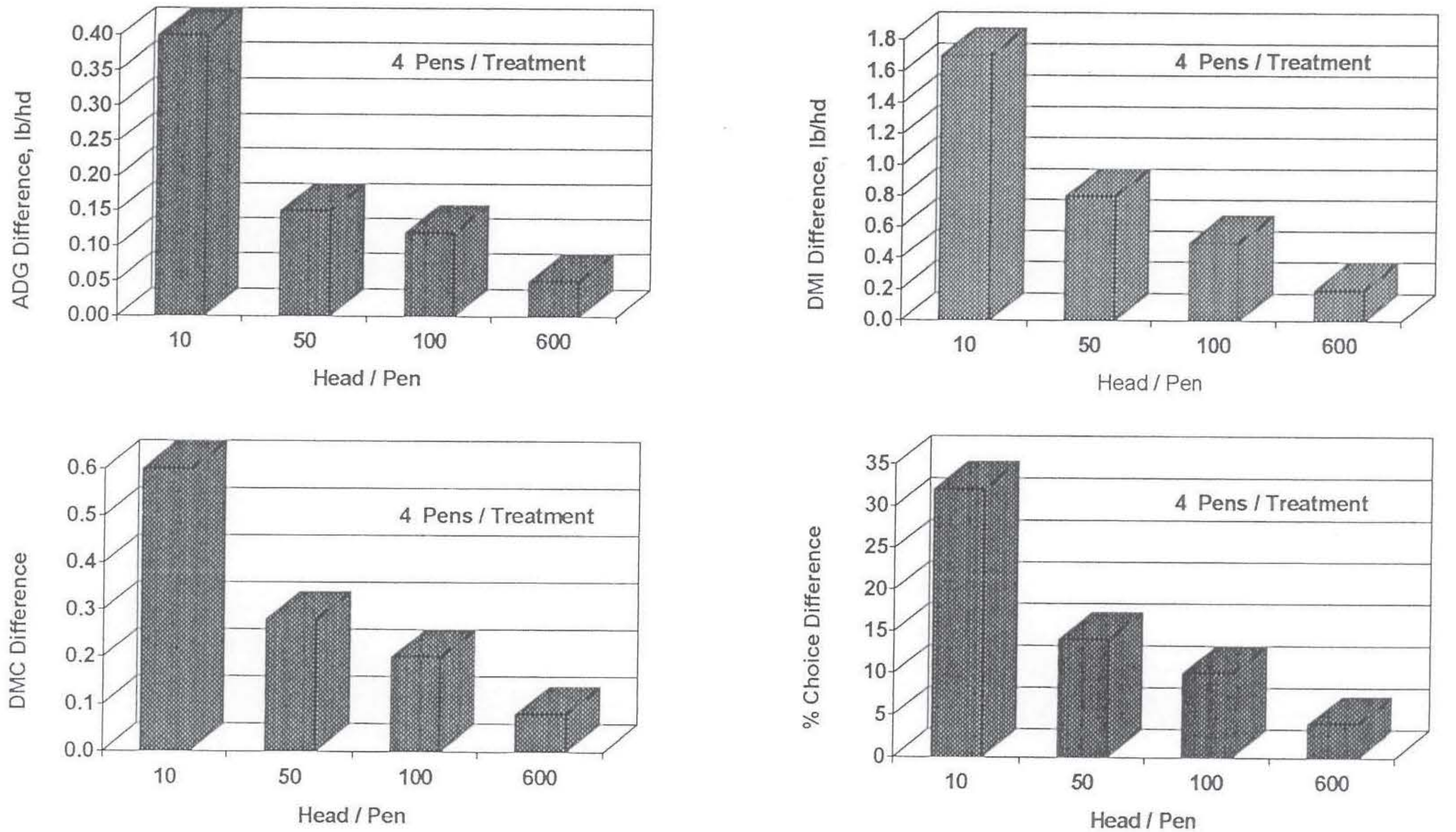

Figure 3. Effect of pen size (head/pen) on detecting a difference ($P < .05$, Power = .80) in average daily gain (ADG), dry matter intake (DMI), dry matter feed conversion (DMC), and percent choice with four pens/treatment.

In order to detect differences in carcass characteristics large numbers of cattle and/or pens are needed (Table 1, Figures 1, 2, and 3). Some researchers have weakened and reverted to using animal as the experimental unit which certainly increases the probability of detecting treatment differences. This raises statistical concern and debate, however, for pen fed animals. Consequently, trends are often relied upon when evaluating carcass characteristics. Case in point. How often is the incidence of dark cutters reported in the Journal of Animal Science? Dark cutters are certainly a small measurement; yet, economically important.

Anomalies exist in large pen feedyard conditions which rarely reveal themselves at the small pen level (Figures 4 and 5). Small pens are referred to as anything less than 50 animals/pen. For example, the Digestive death loss rate average .05% of monthly occupancy (Figure 4). Consequently, a 20,000 head feedyard could expect 10 Digestive deads per month. Applying this to a 200 head research trial results in a Digestive death loss of .10 animals per month or .50 animals for a five month study. Therefore, it is not likely to adequately measure such a small occurrence in a small pen setting. The same is true when one takes into account the incidence of bullers, railers and vaginal prolapses (Figure 5) all of which might influence implant response. These are small yet significant economic problems facing the beef industry.

How might pen size/density influence the implant response? To answer this question one must move out of the world of small pen studies and into the world of large pen feedlots where "real world" problems exist. Buller incidence is seasonal peaking in August (Figure 5). A similar finding was reported by Brower and Kiracofe, 1978. Buller incidence was also a function of pen size. A two-fold increase in buller rate was measured in average pen sizes of 178 steers/pen versus 318 steers/pen, ALL versus SELECTED, respectively (Figure 5). Buller incidence was substantially increased for reimplanted steers (Table 2 and 3). Whether this was due to the implant itself or simply to the act of re-handling the cattle is confounded.

Table 2. Effect of reimplanting on buller incidence in beef feedlot steers[a]

	Estrogen Implant Treatment	
Item	Single Implant Day 1	Reimplant Day 1 and 78
Bullers, %	1.65	3.21

[a] 57,000 Steers. 150 Days.

Table 3. Effect of reimplanting on buller incidence in Holstein feedlot steers[a]

	Treatment	
Item	Two Estrogen Implants[b]	Three Estrogen Implants[c]
Bullers, %	.17	.90

[a] 5,044 Steers. 350 Days.
[b] Day 1 and 164.
[c] Day 1, 134, and 229.

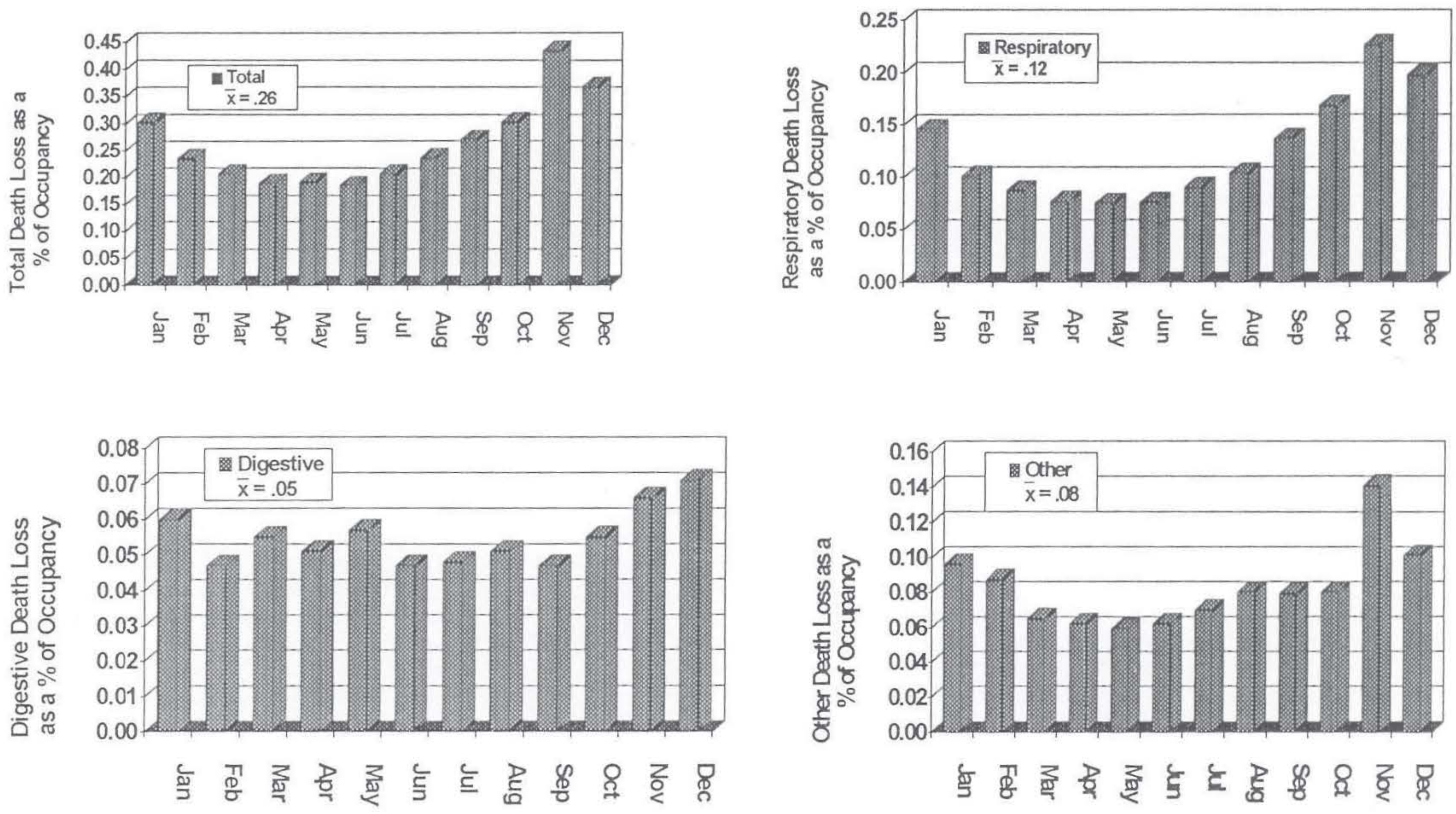

Figure 4. Total, respiratory, digestive and other death losses as a percent of monthly occupancy in commercial feedyards from January 1991 - October 1996.

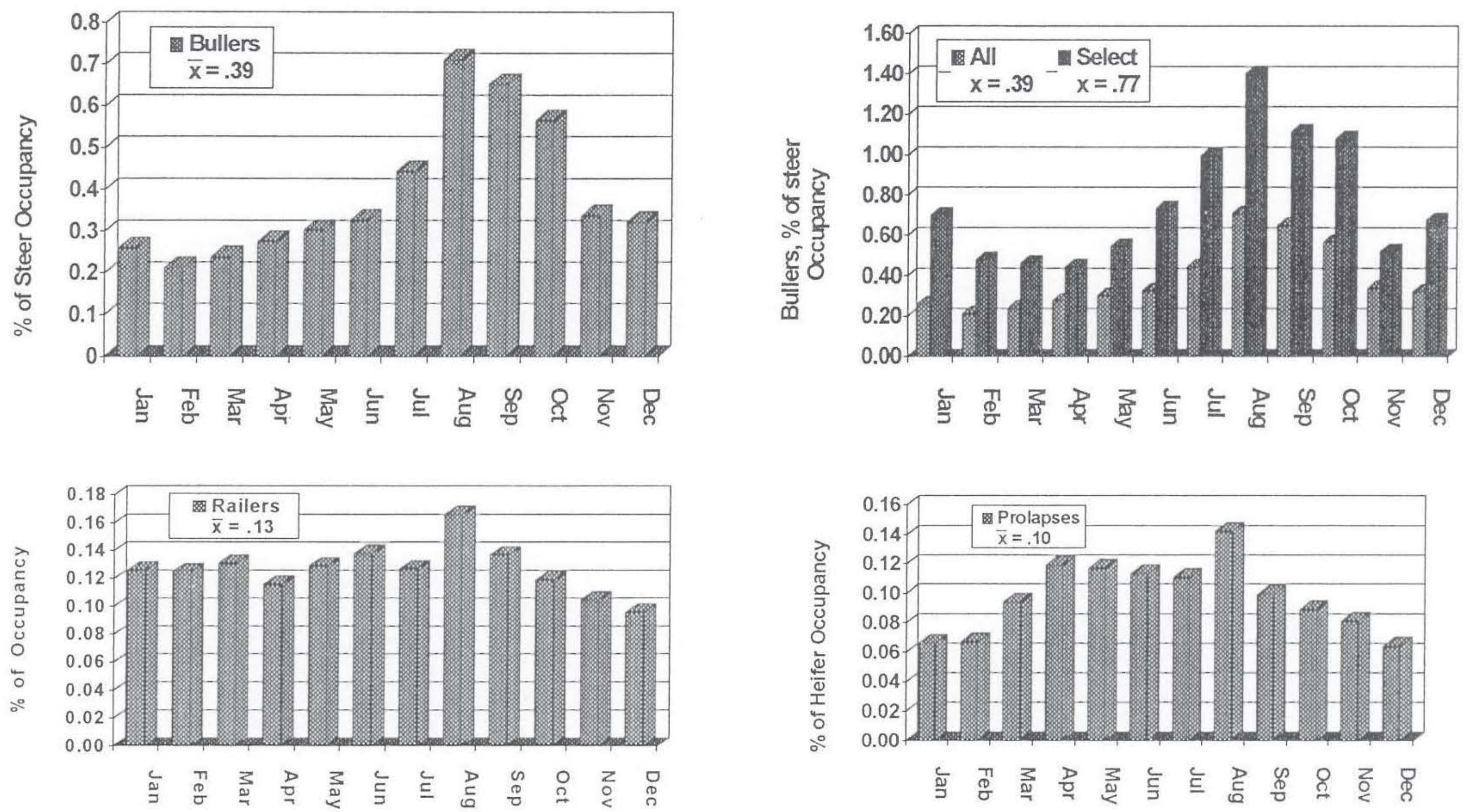

Figure 5. Buller, railer and vaginal prolapse as a percent of the monthly steer and/or heifer population in commercial feedyards from January 1991 - October 1996. All = A pen size of 178 steers/pen. Select = A pen size of 318 steers/pen.

Table 4. Effect of reimplanting on health, railers, and vaginal prolapses in feedlot heifers[a]

Estrogen Implant	Percent			
	Mortality	Morbidity	Railers	Vaginal prolapses
Single, day 1	.86	11.2	1.05	.27
Reimplant[b]	1.12	14.5	1.49	.65

[a] 15,007 Heifers. 155 Days.
[b] Day 1 and 75.

Brower and Kiracofe, 1978 reported a buller cost of $23.00 each. This is consistent with field estimates (Koers-Turgeon, 1997). It is estimated the monthly buller incidence of .39% costs the industry approximately $.50/steer fed ($25.00 x .39% x five months on feed).

Reimplanting increased death loss, morbidity, railers and vaginal prolapses in an evaluation involving 15,007 heifers (Table 4). The economics of this are clearly substantial. It is time for the industry to find alternative products and/or programs to eliminate the need for reimplanting cattle without sacrificing performance or carcass merit.

Implant performance data can be drastically influenced depending whether or not death loss, bullers and railers/rejected cattle are taken into account. This is especially true for reimplant programs because the stress of re-handling large numbers of cattle can impact the implant response. For example, no difference (P>.05) in average daily gain or dry matter feed conversion existed when deads and railers were omitted from performance calculations (Table 5). Carcass characteristics were also similar (Table 7). Results presented in this manner demonstrate the performance of cattle that lived during the course of the trial and is consistent with most scientific publications. Conversely, a 5% improvement (P=.05) in average daily gain existed for the Single Implant program (trenbolone acetate day 1) compared with the Reimplant program (estrogen day 1, trenbolone acetate day 78) when deads and railers were included in the performance calculations (Table 6). Dry matter feed conversion also favored (6.11 vs 6.22) the Single implant program. These differences existed because of the higher death and railer percentages associated with the Reimplant program. Consequently, research information should be presented both ways (1) Deads and Rejects Out and (2) Deads And Rejects In to more accurately evaluate treatment response.

IMPLICATIONS

Pen size, measured as animals/pen, influences implant response because anomalies such as death loss, buller incidence, railer incidence and vaginal prolapses, as well as, carcass differences (P<.05) rarely reveal themselves under small pen conditions. Yet, they significantly alter the outcome of implant studies depending whether or not they were considered in the performance and carcass measurements. When such anomalies were taken into account the benefits of reimplanting cattle, under large pen conditions, was diminished. It is time for the industry to seek out alternative products and/or programs which eliminate the necessary evil of reimplanting cattle without sacrificing animal performance or carcass merit. Researchers should generate power curve statistics, before trial initiation, to more accurately ascertain the number of animals/pen and the number of pens/treatment needed to detect statistical differences (P<.05). GO BIG RED!

Table 5. Effect of reimplanting on feedlot steer performance with deads and railers out (two trial summary)[a]

Item	Implant Treatment: Trenbolone acetate Day 1	Implant Treatment: Estrogen day 1 Trenbolone acetate Day 78	P-value
No. pens	6	6	
No. head	506	530	
ADG, lb	3.03	2.94	.18
DMI, lb/d	17.9	17.4	.07
Feed / Gain	5.95	5.93	.71

[a] 652 lb initial weight. 168 days on feed.

Table 6. Effect of reimplanting on feedlot steer performance with deads and railers in (two trial summary)[a]

Item	Implant Treatment: Trenbolone acetate Day 1	Implant Treatment: Estrogen Day 1 Trenbolone acetate Day 78	P-value
No. pens	6	6	
No. head	522	552	
ADG, lb	2.97	2.82	.05
DMI, lb /d	17.9	17.4	.07
Feed/Gain	6.11	6.22	.35
Mortality, %	.99	2.11	.14
Railers, %	1.72	2.00	

[a] 652 lb initial weight. 168 days on feed.

Table 7. Effect of reimplanting on carcass characteristics of feedlot steers. (two trial summary)[a]

Item	Implant Treatment: Trenbolone acetate Day 1	Implant Treatment: Estrogen Day 1 Trenbolone acetate Day 78	P - value
No. pens	6	6	
No. head	506	530	
Hot carcass wt., lb	737	727	.19
Dress, %	63.78	63.66	.64
Choice, %	44.0	38.2	.40
Yield grade 4, %	8.0	6.6	.58

[a] 652 lb initial weight. 168 days on feed.

LITERATURE CITED

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QUESTIONS & ANSWERS

Horn: You mentioned that the average incidence of bullers was .39% of the monthly steer population. What does that cost in dollars per head against the remaining cattle?

A: Our data showed a .39% buller rate based on the monthly steer population. Data published in the Journal of Animal Science in the late 70's reported a buller cost of about 25 dollars each. This would be consistent with our field estimates. With a monthly rate of .39%, this gives a cost of about 50 cents per head for every steer fed (.39% times 5 months on feed times $25). Big time opportunity.

Stokka: Do you have any data that correlates pen size with death loss?

A: We have not pulled that out of our database.

Q: How about pen size and bullers?

A: Yes. The 178 head pens had about ½ of the buller rate as that presented for the 318 head pens.

Preston: Does the incidence of bullers differ with implant type?

A: Yes, absolutely. We measure, at least 25-50% more bullers with TBA than with estradiol implants alone. I don't think that we are the only ones.

Mader: On your initial slides with statistical comparisons, did you calculate standard errors between 50 and 100 head pens or did you adjust the standard error by calculations? Would that alter conclusions if pen was your experimental unit?

A: First off, pen was the experimental unit for all of the power curves statistics I showed you. We worked with an independent statistician from the University of Nebraska to generate the power curve data. He used actual trial results, including the standard errors and coefficients of variation, in generating those power curve statistics for the 50 and 100 head pens. That data was then used, with the help of Cochran and Cox, to generate the power curve statistics for the 10, 200 and 600 head pens. The power curve data for the 10, 200 and 600 head pens were what was expected from those calculations, so those were projections.

Q: Who is the best consulting company out there?

A: Koers-Turgeon Consulting Service.

Kreikemeier: Do you reach any different conclusions using data from big pens versus small pens? With deads in or deads out? Might an implant increase gain by 15% in small pens but only by 5% in big pens?

A: We recognize that things happen in big pen feedlots that don't necessarily happen at the small pen research level. That was part of the purpose of this presentation. They are two different worlds. Because of these differences, small pen work can be criticized. I still feel, however, that small pen work is extremely valuable information because it adds to our knowledge of implants. The performance differences between small pens and large pens are probably not as great as one might think, especially when one takes into account that the evaluation is made on a similar basis - deads out. I have never seen, however, the Journal of Animal Science report finishing performance data other than deads and rejects out of the database. This is only half of the picture. Where small pen work really misses the boat is in the area of carcass characteristics. Too much emphasis is placed, face value, on carcass data generated from a limited number of small pen studies.

Q: Are you able to pick up significant treatment differences of railers, bullers or deads in large pens?

A: Yes, but it's rare. It takes a lot of numbers to get adequate power.

Van Koevering: Isn't the greatest advantage for large pens in gathering carcass data? In small pens, trends may be detected, but significant differences are rare. It seems like the large pen perspective should have more advantage for detecting differences in carcass data than in average daily gain.

A: Yes, the industry needs to stop all the lip service and get with the program. We need to place much more focus on carcass quality and tenderness of our product. Once we lose sight of these, we are doomed. In the big pen trials, we are normally talking about one thousand to two thousand animals per trial. For average daily gain and dry matter feed conversion, the C. V. runs about 1-2%. The C. V. for percent choice runs about 15-20%. Even though one has a large number of cattle, the C. V. is still very high for percent choice which means a massive amount of cattle is required to show statistical differences. That's why I showed you information for 600 head pens. I'm not saying that data from the small pens are not important. But it is a different world than that of large pens. We detect things that never reveal themselves at the small pen level. How many trials ever measure dark cutters or bullers? And if they do, why isn't it reported? With carcass data from large pens, you have a better probability of showing treatment differences in percent choice, dressing percent, yield and/or dark cutters. It simply takes thousands of cattle to find out what is going on.