SenseHub® FEEDLOT

Comparison of an automated feedlot health detection system versus conventional human pen-riding methods in a U.S. feedlot

KEY POINTS:

- The automated monitoring system, SenseHub® Feedlot, is designed to detect individual animals who require further assessment in a population (i.e., outliers).
- **At 60 days**, compared to traditional pen-riding methods, SenseHub Feedlot technology displayed:
  - A reduction in days on feed at the time of first BRD diagnosis (14 days vs. 16 days)
  - A reduction in overall mortality (3.1% vs. 4.5%)
  - A reduction in BRD pen deads (0.6% vs. 3.0%)
  - A reduction in overall removals (chronic BRD, lameness, etc.; 4.4% vs. 6%)
  - An increase in total number of cattle enduring to 60 days (92% vs. 89%)
  - A reduction in the number of pens entered/day to observe and possibly remove calves for closer inspection
- **Across the entire feeding period**, compared to traditional pen-riding methods, SenseHub Feedlot technology displayed:
  - A reduction in days on feed at the time of first BRD diagnosis (16 days vs. 20 days)
  - A reduction in BRD pen deads (0.7% vs. 3.0%)
  - A reduction in overall chronics (chronic BRD, lameness, etc.; 5.6% vs. 8.3%)
  - An increase in total number of cattle enduring to harvest (88% vs. 84%)
  - An improvement in final live weight per hd originally placed (1,057 lbs vs. 1,017 lbs)
  - An improvement in HCW per hd originally placed (663 lbs vs. 638 lbs)
  - A reduction in the number of pens entered/day to observe and possibly remove calves for closer inspection
- In this study, at both 60 days on feed and at closeout, the SenseHub Feedlot system displayed more value compared to a traditional pen-riding detection system.

INTRODUCTION

Bovine respiratory disease (BRD) is the primary infectious disease syndrome in the backgrounder, stocker and feedlot sectors of the U.S. beef industry.[1] The bovine is very adept at concealing clinical signs of BRD until the disease is advanced (if identified at all). Therefore, improved accuracy and timeliness of diagnosis is imperative to reduce economic losses, maximize animal welfare and support judicious antimicrobial usage. Traditional BRD case definitions (i.e., clinical signs followed by rectal temperature thresholds) are inadequate to accurately detect and diagnose calves with BRD.[2,3] The SenseHub Feedlot (SHF) system is an automated monitoring technology designed to aid those engaged in backgrounding, stocker or feedlot production systems when identifying outliers earlier and more accurately compared to visual inspection of cattle alone. The objective of this study was to compare health and performance between cattle monitored by the SHF technology against cattle monitored by conventional pen-riding practices.

MATERIALS AND METHODS

The study was initiated in August of 2021. The study population was part of a 3x2 factorial treatment design evaluating metaphylaxis therapy (three levels: traditional application, Whisper® On Arrival prediction, negative control) and BRD detection (two levels; described below). No relevant interactions were observed between the factors; therefore, only the BRD detection outcomes will be reported herein. The study reflected a completely randomized block design and was executed at one commercial feedlot in central Oklahoma while under the direction of a contract research organization. The targeted sample population included auction-market derived beef calf lots considered to be at “high risk” for development of BRD. Upon meeting those criteria, cattle were procured through standard industry channels. At arrival, only healthy calves were eligible for study enrollment. Conversely, calves displaying clinical signs of BRD or other infectious/noninfectious syndromes were removed from the study population.

Prior to processing, calves were randomly allocated to one of two BRD detection treatment groups: 1) calves detected by the SHF system (SHF) or 2) calves detected by traditional pen-riding methods (PR). Within 72 hours post-arrival, each respective lot was administered a processing regimen consisting of the following products: a modified-live viral vaccine (Bovilis® Vista® Once SQ), a multivalent clostridium vaccine (Bovilis® Vision® 7), a steroid implant (Revalor®-IH (trenbolone acetate and estradiol)), an oral (Safe-Guard® (fenbendazole) suspension 10%) and injectable (Dectomax®(doramectin)) deworming agent, and a metaphylactic antimicrobial (Zuprevo® (tildipirosin); administration was dependent upon the metaphylaxis treatment group designation briefly described above).

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Ear tissue was collected from each animal to test for persistent infection of bovine viral diarrhea virus (PI-BVDV). Each calf received both a visual ear tag with a unique visual identification number along with an individualized electronic identification tag. Finally, an SHF tag was applied to the left ear of each calf.

All calves were penned by treatment group. The BRD case definition of the SHF group was defined as cattle identified by the SHF software AND displaying no clinical signs of non-BRD syndromes (e.g., bloat, neurological disease, lameness/injury) upon visual inspection and physical exam. Among calves in the PR group, the BRD case definition included one of the following profiles:[4]

- A clinical illness score (CIS) of 1 or 2 AND a rectal temperature ≥ 104 F
- A CIS of 3 regardless of rectal temperature

All calves were eligible for BRD treatment up to three times. The BRD treatment regimen was the same for both groups. The treatment regimen consisted of Resflor Gold® (florfenicol and flunixin meglumine), Baytril 100® (enrofloxacin) and Bio-Mycin 200® (oxytetracycline). A three-day post-treatment interval was assigned for each treatment. If additional BRD therapy was found to be necessary, the calf was classified with chronic BRD and removed from the study population.

Pen was considered the experimental unit and day of enrollment was considered the block. An alpha of ≤ 0.05 was considered significant, while an alpha of > 0.05 but ≤ 0.10 was considered a statistical trend. Analyses were performed using linear mixed models for a pen-level randomized complete block study design (SAS v9.4; Cary, NC). Models were fitted using binomial (pen-level proportion outcomes) or normal distributions (continuous outcomes). Treatment group was included as a fixed effect. A random intercept term was included in all models to account for the design structure (lack of independence among blocks). The outcome of "chronic" was defined as an animal requiring more than three treatments for any specific syndrome (including BRD). The outcome of "fallout" was defined as a sum of both mortality and chronic outcomes.

RESULTS

In this study, 2,542 beef heifers (SHF=1,268, PR=1,274) averaging 567 lbs were enrolled (18 pens per treatment group; ~ 71 hd/pen) over a six-week time frame. All calves originated from auction markets in either Texas or Oklahoma. Within each enrollment group, cattle were sourced from five to nine different auction markets and four (4) calves were removed due to PI-BVDV. Retention/functionality of the SHF tags was 98.3% during the first 60 DOF. Retention and functionality of the SHF tags was 97% at the time of closeout.

Day 0 to 60

A complete description of health outcomes up through 60 days on feed are displayed in Table 1. The SHF group displayed a reduction (P≤0.05) in both days on feed to first BRD treatment (13.9 days vs. 16.3 days) and rectal temperature at first BRD treatment (104.2 F vs. 104.9 F) compared to the PR group, respectively. No differences (P>0.05) were observed between the two groups for BRD morbidity and BRD retreatments. However, the SHF group displayed an improvement (P=0.10) in BRD treatment success (44.5%) compared to the PR group (38.3%); a decrease (P≤0.05) in overall mortality (3.1%) compared to the PR group (4.5%); a reduction (P=0.06) in BRD mortality (3.0%) compared to the PR group (4.3%); a reduction (P<0.01) in BRD pen deads (0.6%) compared to the PR group (3.0%); a reduction (P=0.10) in overall chronics (e.g., BRD, lameness, etc.; 4.4%) compared to the PR group (6.0%); a reduction (P=0.09) in BRD chronics (4.3%) compared to the PR group (5.8%); a reduction (P<0.01) in overall fallouts (7.5%) compared to the PR group (10.6%); and a reduction (P<0.01) in BRD fallouts (7.2%) compared to the PR group (10.2%).

Given the above metrics, a larger proportion (P≤0.05) of animals in the SHF group were still on study compared to the PR group (92.5% vs. 89.4%, respectively) at the 60-day time point (Figure 1).

Day 0 to closeout

Complete descriptions of health outcomes for the entire duration of the feeding period are displayed in Table 2. Retention and functionality of the SHF tags was 97% at the time of closeout. The SHF group displayed a reduction (P≤0.05) in both days on feed to first BRD treatment (16 days vs. 20 days) and rectal temperature at first BRD treatment (104.1 F vs. 105.0 F) compared to the PR group, respectively. Nonetheless, no differences (P>0.05) were observed between the two groups for BRD morbidity, BRD second treatments, and BRD third treatments, or in BRD treatment success. However, the SHF group displayed a decrease (P≤0.05) in BRD pen deads (0.7%) compared to the PR group (3.0%); a reduction (P≤0.05) in overall chronics (5.6%) compared to the PR group (8.3%); a reduction (P≤0.05) in BRD removals (4.6%) compared to the PR group (6.6%); a reduction (P≤0.05) in overall fallouts (i.e., mortalities + removals; 11.1%) compared to the PR group (15.1%); and a reduction (P≤0.05) in BRD fallouts (i.e., mortalities + removals; 9.8%) compared to the PR group (14.1%).

The closeout performance outcomes are displayed in Table 3.

On a *deads and removals out basis*, the PR groups displayed an improvement (P=0.09) in average final body weight (1,212 lb) compared to the SHF group (1,201 lb); an improvement (P=0.07) in weight gain (632 lbs) compared to the SHF group (624 lbs); an improvement in average daily gain (ADG; 2.85 lbs/day) compared to the SHF group (2.79 lbs/day); and an increase (P=0.06) in daily dry-matter intake (15.9 lbs/hd/day) compared to the SHF group (15.6 lbs/hd/day).

On a *deads and removals in basis*, calves allocated to the SHF group displayed an improvement in ADG (P=0.06; 2.34 lbs/day vs. 2.20 lbs/day, respectively). Likewise, feed efficiency (Feed:Gain [F:G]) was improved for the SHF group compared to the PR group (P=0.01; 6.73 vs. 7.20, respectively).

The proportion of animals enduring to closeout was significantly higher (P≤0.05) in the SHF group (88%) compared to the PR group (84%; Figure 2). *Despite the deads and removals out analysis (Table 3)*, this increase

Table 1: Model-adjusted* means and standard error of the means (SEM) for the 60-day health outcomes among auction-market derived beef/beef-cross heifers in one Oklahoma feedlot monitored for BRD by the SenseHub Feedlot technology (N=1,270 calves/18 pens) or by a traditional pen riding method (N=1,274 calves/18 pens).

Parameter	SenseHub® Feedlot technology		Pen Rider		P-value
	Mean	SEM	Mean	SEM	
Arrival weight (lbs)¥	569.5	3.6	564.9	3.6	0.03
BRD morbidity (%)	42.1	2.1	41.0	2.1	0.58
BRD day on feed at 1st trt	13.9	0.6	16.3	0.6	<0.01
Rectal temperature at 1st trt (˚F)	104.2	0.05	104.9	0.05	<0.01
BRD 2nd treatment (%)	52.4	2.9	55.2	2.9	0.39
BRD 3rd treatment (%)	29.4	3.4	24.5	3.2	0.09
BRD treatment success (%)‡	44.5	2.6	38.3	2.6	0.10
Overall mortality (%)	3.1	0.7	4.5	0.9	0.05
BRD mortality (%)	3.0	0.6	4.3	0.9	0.06
BRD case fatality (%)	6.5	1.1	7.0	1.1	0.73
BRD pen deads (%)	0.6	0.3	3.0	0.6	<0.01
Overall removals (%)†	4.4	0.6	6.0	0.8	0.07
BRD removals (%)	4.3	0.6	5.8	0.7	0.09
Overall fallouts (%)**	7.5	1.1	10.6	1.4	<0.01
BRD fallouts (%)	7.2	1.0	10.2	1.3	<0.01

* Mixed models with a random effect to account for the lack of independence among blocks
¥ Due to statistical difference in incoming body weight between the two treatment groups, this variable was utilized as a covariate for the remainder of the models
‡ Calves treated for BRD that did not require additional BRD therapy, were not removed, and did not die
† This estimate reflects non-mortality removals (e.g., chronic BRD, non-BRD syndromes, etc.)
** Mortalities + removals

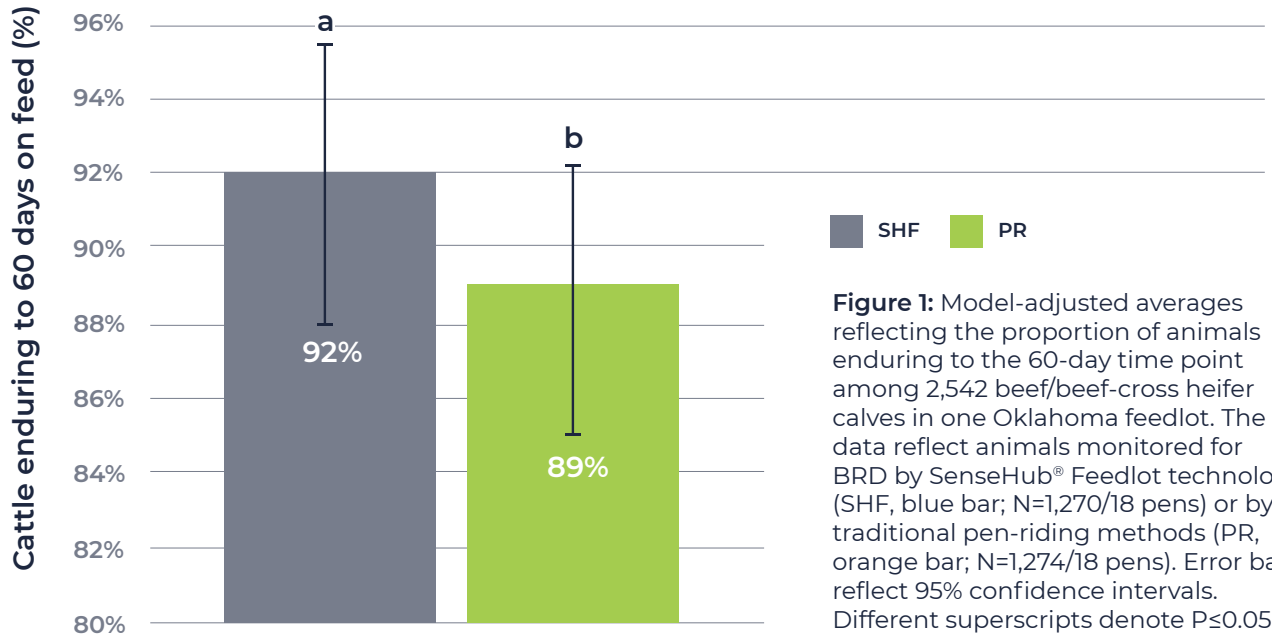


Figure 1: Model-adjusted averages reflecting the proportion of animals enduring to the 60-day time point among 2,542 beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflect animals monitored for BRD by SenseHub® Feedlot technology (SHF, blue bar; N=1,270/18 pens) or by traditional pen-riding methods (PR, orange bar; N=1,274/18 pens). Error bars reflect 95% confidence intervals. Different superscripts denote P≤0.05.

Table 2: Model-adjusted* means and standard error of the means (SEM) for the closeout health outcomes among auction-market derived beef/beef-cross heifers in one Oklahoma feedlot monitored for BRD by the SenseHub Feedlot technology (N=1,270 calves/18 pens) or by a traditional pen riding method (N=1,274 calves/18 pens).

Parameter	SenseHub® Feedlot technology		Pen Rider		P-value
	Mean	SEM	Mean	SEM	
Arrival weight (lbs)¥	569.5	3.7	565.1	3.7	0.04
BRD morbidity (%)	44.1	2.1	44.0	2.1	0.93
BRD day on feed at 1st trt	15.9	1.1	20.0	1.1	<0.01
Rectal temperature at 1st trt (˚F)	104.1	0.1	105.0	0.1	<0.01
BRD 2nd treatment (%)	54.6	2.7	55.6	2.7	0.75
BRD 3rd treatment (%)	32.7	3.2	32.5	3.2	0.93
BRD treatment success (%)‡	43.0	2.4	37.6	2.3	0.14
Overall mortality (%)	5.7	0.8	6.7	0.9	0.26
BRD mortality (%)	4.7	0.8	5.7	1.0	0.26
BRD case fatality (%)	9.9	1.3	9.2	1.3	0.69
BRD pen deads (%)	0.7	0.3	3.0	0.7	<0.01
Overall removals (%)†	5.6	0.8	8.3	1.0	<0.01
BRD removals (%)	4.6	0.7	6.6	0.8	0.02
Overall fallouts (%)**	11.1	1.4	15.1	1.7	<0.01
BRD fallouts (%)	9.8	1.3	14.1	1.6	<0.01

* Mixed models with a random effect to account for the lack of independence among blocks
¥ Due to statistical difference in incoming body weight between the two treatment groups, this variable was utilized as a covariate for the remainder of the models
‡ Calves treated for BRD that did not require additional BRD therapy, were not removed, and did not die
† This estimate reflects non-mortality removals (e.g., chronic BRD, non-BRD syndromes, etc.)
** Mortalities + removals

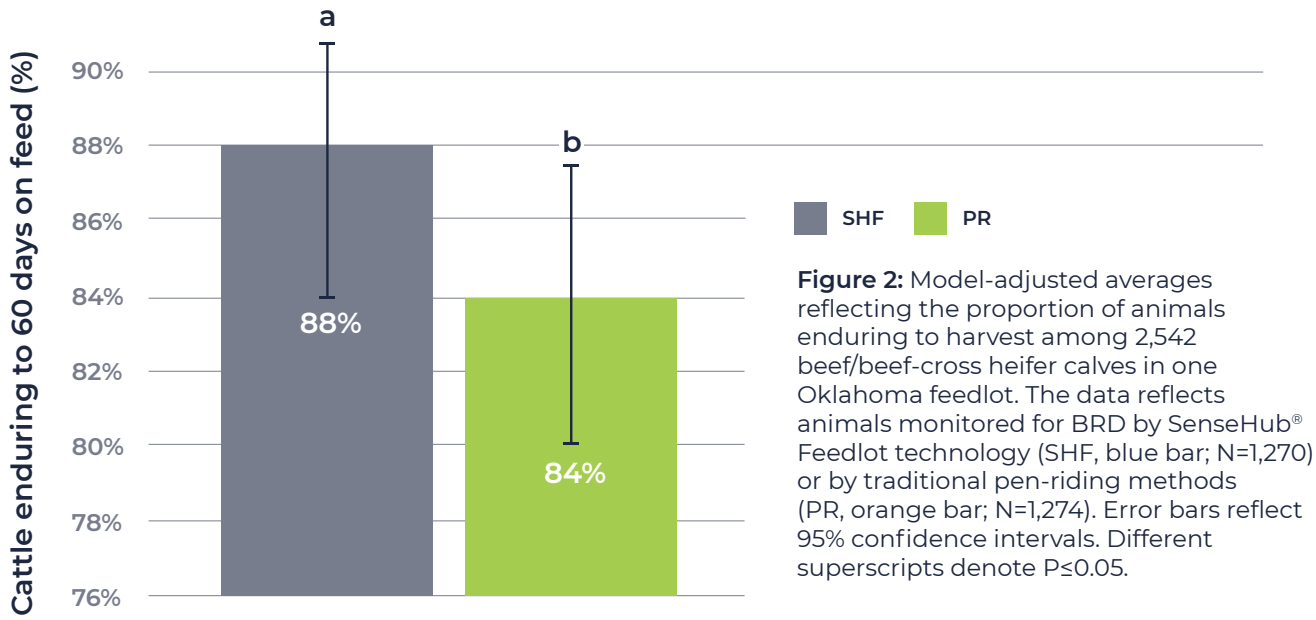


Figure 2: Model-adjusted averages reflecting the proportion of animals enduring to harvest among 2,542 beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflects animals monitored for BRD by SenseHub® Feedlot technology (SHF, blue bar; N=1,270) or by traditional pen-riding methods (PR, orange bar; N=1,274). Error bars reflect 95% confidence intervals. Different superscripts denote P≤0.05.

Table 3: Model-adjusted* means and standard error of the means (SEM) for the closeout performance outcomes among auction-market derived beef/beef-cross heifers in one Oklahoma feedlot monitored for BRD by the SenseHub Feedlot technology (N=1,270 calves/18 pens) or by a traditional pen riding method (N=1,274 calves/18 pens).

Parameter	SenseHub® Feedlot technology		Pen Rider		P-value
	Mean	SEM	Mean	SEM	
Arrival weight (lbs)¥	577.4	3.8	579.5	3.8	0.45
Final body weight (D/R**-out; lbs)	1,201.4	10.9	1,212.2	10.9	0.09
Weight gain (D/R-out; lbs)	624.1	9.3	632.8	9.3	0.07
ADG (D/R-out; lbs/day)	2.79	0.03	2.85	0.03	0.07
ADG (D/R-in; lbs/day)	2.34	0.05	2.20	0.05	0.06
Daily DMI (lbs/hd)	15.6	0.1	15.9	0.2	0.06
Feed:gain (D/R-out; lbs feed/lbs gain)	5.58	0.07	5.65	0.07	0.90
Feed:gain (D/R-in; lbs feed/lbs gain)	6.73	0.18	7.20	0.18	0.01
Final body weight per hd placed (lbs)	1,056.7	13.4	1,016.6	13.4	0.03

* Mixed models with a random effect to account for the lack of independence among blocks
¥ Due to statistical difference in incoming body weight between the two treatment groups, this variable was used as a covariate for the remainder of the models
** D/R-out: D=deads, and R=removals; dead and removed cattle were either not included (D/R-out) or included (D/R-in) within the stated outcome metric

Figure 3a: Model-adjusted averages reflecting the average **final live weight** per animal originally placed among beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflect animals monitored for BRD by SenseHub® Feedlot technology (SHF; grey bar) or by traditional pen-riding methods (PR; green bar). Error bars reflect 95% confidence intervals. Different superscripts denote P≤0.05.

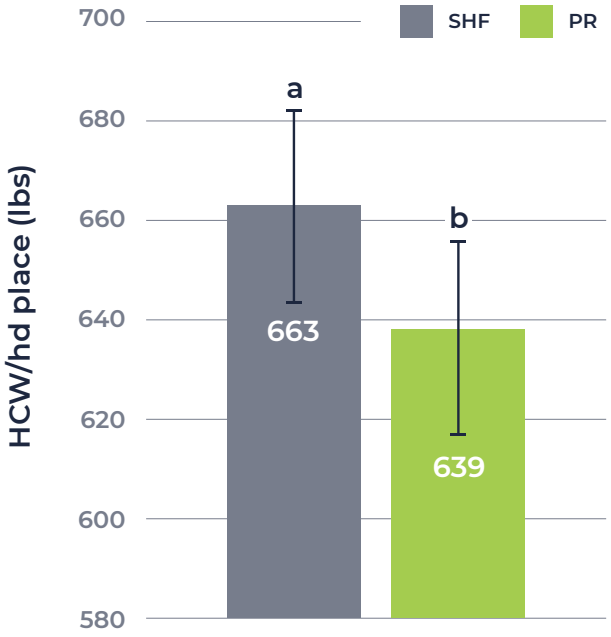


Figure 3b: Model-adjusted averages reflecting the average **hot carcass weight** per animal originally placed among beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflect animals monitored for BRD by SenseHub® Feedlot technology (SHF; grey bar) or by traditional pen-riding methods (PR; green bar). Error bars reflect 95% confidence intervals. Different superscripts denote P≤0.05.

Table 4: Model-adjusted* means and standard error of the means (SEM) for the carcass outcomes among auction-market derived beef/beef-cross heifers in one Oklahoma feedlot.

Parameter	SenseHub® Feedlot technology		Pen Rider		P-value
	Mean	SEM	Mean	SEM	
Carcass count (N)	N=1,118		N=1,070		
HCW (D/R-out**; lbs)	767.0	10.5	775.6	10.5	0.03
Yield, %	63.1	0.2	63.2	0.2	0.38
Yield Grade	% of treatment group (count)				0.76
1	3.5% (39)		4.8% (51)		N=2,184
2	35.2% (393)		34.6% (370)		
3	45.5% (508)		42.9% (458)		
4	13.8% (154)		15.4% (164)		
5	1.1% (12)		1.7% (18)		
Quality grade	% of treatment group (count)				0.80
Prime	2.2% (25)		3.0% (32)		N=2,184
Choice	68.6% (766)		64.7% (691)		
Select	28.0% (312)		31.3% (334)		
Other	1.2% (13)		1.0% (11)		
Avg. total HCW per pen (lbs)	46,741	837.7	45,190	837.7	0.06
Avg. total HCW per hd placed (lbs)	663.4	9.3	638.6	9.3	0.03

* Mixed models with a random effect to account for the lack of independence among blocks
** D/R-out: D=deads, R=removals; HCW estimates for cattle that either died or were removed for any non-mortality reason are not reflected in this estimate

in the total number of animals harvested between the two groups resulted in an increase (P=0.06) total final body weight per pen for the SHF group (74,455 lbs/pen) compared to the PR group (71,937 lbs/pen).

On a deads and removals OUT basis, the average hot carcass weight (HCW) outcome for the PR group was significantly higher (P≤0.05) compared to that of the SHF group (775 lbs and 767 lbs, respectively). No statistical differences (P>0.05) were observed in carcass yield, yield grade, and quality grade.

However, in parallel with the closeout performance metrics, the proportion of animals enduring to harvest was significantly higher (P≤0.05) in the SHF group (88%) compared to the PR group (84%; Figure 2). Once again, this outcome resulted in an increase (P=0.06) in the average total HCW per pen in the SHF group compared to the PR group (46,741 lbs and 43,190 lbs, respectively; Table 4).

The increases in total final live weight and total HCW per pen (Tables 3 and 4, respectively) were then calculated across the original number of animals placed within each group. This resulted in a significant increase (P≤0.05) in final live weight (lbs) per hd placed and hot carcass weight per hd placed between the SHF group and the PR group (Figures 3a and 3b), respectively.

Labor estimation

Recall that both the SHF and PR treatments were each allocated to 18 pens (36 pens total). During the first 60 DOF, the average number of pens entered to monitor cattle health on any given day was reduced (on average) by 71% in the SHF group (5.3 pens/day) compared to the PR group (18 pens/day). For the duration of the feeding period, the average number of pens entered to monitor cattle health on any given day was reduced (on average) by 93% in the SHF group (1.3 pens/day) compared to the PR group (18 pens/day). A temporal reflection of pens entered per day for both the SHF and PR groups at both

Figure 4a: Daily pen counts of pens entered per day from Day 0 to 60 among 2,542 beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflect animals monitored for BRD by SenseHub® Feedlot technology (SHF; grey bars) automated feedlot health detection system or the pen rider (PR; green bars).

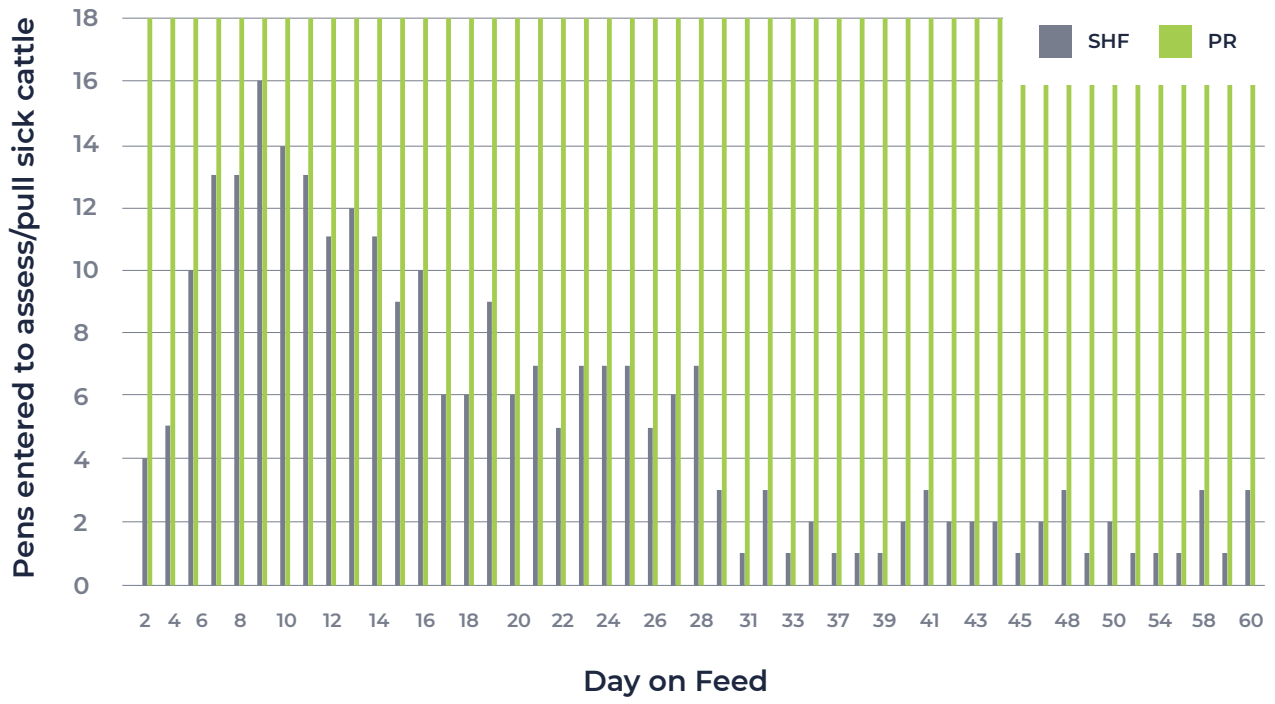
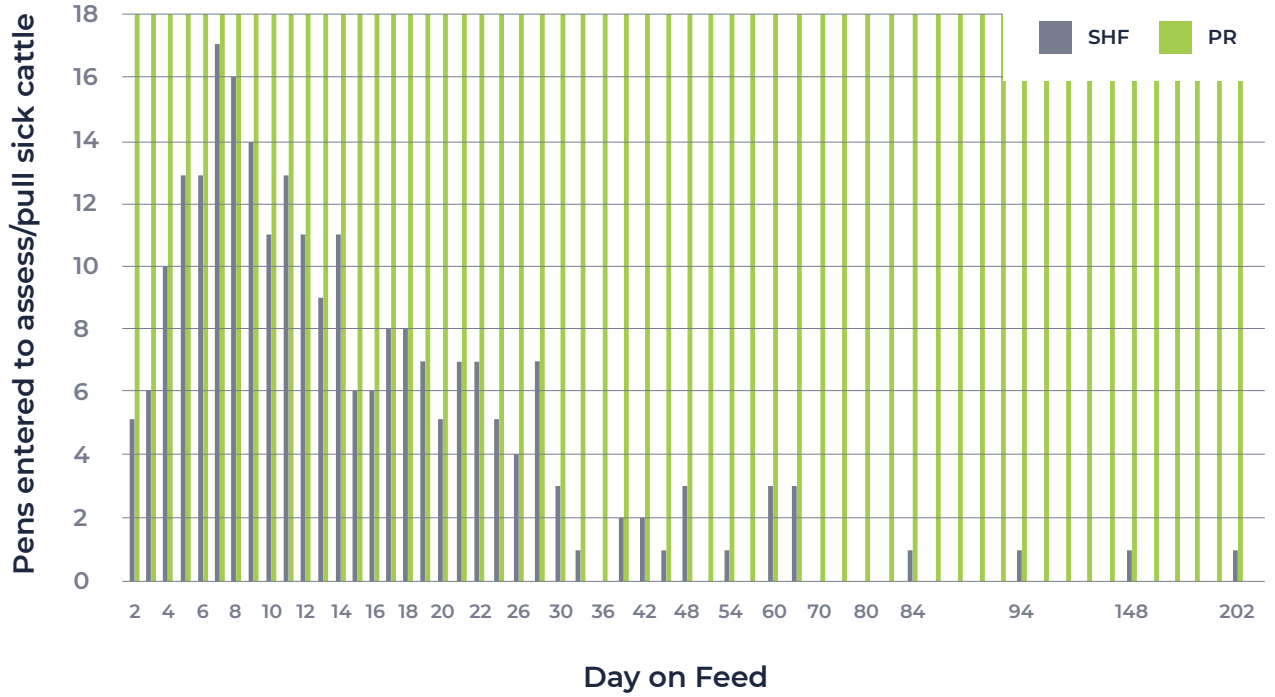


Figure 4a: Daily pen counts of pens entered per day from Day 0 to closeout among 2,542 beef/beef-cross heifer calves in one Oklahoma feedlot. The data reflect animals monitored for BRD by SenseHub® Feedlot technology (SHF; grey bars) automated feedlot health detection system or the pen rider (PR; green bars).



60 days on feed and for the duration of the feeding period are displayed in Figure 4a and Figure 4b, respectively. Note that these results are descriptive due to lack of statistical model convergence.

No adverse events were observed in this study.

CONCLUSION

Up through 60 days on feed and at closeout, the group of animals under the SHF system displayed a significant reduction in mortality and chronic disease compared to the PR group. These outcomes led to a significant decrease in cattle falling out of production (due to a combination of mortality and chronic disease) at either time point in the SHF group, thereby increasing total sellable pounds compared to the PR group. Additionally, the SHF system improved cattle monitoring efficiency compared to the PR group. These findings demonstrate that the SHF technology provides value to producers engaged in either the backgrounder and/or feedlot stages of beef production.

REFERENCES

1. USDA NASS, Animal and Plant Health Inspection Service. USDA. Feedlot 2011 "Part IV: Health and Health Management on U.S. Feedlots with a Capacity of 1,000 or More Head." USDA–APHIS–VS–CEAH–NAHMS. Fort Collins, CO, ed, 2011.

2. White BJ, Renter DG. Bayesian estimation of the performance of using clinical observations and harvest lung lesions for diagnosing bovine respiratory disease in post-weaned beef calves. *J. Vet. Diagn. Invest*. 2009; 21:446-453.

3. Timsit E, Dendukuri N, Schiller I, Buczinski S. Diagnostic accuracy of clinical illness for bovine respiratory disease (BRD) diagnosis in beef cattle placed in feedlots: A systematic literature review and hierarchical Bayesian latent-class meta-analysis. *Preventive Veterinary Medicine*. 2016; 135:67-73.

4. Perino LJ, Apley MD. Clinical trial design in feedlots. *Vet. Clin. North Am. Food Anim. Pract.* 1998; 14:343-365.

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SenseHub® Feedlot is not intended to diagnose, treat, cure, or prevent any disease in animals. For the diagnosis, treatment, cure, or prevention of diseases in animals, you should consult your veterinarian. The accuracy of the data collected and presented through this product is not intended to match that of medical devices or scientific measurement devices.

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