Persistently Infected: Does it pay to test?

Mallory K. Vestal and John T. Richeson

Mallory K. Vestal is an Assistant Professor of Agricultural Business and Economics in the Department of Agricultural Sciences at West Texas A&M University.

John T. Richeson is an Assistant Professor of Animal Science the Department of Agricultural Sciences at West Texas A&M University.

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Contact Information:
Mallory K. Vestal
WTAMU Box 60998
Email: m.vestal@wtamu.edu
Office: 806-651-2718

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Abstract

BRD accounts for approximately 70% of feedlot morbidity and 50% of feedlot mortality, negatively affecting profit (Edwards 1996; Galyean, Perino, Duff 1999; Loneragan et al. 2001; Chirase and Greene 2001; Smith 1998). This study provides an economic evaluation and net return estimate associated with testing and removal of BVDV persistently infected (PI) calves of differing management backgrounds (low-risk preconditioned calves vs. high-risk auction market calves). Results show that establishment of a PI-BVDV control program within auction market calves increases net returns while a PI-BVDV control program for preconditioned calves is not economically justified.

Keywords: *beef cattle, bovine respiratory disease, persistently infected, precondition calves, net returns*

Introduction

The majority of cattle morbidity and mortality is due to bovine respiratory disease (BRD). It is estimated that BRD accounts for 70% of feedlot morbidity and up to 50% of feedlot mortality resulting in large annual economic losses (Edwards 1996; Galyean, Perino, Duff 1999; Loneragan et al. 2001; Chirase and Greene 2001; Smith 1998). Chirase and Greene (2001) estimated that BRD causes hundreds of millions of dollars in annual losses due to mortality, reduced feed efficiency, and morbidity costs. Of the calves diagnosed with BRD, 91% are diagnosed within the first 27 days after arrival (Buhman 2000), and the majority of BRD mortalities occur in the first 45 days (Loneragan et al. 2001; Edwards 1996).

BRD control among newly received cattle is the greatest challenge facing the stocker and feedlot segments of beef cattle production (Edwards 2010). Preconditioning is a management practice designed to reduce stress and enhance disease protection through pre-arrival vaccination and management (Cole, 1985; Duff and Galyean, 2007). Preconditioned calves have improved health and performance compared with high-risk auction market calves (Clark et al. 2006; Seeger et al. 2008). Backgrounders and feedlots are now able to purchase calves which are more likely to remain healthy during the feeding period and thus increase their profits through reduced costs and higher revenues (Brooks et al. 2011). However, the adoption rate of these preconditioning management factors remains low in the U.S. beef cow-calf operations (USDA, 2010).

In an effort to decrease the losses suffered from BRD, some stocker/feedlot producers have implemented testing of newly received calves for persistent infection (PI) with bovine viral diarrhea virus (BVDV). A PI-BVDV positive calf is infected with BVDV between 45 and 125 days of gestation and is born immunotolerant to the virus. Many PI-BVDV positive calves die shortly after birth, but a number live to make it into the breeding herd or feedlot. This is the problem, as a PI-BVDV positive calf is constantly shedding the virus, potentially exposing healthy cohorts (Wells). BVDV has been identified as one of the leading causes of respiratory disease in cattle, and can be economically devastating when present (McClure 2007).

The prevalence of PI-BVDV calves in the feedlot is estimated to be 0.3% (Loneragin et al. 2005), but a single PI-BVDV animal has the potential to continuously expose cohorts in an entire pen and adjacent pens to the virus.

Stocker and feedlot operators are faced with numerous decisions such as the ‘type’ of calf to purchase. Two options are: purchase “low-risk” preconditioned calves at a premium or “high-risk” auction market calves at a discounted price with increased health risks. Previous research has determined the premium garnered for a preconditioned direct source calf is from $7 to $10/cwt (Zimmerman et al. 2012). These operators are facing two decisions which could require an additional $55/head investment (PI tested 500 pound preconditioned calf; PI test cost: $5/hd). The decision to invest in testing each animal for determination of PI-BVDV is costly and the literature remains controversial. The prevalence of PI positive calves among auction market cattle is approximately 0.399% and among preconditioned cattle is 0.301% (Gold Standard Labs); therefore economic validity behind this investment merit evaluation.

The primary objective is to provide an economic evaluation and net return estimate associated with PI-BVDV control and determine if the economic return differs according to the type of cattle (preconditioned calves vs auction market cattle). The secondary objective of this research is to calculate the sensitivity of the net return estimates associated with PI-BVDV control in auction market and preconditioned calves to changes in cost of PI-BVDV control as well as the premium of preconditioned calves.

Materials and Methods

Cattle

Animal methods and experimental procedures were approved by the University of Arkansas Animal Care and Use Committee. Specific details regarding rations, animal management, and experimental procedures are fully described by Richeson et al. (2011).

A total of 529 crossbred, male beef calves were used to determine effects of weaning management and PI-BVDV exposure. Calves from 2 different weaning management systems were used for the receiving trial: 1. low-risk, single-sourced, preconditioned (PC) crossbred steer calves (n=236; average initial body weight (BW)=553 lbs) arrived in 4 shipment blocks from 3 Arkansas cow-calf ranches and 2. high-risk, commingled, auction market (AM) crossbred bull (n=211) and steer (n=82) calves (average initial BW=540 lbs) that arrived in 4 shipment blocks assembled from multiple auction markets located in Arkansas.

The main effects of management (AM or PC) and PI-BVDV exposure (exposed=PI or not exposed=CON) resulted in 4 treatments arranged as a 2x2 factorial.

Preconditioned Calves

The 4 shipment blocks of PC calves arrived at the University of Arkansas Agricultural Experiment Station near Savoy on October 27, 2008, January 19, August 11, or December 6, 2009, respectively. The PC cattle were considered to be low-risk for developing signs of BRD because they were weaned and vaccinated against BRD pathogens more than 42 days before shipment and maintained a single source without commingling.

The PC calves were randomly selected steers which were weaned and ear-notched to test for PI-BVDV status at a commercial laboratory (Cattle Stats, LLC, Oklahoma City, Oklahoma). On weaning day, PC calves were administered: 1) a pentavalent modified –live virus (MLV) respiratory vaccine containing infectious bovine rhinotracheitis virus, BVDB type 1a and 2a, parainfluenza=3 virus, and bovine respiratory syncytial virus isolates at 2 mL per head ($1.089/head) [Express 5, Boehringer Ingelheim Vetmedica, Inc. (BIVI), St. Joseph, MO], 2) Manheimia haemolytica-Pastuerrela multocida bacterin-toxid at 2 mL per head ($2.537/head) (Pulmo-guard PHM-1, BIVI), and 3) injectable anthelmintic at 1mL/22 lbs ($0.084/mL)(Cydectin, BIVI). Approximatley 14 days later, PC calves were administered a clostridial bacterintoxoid at 2 mL/head ($0.738/head)(Alpha7, BIVI) and revaccinated with a pentavalent MLV respiratory vaccine at 2 mL/head ($1.089/head)(Express 5, BIVI). During the 42-91 day preconditioning phase, PC steers were isolated from other cattle on the ranch, fed hay or pasture along with a supplement and remained on their origin ranch until approximately 2 days before trial initiation. Upon arrival to the experimental station, calves were held in an isolation pen with access to ad libitum hay and water until initiation. The day before trial initiation the calves were weighed and then assigned randomly to treatment (PCCON or PCPI).

Auction Market Calves

Each shipment block of AM calves was assembled by an order buyer from 2 to 3 auction markets located in Northwest or North Central, AR and arrived at the experiment station on October 25, 2008, January 20, August 10, or December 5, 2009, respectively for the 4 shipment blocks. Order buyers were instructed to purchase AM cattle of similar BW and phenotype as the accompanying PC steers. The AM cattle were considered to be high-risk for developing signs of BRD because they did not have known health or vaccination history and were commingled extensively resulting in a greater probability of physiological stress and exposure to BRD pathogens.

AM calves were delivered to the experimental station ±36 hours from PC arrival. Upon arrival AM calves were isolated with ad libitum access to hay and water until trial initiation. The day before each trial began, calves were weighed, identified with a unique ear identification tag, ear notched to test for PI-BVDV status at a commercial laboratory (Cattle Stats), and returned to their isolated holding pen. On day 0, AM cattle received the same vaccination and processing regimen as described for PC on their origin ranch; therefore, the first known vaccination and processing for AM occurred on day 0 rather than 42 to 91 days previously. Additionally, AM bull calves were castrated surgically, stratified by gender, and randomly assigned to treatment (AMCON or AMPI). For AM calves, revaccination (Alpha 7 and Express 5, BIVI) occurred on day 14. All BW measurements were obtained individually without withholding feed or water on 2 consecutive days at the beginning (d -1 and 0) and end (d 42 and 43) of the trial using a stanchion equipped with electronic load cells to determine overall differences in gain performance. Labor costs were assessed at $2.00 per head per chute trip therefore resulting in a $4.00 labor charge (initial processing and revaccination).

Persistently Infected Cattle

Two groups of animals identified as positive for PI-BVDV were acquired from a stocker cattle operation in Washington County, OK to be used as PI-BVDV exposure sources. Group 1 (n=10) was assembled before trial initiation and used for block 1 and 2, while group 2 (n=9) was assembled before beginning block 3 and used for block 3 and 4. Depending on block, 4-8 PI-BVDV calves were randomly assigned to 1 of 4 or 1 of 8 PI- designated pens. An appropriate number of PI-BVDV calves were assembled for each group to allow for available alternatives if an originally designated PI-BVDV animal died. Each PI-BVDV calf that died during the trial (Group 1, n=2; Group 2, n=1) was replaced immediately with an alternative PI calf. Of the PI-BVDV calves 18 out of 19 were identified as subgenotype 1b. One PI-BVDV animal from Group 2 was identified as subgenotype 1a, and the pen in which this animal was assigned was removed from all statistical analysis. It is important to note that BVDV type 1b, is the predominant BVDV subgenotype strain isolated from cattle in the US (Fulton et al. 2002; Ridpath et al. 2010).

Pen Assignment and Arrangement

To avoid unwanted PI-BVDV fence-line or water source contact with CON, receiving pens were arranged spatially before treatment allocation (Figure 1). The spatial arrangement used in the current study eliminated fence line and water source contact between PI and CON. Furthermore, the pens were configured so the pens of different treatments were separated by either a drovers or feed ally. Within management group (AM or PC), calves were stratified by gender (AM only) and d-1 BW, then assigned randomly to 1 of 2 or 1 of 4 PI or CON pens depending on block (8-11 calves/pen) resulting in total experimental pen replication of 14, 14, 12, 11 for AMCON, AMPI, PCCON, and PCPI, respectively. For PI treatments a PI-BVDV type 1b challenged animal was assigned randomly to each PI designated treatment pen. During all weighing and BRD evaluation procedures, CON treatments were evaluated first, followed by PI treatment to avoid unwanted CON contact with PI challenge animals or experimental cattle in the PI treatments and to reduce potential exposure to fomites contaminated with body fluids or fecal material containing BVDV. Because of spatial treatment arrangement and the necessity to evaluate CON followed by PI, morbidity investigators were not blinded to experimental treatment.

BRD Evaluation and Treatment

Calves were observed daily for clinical signs of BRD (depression, nasal discharge, ocular discharge, cough, gaunt appearance, inappetance) by 2 experiment station personnel with a combined 35-yr experience evaluating cattle with BRD. If at least 2 visual signs existed, calves were brought to the restraining chute, weighed, and rectal temperature was recorded via a digital thermometer. If rectal temperature was greater than 40ºC, cattle were considered morbid, administered antibiotic therapy with enrofloxacin (Baytril, Bayer Animal Health, Shawnee Mission, KS) at a dosage rate of 10mg/kg of BW ($0.92865/mL), and immediately returned to their study pen. A 48-hour post-treatment interval (PTI) was implemented after administration of enrofloxacin, and a second temperature was recorded upon expiration of the initial antibiotic PTI. If the second temperature was greater than 40ºC, a second antibiotic treatment with florfenicol (Nuflor, Schering-Plough Animal Health, Summit, NJ) at a dosage rate of 40mg/kg of BW ($0.676/mL). A 48-hour PTI was also implemented and rectal temperature was evaluated upon expiration of the florefenicol antibiotic treatment. If the temperature was greater than 40ºC, a third and final antibiotic treatment with ceftiofur HCI (Excenel RTU, Zoetis) was administered at a dosage rate of 2.2 mg/kg of BW and repeated for 2 consecutive days after the initial injection of ceftiofur HCI ($0.823/mL). Morbidity labor charges were estimated at $4.00 per head per treatment with the third treatment resulting in a total of $12.00 in labor treatment costs.

Calf Prices

The primary objective of this study is to determine economic feasibility and net return associated with a PI control program, therefore calf purchase and sell prices are vital. Actual calf purchase and sell price data was unavailable for the calves used in this study (October 2008-January 2010). Therefore the most recent Arkansas Weekly Livestock Summaries were gathered from the USDA Agricultural Marketing Services website starting in October 2012 and concluding with the last study block's shipment in January of 2014.

Prices were assessed using the weekly summary data from the weeks of arrival and shipment according the weight and sex classification of each individual animal. For purchase price of PC cattle, each steer was assigned a base price derived from their initial BW and a premium of $8.50/cwt ($0.085/lb). In 2012, Zimmerman et al. estimated that weaned steer calves sold through Superior Livestock Auction Video Markets with a certified health program realized

$7 to $10 per cwt premium. The calves used in this study were direct sourced and were not exposed to commingling at an auction market. Due to this significant commonality (direct non-commingled calves); this is a valid premium to assess to the PC calves.

Further, calves treated 3 times with an antibiotic and that recorded ≤ 1lb average daily gain (ADG) were considered 'chronic' and their selling price was discounted. Visual signs of a chronic are extremely noticeable and as such they will be discounted at marketing. These calves were discounted 25% back of their estimated price per pound from the Arkansas weekly livestock summary.

Net Returns

To calculate the net returns of each animal the following calculation was used for experiment treatments where the cattle (in theory) would have been individually tested ($5/head) for PI-BVDV and any positive cases would have been removed[1]. These treatments would be PCCON and AMCON. Net revenue was calculated as shipment revenue less purchase cost, vaccination and labor costs (AM calves only), PI-BVDV cost, antibiotic BRD treatment costs, and morbidity labor costs.

The net revenue calculation for the remaining two treatments (PCPI and AMPI) are representative of the case where no PI control plan was implemented and a PI positive calf was left within the group unbeknown to the operator. Shipment revenue less purchase cost, vaccination and labor costs (AM only), antibiotic BRD treatment costs, and morbidity labor costs. Processing costs were varied depending on the initial BW of the animal. Shipment revenue was defined as dollars per steer at the end of the 42 day receiving period using USDA AMS Arkansas livestock prices as previously discussed.

[1] A small market value would exist for a positive PI-BVDV calf. Niche producers buy PI-BVDV calves at a significant discount and completely feed them to slaughter as it is not ethical to reintroduce a PI-BVDV calf to the normal supply. This market value was not included in this study as the objective is to assess if the economics of testing are different across cattle of differing management backgrounds rather than pen profit.

Statistical Analysis

A mixed model was estimated to test the hypotheses regarding the fixed effect of management background, PI-BVDV exposure, as well as the interaction of the two. Random effects were included for study block (1-4). The equation to estimate the effect of treatment on net returns was

$$(1) \qquad NR_i = \alpha + \beta_1 PI_i + \beta_2 PC_i + \beta_3 (PI_i PC_i) + \mu_i + \varepsilon_i$$

where NR_i is the net return for the *i*th calf; α is the net return intercept; PI_i is an indicator variable for PI-BVDV testing program; β_1 is the response in net returns to the PI-BVDV testing program; PC_i is an indicator variable for PC; β_2 is the response in net returns to a PC calf; $PI_i PC_i$ is the interaction effect between PI-BVDV testing on PC calves; β_3 is the response in net returns to PI-BVDV testing PC calves; μ_i is the study random effect with mean zero and variance σ_μ^2; and ε_i is the random error term with mean zero and variance σ_ε^2. The parameters in equation 1 were estimated using proc MIXED in SAS (SAS Institute Inc.).

Results

Over all cattle included in the trial, 42% (n=223) were treated at least one time, 24% (n=127) were treated twice, and 8.7% (n=46) required a third and final treatment. Of the 46 head which required three BRD antibiotic treatments, 24% (n=11) were classified as ‘chronic’ steers, and over the entire trial a .567% mortality rate (n=3) was observed. When examined by management background (AM or PC), total morbidity rate was greater for AM calves than PC calves at 70.4% and 6.7% respectively. Animal performance (ADG) was not shown to be significantly impacted by PI-BVDV exposure over the 42 day trial. However the PC calves gained 2.65lbs/day while the AM calves gained 1.87lbs/day, a statistically significant difference.

From the mixed model estimated it is shown that testing and removal of PI-BVDV challenged calves among AM sourced calves is positively related to net returns by upwards of

$27 per head. Although total BRD morbidity rate was not affected by PI-BVDV exposure, treatment with a third antibiotic occurred more often for PI-BVDV-exposed cohorts. Further, the AMPI treatment had the greatest number of chronically ill calves (7.6%). This observation along with the parameter estimates suggests that weaning management and exposure to a PI-BVDV pen mate affect health additively because the percentage of chronically ill was greatest for AMPI. Although there was not a statistical difference in ADG from PI-BVDV exposure, it is likely that economical returns from a PI-BVDV program come from reduced morbidity expenses and the discount received at marketing for chronic steers.

The purchase of PC calves versus AM has a significant and positive impact on net returns of $26.94/head. The significant difference in morbidity rate between AM and PC calves (70%, 6.7%) along with the additional gain performance (ADG 2.65 lbs vs 1.87 lbs) and low chronic rate (<0.5%) make the positive relationship clear. The premium for direct source preconditioned calves is highly variable; therefore a sensitivity analysis is included in table 4. While it is clear to see that a producer can economically justify purchasing PC calves at an $8.50/cwt premium, this does not hold to be statistically significant at a premium of $10.00/cwt. Lastly, the interaction effect which is representative of a PI-BVDV control program on PC calves is shown to be negatively related to net returns. Due to the premium of PC calves at purchase, low morbidity rate and no difference in ADG performance among PC calves challenged with exposure to a PI-BVDV calf, it is not economically valid to expend the additional $5.00/head to PI-BVDV test each animal. The model shows a loss in net returns of $1.78/head if you chose to implement a PI-BVDV control program with PC calves.

Table 4 contains a sensitivity analysis of the mixed model estimated to changes in both PC premium at purchase as well as changes in cost of PI-BVDV control. These results show the model to be robust. Future work is targeted at clearly identifying the prices at which PI-BVDV testing is no longer economically feasible.

Conclusion

Testing and control of PI-BVDV continues to be a challenge for the cattle industry. As stocker and feedlot producers continue to face tighter profit-margins, the question of 'does it pay to test?' is a valid one. This study provides a better understanding as to when a producer is economically justified to use a PI-BVDV control program: on high-risk AM cattle that have been extensively commingled and have an unknown vaccination record. Further, the sensitivity of this result holds to be robust against varying PI-BVDV testing costs.

Economic research is abundant in the field of cow-calf producer premiums received for preconditioning their calves, however very little work has been done from the stocker/feeder side of production to determine if these premiums are economically feasible. The results from this study show that the premium paid for a PC calf is not constantly justified within the next stage of production. Further, a common management tool used within the stocker/feedlot industry is the the practice of metaphylaxis treatment as a control for BRD related morbidity. This practice coupled with relatively lower antibiotic costs could translate into the premium for PC calves being significantly overstated and not economically justified. This is outside of the scope of this study and we leave it to future research.

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Table 1. Variable Definitions

Variable	Definition
Baytril	Amount Baytril administered (mL)
Bay_Cost	Cost of Baytril treatment
Nuflor	Amount of Nuflor administered (mL)
Nuf_Cost	Cost of Nuflor treatment
Excenel	Excenel administered (mL)
Exc_Cost	Cost of Excenel
Chronic	1 if calf was treated 3 times, and gained less than 1 lb in ADG, 0 otherwise
EndBW	Body weight at day 42
$/lb ship	Dollar per pound at end of 42 day study
Sell	Selling price (*EndBW*$/lb ship*)
Vac_Cost	Cost per animal of vaccination; (excluding Cydectin)
Cyd_Cost	Cost per animal of Cydectin application
Re_Vac	Cost per animal of revaccination
Labor	Vaccination and revaccination labor cost ($2/animal/chute trip)
Labor_T1	Labor cost for Baytril treatment ($4/animal/chute trip)
Labor_T2	Labor cost for Nuflor treatment ($4/animal/chute trip)
Labor_T3	Labor cost for Excenel treatment ($4/animal/chute trip)
PI_Cost	Cost of PI-BVDV test
PI_Test	1 if animal had been tested for PI-BVDV, 0 otherwise
P_C	1 if calf was preconditioned, 0 otherwise

Table 1. Continued

Variable	Definition
PC_Premium	Premium added per pound for preconditioned calves
IntBW	Body weight at trial initiation
$/lb purchase	Dollar per pound at purchase
$/lb	Dollar per pound +premium (if PC calf)
Purchase Price	Cost of animal at purchase (*$/lb***IntBW*)
Sell_Discount	Discount of 25% on sell price
$/lb sell	Dollar per pound at end of 42 day trial (including sell discount if applicable)
Sell Price	Sell price of animal (*$/lb sell***EndBW*)
Doctor_Labor	Total labor cost for all treatments
Morb_Cost	Total cost of all antibiotic treatments
Net Return	Return above costs

Table 2. Summary Statistics (N=529)

Variable	Frequency	Mean	Std. Dev.	Min. Value	Max. Value
Baytril	222	11.19	13.27	0	35
Bay_Cost	222	10.39	12.32	0	32.50
Nuflor	126	7.72	13.9	0	42
Nuf_Cost	126	5.21	9.39	0	28.38
Excenel	45	2.16	7.12	0	31
Exc_Cost	45	1.79	5.91	0	25.71
Chronic	11	0.02	0.14	0	1
EndBW	526	638.17	82.34	0	841.5
$/lb ship	529	1.50	0.14	0	1.73
Sell	526	956.93	107.68	0	1189.57
Vac_Cost	293	2.01	1.80	0	3.63
Cyd_Cost	293	1.14	1.04	0	2.64
Re_Vac	293	1.01	0.91	0	1.83
Labor	293	2.22	1.99	0	4
Labor_T1	222	1.69	1.98	0	4
Labor_T2	126	0.95	1.71	0	4
Labor_T3	45	1.02	3.35	0	12
PI_Cost	278	2.63	2.50	0	5
PI_Test	278	0.53	0.50	0	1
P_C	236	0.45	0.50	0	1
PC_Premium	236	0.04	0.04	0	0.09
IntBW	529	544.72	58.8	385.5	705
$/lb purchase	529	1.58	0.11	1.27	1.95
$/lb	529	1.61	0.13	1.27	2.03
Purchase Price	529	874.4	74.2	708.48	1100.78
Sell_Discount	11	0.01	0.06	0	0.43
$/lb sell	529	1.49	0.14	0	1.73
Sell Price	526	952.17	114.10	0	1189.57
Doctor_Labor	222	3.66	5.78	0	20
Morb_Cost	222	21.05	28.69	0	106.60
Net Return	529	47.69	95.93	-916.18	294.98

Table 3. Coefficient Estimates of Net Return Model Estimated

Variable	
Intercept	26.95
	(12.86)[a]
PI-BVDV Testing	27.48**
	(10.97)
PC calves	26.94**
	(12.00)
*PI-BVDV * PC calves*	-29.26*
	(16.43)

* Significance levels where α=0.1
** Significance levels where α=0.05
*** Significance levels where α=0.01
[a] Numbers in parentheses are standard errors.

Table 4. Sensitivity Analysis of Estimated Net Returns to changes in PI-BVDV test cost and Precondition Premiums

Precondition Premium ($/cwt)	PI-BVDV Cost ($/head)	$3.50/head	$5.00/head	$6.50/head
$7.00/cwt	*Intercept*	27.00	27.00	27.00
	PI-BVDV Testing	28.98***	27.48**	25.98**
	PC calves	35.16***	35.16***	35.16***
	*PI-BVDV * PC calves*	-29.26*	-29.26*	-29.26*
$8.50/cwt	*Intercept*	26.95	26.95	26.95
	PI-BVDV Testing	28.98***	27.48**	25.98**
	PC calves	26.94**	26.94**	26.94**
	*PI-BVDV * PC calves*	-29.26*	-29.26*	-29.26*
$10.00/cwt	*Intercept*	26.90	26.90	26.90
	PI-BVDV Testing	28.98***	27.48**	25.98**
	PC calves	18.73	18.73	18.73
	*PI-BVDV * PC calves*	-29.25*	-29.25*	-29.25*

* Significance levels where α=0.1
** Significance levels where α=0.05
*** Significance levels where α=0.01

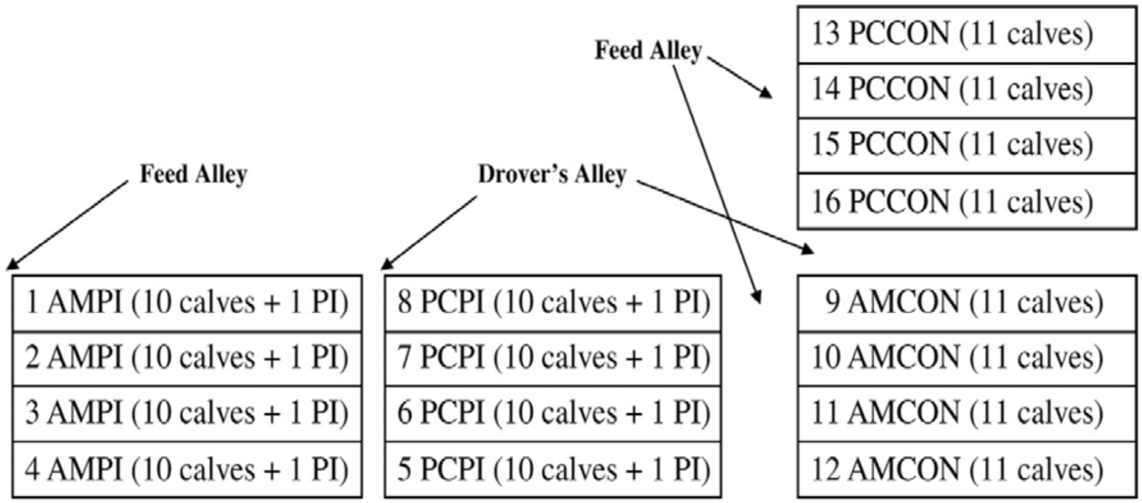

Figure 1. Illustration of spatial treatment arrangement of newly received called at experiment station. AMPI=auction market, no PI-BVDV control program, PCPI=preconditioned, no PI-BVDV control program, PCCON=preconditioned, PI-BVDV control program, AMCON=auction market, PI-BVDV control program.