

Bovine respiratory disease and its effects on productive performance indicators and carcass yield

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ABSTRACT

Objective: To evaluate the impact of bovine respiratory disease (BRD) on productive performance indicators and hot carcass yield in feedlot cattle raised under intensive tropical production conditions.

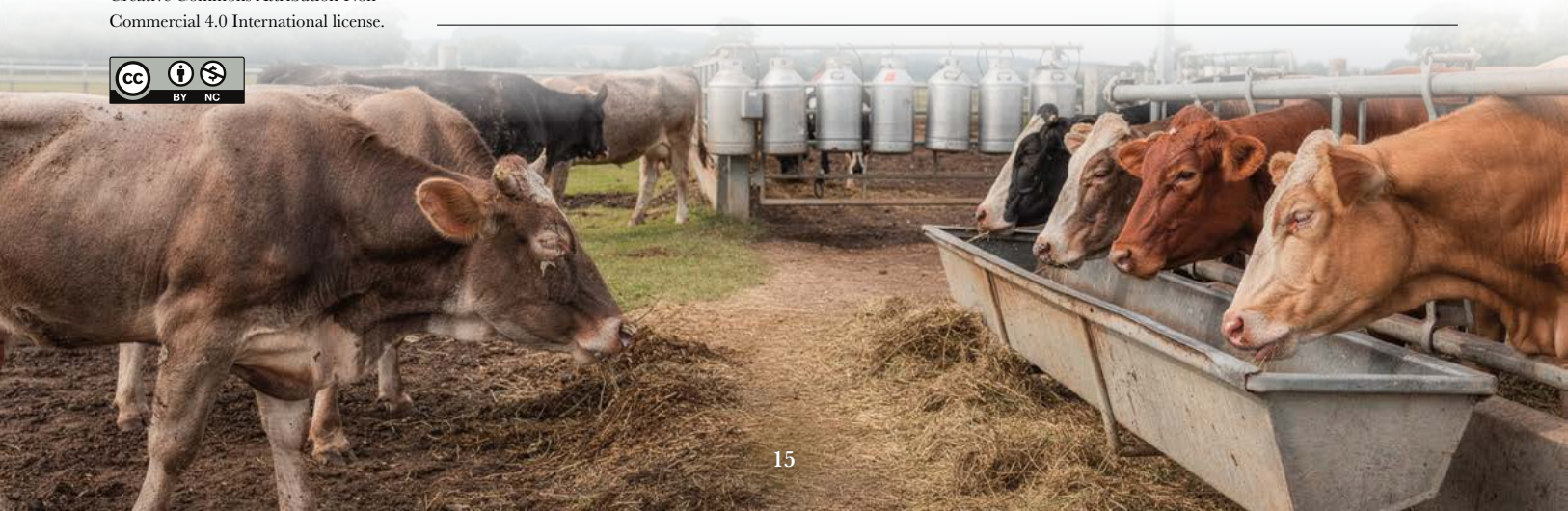
Design/methodology/approach: A total of 1,378 cattle were classified into three groups: animals without clinical signs of BRD, animals with one clinical event, and animals with two events during the fattening period. An ANCOVA model was applied using arrival weight as a covariate, followed by Fisher's LSD test for multiple comparisons. Logistic regression was used to estimate the probability of presenting BRD as a function of hot carcass yield (%).

Results: Cattle experiencing one or two BRD episodes showed significant decreases ($p < 0.05$) in average daily feed intake, daily weight gain, total weight gain, final live weight, and feed efficiency. Hot carcass weight and carcass yield also declined progressively as the number of BRD episodes increased. Logistic regression revealed a negative association between carcass yield and the probability of BRD occurrence, with stronger effects observed in cattle that experienced two clinical events.

Limitations on study/implications: The study was conducted in a single feedlot operation, limiting the generalizability of the findings. Further research in different production systems and climatic regions is recommended to strengthen external validity.

Findings/conclusions: BRD exerts a clear and cumulative negative impact on cattle growth performance and carcass yield. These findings highlight the need for strengthened preventive health programs, early diagnostic tools, and improved management practices to mitigate the effects of BRD in tropical feedlot systems.

Keywords: feedlot cattle; BRD; carcass yield; productive performance; logistic regression.



INTRODUCTION

Bovine respiratory disease (BRD) represents the condition with the greatest economic and productive impact on beef cattle production worldwide and in Mexico (Snowder *et al.*, 2007; Rodríguez-Castillo *et al.*, 2017). Its relevance is not limited to the high morbidity and mortality it causes, but also to the substantial subclinical losses associated with reduced average daily gain (ADG) and feed efficiency, and deterioration of carcass yield and quality (Blakebrough-Hall *et al.*, 2020; Fernandes *et al.*, 2025). BRD is a multifactorial syndrome involving the interaction of infectious agents, environmental and management factors, and animal-related characteristics, which together determine the clinical and subclinical expression of the disease (Taylor *et al.*, 2010; Blakebrough-Hall *et al.*, 2022).

BRD involves the synergistic interaction of respiratory viruses, including bovine herpesvirus type 1 (BoHV-1), bovine viral diarrhoea virus (BVDV), bovine respiratory syncytial virus (BRSV), parainfluenza virus type 3 (PI3), and bovine respiratory coronavirus, as well as opportunistic bacteria such as *Mannheimia haemolytica*, *Pasteurella multocida*, *Histophilus somni*, *Mycoplasma bovis*, and *Trueperella pyogenes* (Taylor *et al.*, 2010; Fernandes *et al.*, 2025; Monge-Navarro *et al.*, 2025; Pratelli *et al.*, 2024). Viral infections cause epithelial damage and impair mucociliary clearance, facilitating deep bacterial invasion that results in fibrinous bronchopneumonia, lung consolidation, and chronic pulmonary lesions (Taylor *et al.*, 2010; Fernandes *et al.*, 2025).

Recent studies have demonstrated that even small lung consolidation lesions ($\geq 1 \text{ cm}^2$), detected by thoracic ultrasonography in calves at weaning, are associated with significant reductions in early growth and persistent effects on carcass quality, particularly reduced marbling scores (Fernandes *et al.*, 2025). Persistent lung consolidation has also been linked to increased susceptibility to secondary infections and systemic effects, including alterations in the hepatic microbiota, although without conclusive evidence of profound dysbiosis (Fernandes *et al.*, 2025).

BRD shows higher prevalence during the receiving and adaptation phases in feedlot systems, especially when animals are exposed to multiple stressors. These include long-distance transportation, commingling of cattle from different sources, abrupt changes in temperature and humidity, overcrowding, inadequate handling, dehydration, and sudden dietary changes (Madureira-Ferreira *et al.*, 2024). In tropical and subtropical regions, high ambient temperature and humidity contribute to immunosuppression and enhance environmental pathogen survival, thereby increasing the risk of disease outbreaks (Pratelli *et al.*, 2024).

Cattle affected by BRD exhibit reduced ADG, lower feed intake and nutrient utilization, extended finishing periods, and poorer feed conversion efficiency (Blakebrough-Hall *et al.*, 2020; Blakebrough-Hall *et al.*, 2022; Wilson *et al.*, 2017). Reported reductions in ADG range from 0.11 to 0.14 kg/day in calves with early lung consolidation (Sáadatnia *et al.*, 2023; Fernandes *et al.*, 2025), while decreases of up to 24 kg in carcass weight have been observed in cattle repeatedly treated for BRD (Wilson *et al.*, 2017).

The impact on carcass traits includes significant reductions in marbling score, ribeye area, and hot carcass weight, as well as a higher proportion of carcasses classified in lower quality categories (Fernandes *et al.*, 2025; Blakebrough-Hall *et al.*, 2020). In addition,

chronic lung lesions identified at slaughter have been associated with reduced carcass yield, metabolic impairment, and increased likelihood of viscera condemnation (Fernandes *et al.*, 2025). Therefore, the objective was to evaluate, in an intensive tropical feedlot production unit, the effect of BRD on key productive performance indicators and hot carcass yield.

MATERIALS AND METHODS

Study area

The study was conducted in a livestock production unit (LPU) located in the central region of the state of Veracruz, Mexico. The climate of the area is classified as Aw2 (warm sub-humid climate) according to the Köppen-Geiger classification (Beck *et al.*, 2018; Vidal-Zepeda, 2005). Mean annual temperature ranges from 22 to 26 °C. From May to September, the region experiences intense rainfall and tropical storms, with annual precipitation reaching up to 1,500 mm, concentrated during the summer months. Predominant northerly winds occur from October to March.

The sampling period extended from January 2023 to June 2024.

Animals and data collection

A simple random sampling design was applied, comprising 5% of the monthly cattle population of the LPU, equivalent to approximately 82 animals per month (n=1,378). Data for the present study were obtained in situ through clinical evaluation of animals and from the daily production records of the LPU, including dates, live weights, and feeding information. Data on hot carcass yield were obtained from slaughterhouse records where the evaluated animals were processed.

Variables evaluated

The dependent variables analyzed were: live weight at arrival to the LPU (kg), time to first antimicrobial treatment following clinical diagnosis of BRD (days), time to second antimicrobial treatment following clinical diagnosis of BRD (days), average daily feed intake (kg), duration of the fattening period (days), final live weight at the end of the fattening period (kg), total feed intake during the fattening period (kg), total weight gain (kg), average daily gain (kg/day), feed conversion ratio (kg of feed/kg of live weight gain), and hot carcass yield (kg and %).

Experimental grouping

Independent variables were defined according to the clinical health status of the animals during the fattening period:

- Group 1: Animals without clinical signs of BRD (fever, cough, epiphora, nasal discharge, tachypnea) throughout the entire fattening period in the LPU.
- Group 2: Animals that exhibited clinical signs of BRD on one occasion during their stay in the LPU and received treatment.
- Group 3: Animals that exhibited clinical signs of BRD on two separate occasions during the fattening period and received treatment.

Statistical analysis

Data were analyzed using analysis of covariance (ANCOVA), where the main factor was health status group and arrival live weight was included as a covariate. The statistical model used was:

$$Y_{ij} = \mu + \tau_i + \beta(x_{ij} - \bar{X}) + \varepsilon_{ij}$$

where: Y_{ij} is the response variable; μ is the overall mean; τ_i is the effect of the i -th group ($i=1, 2, 3$); β is the regression coefficient for the covariate, x_{ij} is the arrival weight of the j -th observation in the i -th group, \bar{X} is the mean arrival weight, and ε_{ij} is the random error assumed to be normally distributed $[N(0, \sigma^2)]$.

Multiple comparisons among group means were performed using Fisher's least significant difference (LSD) test ($p < 0.05$). All statistical analyses were conducted using STATISTICA v10 (2011).

Additionally, logistic regression analysis was performed to estimate the probability of animals having experienced one or two BRD clinical events as a function of hot carcass yield (%). The logistic regression model was expressed as:

$$\log\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 X$$

where: P represents the probability of BRD occurrence; β_0 is the intercept; β_1 is the slope coefficient; X corresponds to hot carcass yield (%).

RESULTS AND DISCUSSION

The analysis included a total of 1,378 cattle distributed into three groups according to the presence of clinical signs compatible with bovine respiratory disease (BRD): animals that remained clinically healthy throughout the fattening period ($n=1,062$), animals that experienced one clinical event ($n=204$), and animals that experienced two clinical events ($n=114$). Significant differences ($p < 0.05$) were detected among groups for all productive variables evaluated (Table 1).

Healthy animals exhibited the highest values for growth performance and feed efficiency indicators, whereas cattle that experienced two BRD events showed the lowest values. Live weight at arrival to the LPU differed significantly among groups ($p=0.001$), with mean values of 288.69 ± 1.58 kg for healthy animals, 273.22 ± 3.27 kg for animals with one BRD event, and 255.42 ± 4.04 kg for animals with two BRD events. These initial differences were consistently reflected in productive performance throughout the fattening period.

Average daily feed intake decreased progressively as the number of BRD clinical events increased ($p=0.001$). This reduction was accompanied by a significant decline in average daily gain, which averaged 1.22 ± 0.01 kg/day in healthy animals, 1.15 ± 0.01 kg/day in animals with one BRD event, and 1.04 ± 0.02 kg/day in animals with two BRD events.

Table 1. Productive performance indicators of healthy cattle and cattle that showed clinical signs of bovine respiratory disease (BRD) on one or two occasions during the fattening period in the livestock production unit.

Dependent variables	Healthy animals (N=1,062)	Animals affected once (N=204)	Animals affected twice (N=114)	p-value
Live weight at arrival to the LPU (kg)	288.69±1.58 ^c	273.22±3.27 ^b	255.42±4.04 ^a	0.001
Time to treatment application (days)	***	19.50±1.71	15.97±2.43	***
Average daily feed intake (kg)	9.40±0.01 ^c	9.36±0.04 ^b	9.09±0.05 ^a	0.001
Duration of the fattening period (days)	196.64±0.99 ^a	194.50±2.27 ^a	209.66±3.05 ^b	0.001
Final live weight (kg)	518.00±1.51 ^c	508.00±3.46 ^b	499.93±4.66 ^a	0.001
Total feed intake (kg)	1830.00±8.87 ^a	1810.46±20.34 ^a	1889.39±27.34 ^b	0.001
Total weight gain (kg)	234.30±1.51 ^b	224.30±3.46 ^{ab}	216.23±4.66 ^a	0.001
Average daily gain (kg/day)	1.22±0.01 ^c	1.15±0.01 ^b	1.04±0.02 ^a	0.001
Feed conversion ratio (kg of feed/kg of live weight gain)	8.20±0.07 ^a	8.64±0.16 ^{ab}	9.31±0.22 ^b	0.001
Hot carcass weight (kg)	310.04±0.97 ^c	300.98±2.22 ^b	291.09±2.99 ^a	0.001
Hot carcass yield (%)	59.89±0.10 ^c	59.30±0.23 ^b	58.24±0.31 ^a	0.001

^{a, b, c} Different superscript letters within the same row indicate significant differences among groups (Fisher's LSD test, $p < 0.05$).

Similarly, feed conversion ratio deteriorated significantly ($p=0.001$), reaching values of 8.20 ± 0.07 , 8.64 ± 0.16 , and 9.31 ± 0.22 kg of feed per kg of live weight gain for Groups 1, 2, and 3, respectively.

Final live weight at the end of the fattening period also decreased significantly in association with BRD occurrence ($p=0.001$). Consequently, marked differences were observed in hot carcass yield. Healthy animals achieved a mean carcass yield of $59.89 \pm 0.10\%$, whereas animals with one and two BRD events recorded yields of $59.30 \pm 0.23\%$ and $58.24 \pm 0.31\%$, respectively ($p=0.001$). In addition, hot carcass weight declined significantly with increasing disease recurrence, with values of 310.04 ± 0.97 kg for healthy animals, 300.98 ± 2.22 kg for animals with one BRD event, and 291.09 ± 2.99 kg for animals with two BRD events.

Logistic regression analysis (Table 2) indicated that hot carcass yield was negatively associated with the probability of experiencing a BRD clinical event. For animals with one BRD event, the model showed a negative slope ($B1 = -0.0811$; $p=0.0001$), indicating that lower carcass yield percentages were associated with increased probability of disease. This effect was more pronounced in animals with two BRD events ($B1 = -0.1084$; $p=0.0001$). Odds ratio estimates confirmed this relationship, showing that for each one-percentage-point decrease in hot carcass yield, the probability of having experienced one or two BRD events increased by 7.8% and 10.3%, respectively.

Figure 1 illustrates the negative relationship between hot carcass yield and the probability of BRD occurrence, showing that disease probability increased as carcass yield decreased, with a steeper slope observed in animals that experienced two clinical events. Within the biological window of 40–70%, a clear separation between both curves was observed, confirming the sensitivity of carcass yield as a variable associated with the clinical history of BRD.

Table 2. Logistic regression estimates for the probability of showing clinical signs of bovine respiratory disease (BRD) on one or two occasions in relation to hot carcass yield (%).

N= 1378	Animals affected once (n=204)		Animals affected twice (n=114)	
	Intercept B ₀	Slope B ₁	Intercept B ₀	Slope B ₁
Estimate	3.6072	-0.0811	4.0048	-0.1084
Standard error	1.1183	0.0188	1.4157	0.0241
t-value (1376)	3.2255	-4.3029	2.8289	-4.4987
p-value	0.0013	0.0001	0.0047	0.0001
95% CI (lower)	1.4133	-0.1180	1.2276	-0.1557
95% CI (upper)	5.8010	-0.0441	6.7820	-0.0611
Odds ratio (per unit change)	36.8621	0.9221	54.8621	0.8973
95% CI (lower)	4.1096	0.8887	3.4132	0.8559
95% CI (upper)	330.6413	0.9569	881.8292	0.9407

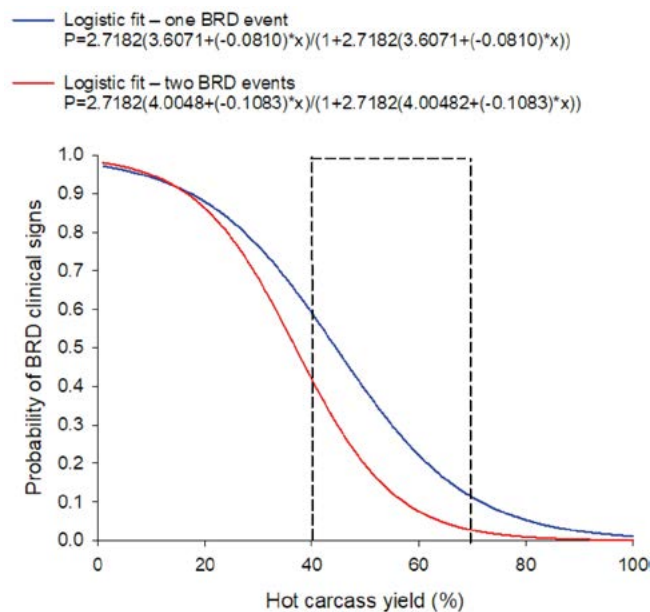


Figure 1. Logistic regression analysis showing the probability of having presented clinical signs of bovine respiratory disease (BRD) as a function of hot carcass yield (%). The blue line represents the logistic regression fit for animals that experienced one clinical event, while the red line represents the fit for animals that experienced two clinical events. The dashed box (40-70%) represents the biological analysis window.

The results of the present study demonstrate that the occurrence of clinical signs compatible with bovine respiratory disease (BRD) has a significant negative impact on productive performance indicators and carcass yield in cattle raised under an intensive feedlot system in the humid tropics of Veracruz. Consistently, animals that experienced one or two BRD clinical events exhibited lower average daily gain, poorer feed conversion efficiency, and reduced carcass weights compared with healthy animals. These findings are consistent with previous reports from intensive production and feedlot systems, where

BRD has been identified as the primary cause of reduced productive efficiency in beef cattle (Blakebrough-Hall *et al.*, 2020; Wilson *et al.*, 2017).

The observed decline in productivity can be explained by the pathophysiology of BRD, which is characterized by pulmonary parenchymal inflammation, reduced effective respiratory capacity, hypoxemia, and alterations in energy metabolism (Taylor *et al.*, 2010). Systemic inflammation is associated with increased maintenance energy requirements, as well as a reduction in voluntary feed intake (Fernandes *et al.*, 2025). These mechanisms are consistent with the findings of the present study, in which average daily feed intake decreased progressively as animals experienced one or more BRD clinical events. Similar patterns have been reported by Sáadatnia *et al.* (2023), who demonstrated that calves with early lung consolidation exhibit reduced feed intake and significant decreases in average daily gain.

The reduction in final live weight and carcass yield observed in this study agrees with previous reports describing cattle that experienced repeated BRD events. Wilson *et al.* (2017) reported that cattle treated multiple times for BRD exhibited lower carcass weights and reduced deposition of muscle and adipose tissue. Likewise, Fernandes *et al.* (2025) demonstrated that even small lung consolidation lesions can have long-term effects on marbling and carcass classification at slaughter. In the present study, both hot carcass weight and carcass yield percentage decreased significantly as the frequency of BRD clinical events increased, indicating that BRD compromises muscle growth, metabolic efficiency, and the animal's capacity for tissue accretion and carcass development.

Logistic regression analysis provided additional evidence of the association between carcass yield and the probability of disease occurrence. The negative slope coefficients indicate that as carcass yield decreases, the probability that an animal experienced one or two BRD clinical events increases. This pattern is consistent with findings reported by Snowden *et al.* (2007), who identified negative correlations between BRD incidence and carcass traits, and it reinforces the usefulness of carcass yield parameters as indirect indicators of the animal's respiratory health history.

The greater productive impact observed in animals that experienced two BRD events suggests that disease recurrence has a cumulative effect on performance. This finding is in agreement with Blakebrough-Hall *et al.* (2022), who reported that the duration and repetition of BRD events increase the likelihood of residual lung damage and amplify variability in productive responses. In addition, studies conducted in Mexico have documented that long-distance transportation, thermal stress, and commingling of animals from different origins increase BRD morbidity and directly affect feedlot efficiency (Rodríguez-Castillo *et al.*, 2017; Monge-Navarro *et al.*, 2025). These factors are particularly relevant in tropical production systems, where environmental conditions may further exacerbate cattle susceptibility to respiratory disease.

The present study also confirms that feed conversion efficiency is compromised in animals with a history of BRD. Epidemiological studies have shown that BRD alters protein and energy metabolism by diverting nutrients toward immune responses, thereby limiting growth efficiency (Madureira-Ferreira *et al.*, 2024). This reduced metabolic efficiency

constrains the animal's ability to fully recover productive performance following a clinical disease event.

Finally, although this study was conducted in a single livestock production unit, the results are consistent with both international and national reports, suggesting that BRD is a key determinant of productive performance and carcass economic value in beef cattle systems in the Mexican tropics. Future studies should incorporate physiological, environmental, and genetic variables to better model individual disease risk and to develop more precise mitigation and prevention strategies.

CONCLUSIONS

Bovine respiratory disease (BRD) significantly affects productive performance and carcass yield in feedlot cattle, as animals that experienced one or two clinical events exhibited lower average daily gain, poorer feed conversion efficiency, and reductions in both hot carcass weight and yield. These negative effects became more pronounced as the recurrence of clinical disease increased. The negative association observed between carcass yield and the probability of BRD occurrence confirms that the disease exerts a direct and cumulative impact on productive efficiency. Therefore, these findings highlight the need to strengthen preventive strategies, early diagnostic approaches, and health management practices in intensive feedlot systems operating under tropical conditions.

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