

A survey of Mississippi cow-calf producers regarding factors associated with veterinarians performing bull breeding soundness evaluations and/or pregnancy diagnosis

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Abstract

Reproductive efficiency is a major driver of profitability in beef cow-calf herds, yet many beef producers do not hire veterinarians to perform services intended to improve reproductive efficiency such as bull breeding soundness evaluation (BSE) or pregnancy diagnosis. The objective of this study was to determine reasons Mississippi cow-calf producers do or do not hire veterinarians to perform these services. Anonymous surveys were mailed to 1,500 randomly selected members of the Mississippi Cattlemen's Association. Multivariable logistic regression was used to test respondent characteristics for association with outcome variables (e.g., respondents hire a veterinarian for BSEs and/or pregnancy diagnosis). Of 414 returned surveys, 397 (96%) qualified for analysis for an overall response rate of 26%. Of respondents that answered the respective questions, 155/386 (40%) hire a veterinarian for BSEs, and 103/392 (26%) hire a veterinarian for pregnancy diagnosis. Of 396 respondents, 229 (58%) indicated they had some form of a defined breeding season. The most commonly indicated reasons for not hiring a veterinarian were lack of time/help (82/202, 41%) for BSEs and cost (91/248, 37%) for pregnancy diagnosis. On inferential analysis, the factors positively associated with hiring a veterinarian for BSEs were having a defined breeding season (OR = 6.8, 95% C.I. = 4.1-11.1) and raising seedstock cattle (OR = 1.7, 95% C.I. = 1.0-13.3). The only factor positively associated with hiring a veterinarian for pregnancy diagnosis was having a defined breeding season (OR = 4.2, 95% C.I. = 2.5-7.3). Management style and operation type influenced producers hiring a veterinarian for BSEs and pregnancy diagnosis.

Key words: reproductive efficiency, producer survey

Introduction

Reproductive efficiency is a leading driver of profitability in cow-calf operations.¹⁻³ The sources of reproductive inefficiencies in a cow-calf herd are myriad. However, breeding soundness evaluations (BSEs) are a potential tool for reproductive management by screening bull batteries to identify and remove subfertile bulls. Numerous studies have demonstrated benefits from performing BSEs.²⁻⁹ Additionally, pregnancy diagnosis in beef herds can enable producers to make timely and appropriate culling decisions for cows, identify groups of cows that may require different management strategies, and troubleshoot reproductive inefficiencies.^{10,11} Despite these apparent benefits, data from the 2017 National Animal Health Monitoring System (NAHMS) Beef Study showed that only

19.7% of all beef producers in the United States, and 14.5% of smaller herds (i.e., 49 or fewer cows), performed semen tests (i.e., BSEs) on their bulls.¹² Similarly, few small operations tested their cows for pregnancy; 14.2% of herds with 49 cows or less used palpation for pregnancy diagnosis, 4.7% used ultrasound, and 2.8% performed blood tests for pregnancy diagnosis.¹² Because herds of 49 or fewer cows comprise over 80% of herds in the state of Mississippi, better understanding of why producers choose to use these tools may help veterinarians develop programs and services that more effectively meet the needs of their clientele.¹³ Therefore, the objective of this study was to determine the reasons Mississippi cow-calf producers do, or do not, hire veterinarians for BSEs and/or bovine pregnancy diagnosis.

Materials and methods

Target population and sample size

The target population for this survey was Mississippi cow-calf producers. As of 2017 there were an estimated 14,752 beef cow operations in Mississippi.¹² The sampling frame for this study was the 2021 membership roster of the Mississippi Cattlemen's Association. Sample size was determined for a population survey using a public domain epidemiologic calculator^a. We estimated a sample of 374 individuals would be sufficient to observe a difference of up to 25% between unexposed and exposed groups with a 95% confidence interval and a 5% acceptable margin of error. The sample size calculation assumed a ratio no less than 6:1 of unexposed to exposed individuals (i.e., for every 6 individuals without a risk/protective factor there would be 1 individual with that factor), an expected frequency of 50% for any given outcome variable, and a study power of 92.5%. A previous survey performed on this population achieved a response rate of approximately 25%.¹⁴ Therefore, we anticipated that sending out 1,500 surveys would obtain our minimum sample size based on an expected response rate of 25%. Survey recipients were selected at random from the roster provided by the Mississippi Cattlemen's Association. Association members who had addresses outside of Mississippi, or who were known to be veterinarians, were excluded from the study. A random number was assigned to each address on the roster using a random number generator in spreadsheet software^b. The list was sorted by these random numbers in ascending order, and the first 1,500 names were placed on the mailing list.

Survey development

A 2-page paper survey was developed to gather information regarding the demographics of participants and their cow-calf herds, herd reproductive management, and veterinary involvement. The first question on the survey asked respondents if they were actively involved in cow-calf production, and was intended to screen responses from any recipients that were not actively involved in cow-calf production. Survey recipients were asked questions regarding their role in the operation (e.g., owner, manager, family member, etc.), operation type (e.g., seedstock, commercial, or a combination of both), and herd size. Producers were also asked their motivations for being in the cattle business (e.g., cattle are a primary or significant source of income, lifestyle, tax deduction, land use, etc.). Questions regarding breeding season management (e.g., bulls are in with the cows for 65 days or less, bulls are in with the cows for longer than 65 days, producer has 2 breeding seasons, bulls are always out with the cows, etc.) and reproductive management (e.g., use of BSEs and pregnancy diagnosis) were also included. Survey recipients were asked if they evaluated the ability of their bulls to breed each year prior to use, then to indicate all the ways they evaluated their bulls (e.g., performed their own assessment with or without evaluating semen, hired a veterinarian to perform a BSE, hired a non-veterinarian to perform a BSE, or other). Respondents who indicated they did not hire a veterinarian to evaluate their bulls were asked to indicate why (e.g., too expensive, don't trust the results, don't need the results, difficult to find a veterinarian, not enough time/help, inadequate facilities, and/or other). Survey recipients were asked if their cattle were tested for pregnancy, by whom they were tested (e.g., diagnosed pregnancy themselves, hired a veterinarian, or hired a non-veterinarian), and by what methods pregnancy diagnosis was achieved (e.g., palpation, ultrasound, blood test, or other). Respondents who indicated they did not hire a veterinarian to test their cows for pregnancy were also asked to indicate why.

The survey was limited to 2 pages to encourage a higher response rate. However, because this limited the number of questions that could be asked, and the BSE was the primary topic of interest, most of the second page focused on questions related to the BSE. Survey recipients were presented with criteria they might consider when choosing a veterinarian to perform BSEs (e.g., practitioner's speed of performing the exam, practitioner's accuracy of classifying bulls, etc.), and asked to rank them from most important to least important. Survey recipients were first given these criteria in 3 sets of 3, and asked to pick the most and least important in each set. Then survey recipients were asked to pick the overall most and least important criterion from the 9 they had previously evaluated. Survey recipients were also asked whether they were aware that there were veterinary standards for how to perform BSEs.

Recipients were asked to indicate which of 3 different aspects of their veterinary-client relationship were most and least important to them (e.g., access to emergency services, prescription drugs or preventive herd health). The last question on the survey asked recipients for the county where their operation was located. The survey questionnaire was piloted on beef cow-calf producers outside of Mississippi to evaluate question content and clarity prior to dispersal, but their responses were not included in the survey.

Survey packets containing the questionnaire and a self-addressed, postage-paid #9 business reply envelope, were mailed on February 28, 2022. The survey did not ask respondents for any identifiable information, nor did the return envelopes contain or display any information that could identify the respondents when they were sent. As a result, the responses were anonymous and the survey was not human subjects research. For this reason, it did not require review by the Mississippi State University Institutional Review Board for Protection of Human Subjects in Research.

Data collection and analysis

Survey responses received prior to June 27, 2022 were recorded and organized using spreadsheet software^b. Because this was an anonymous paper survey, respondents were able to return the survey only partially completed if they so desired. Answers from partially completed surveys were included in the analysis; the notable exception being surveys that did not include data for all variables being assessed in an inferential analysis. In these specific analyses, surveys with missing data were excluded. Blank responses were left blank in the spreadsheet, and questions marked as not applicable (e.g., N/A) were treated as blank. For questions where the respondent was asked to "Check ALL that apply", if none of the options were selected then the responses for all options were left blank because we could not distinguish all negative answers from not answering the question. Otherwise, if at least one option was selected, then all non-selected options were treated as "No" or "False" responses. During analysis, each of the responses from a "Check ALL that apply" question were treated as separate questions, except for in cases of variable aggregation. Aggregation of variables was accomplished using conditional statements in either spreadsheet software^b or a statistics software package^c. Because producers who rely on their cattle for all, or a significant portion, of their income may be more likely to base their decisions on purely financial rationale, producers who indicated that cattle were either a primary source of income or a non-primary, but still significant, source of income were aggregated into 1 category (i.e., if either category was indicated, then the response was coded as cattle being a significant/primary source of income). Because producers who sell any seedstock animals have different incentives for performing BSEs than producers who only purchase seedstock animals (i.e., commercial producers), producers who indicated they were either seedstock producers, or a combination of seedstock and commercial, were also aggregated into 1 category (i.e., if the respondent indicated they were either seedstock or a combination of seedstock and commercial, then the response was coded as "Yes" for having any seedstock, otherwise it was coded as "No"). Because the variables of lacking time/help and/or facilities both represented a decreased ability to process cattle for BSEs and/or pregnancy diagnosis, these 2 responses were aggregated as well (i.e., if the respondent indicated either they lacked time/help or facilities, or both, then the response was coded as a lack of time/help and/or facilities). For analyses that evaluated variables related to breeding season management, any indicated breeding management system other than leaving the bulls out with the cows all year was categorized as a "defined" breeding season. Producers who indicated they operated in 2 counties received half a count for each county when assessing frequency of responses by county.

Statistical analysis was performed using statistics software^c. Multivariable logistic regression was used to test respondent characteristics for associations with binary outcome variables (e.g., hiring a veterinarian for BSEs and/or pregnancy diagnosis). Variable selection was accomplished using manual forward multivariable modeling. The Tukey-Kramer test was used to adjust for multiple comparisons. Because respondents who indicated they have specific breeding season management programs (i.e., they leave their bulls in for ≤ 65 days, have multiple breeding seasons, etc.) should be mutually exclusive from producers who indicated they always leave their bulls out with the cows, these variables were assumed to be collinear and were not included together in final multivariable models. However, in the first step of manual forward selection, collinear variables were assessed as univariable models, and the variable with the most significant association was chosen for subsequent multivariable analysis. An α of 0.05 was set a priori and used for all analyses.

To explore factors related to whether respondents hire a veterinarian to perform BSEs and/or pregnancy diagnosis, we developed models with the outcome variable being whether or not producers hire a veterinarian to perform these services. Respondents who do not evaluate the ability of their bulls to breed or test their cattle for pregnancy, or perform the services themselves, or hire a non-veterinarian to perform these services, were aggregated into the “does not hire a veterinarian” category. Independent variables analyzed in the first step of manual forward selection included herd size, operation type, cattle being a primary/significant source of income, having a defined breeding season (i.e., not leaving the bull[s] with the cows all year), and having a breeding season ≤ 65 days.

To assess which variables were associated with cost being most important to producers when choosing a veterinarian for BSEs, we developed models with the outcome variable being cost as the most important criterion; the explanatory variables were owning cattle as a primary/significant source of income, having a defined breeding season, operation type and herd size.

Results

Out of 1,500 surveys mailed, 414 return envelopes with at least partially completed surveys were received as of June 27, 2022. Of these, 13 indicated that they were not involved in cow-calf production and were excluded, leaving 401 responses for preliminary analysis.

Producer characteristics

Descriptive statistics for producer characteristics are provided in Table 1. Of 401 respondents, 381 (95%) indicated that they were owners or part-owners of the operation, 9 (2%) indicated that they were family members on the operation, 5 (1%) indicated that they were non-owner managers, and 6 (1%) were in the “Other” category. Of the 6 respondents in the “Other” category, 2 made comments in the provided space that classified them as either an owner, family member or non-owner manager, and were categorized as such. The other 4 were excluded, leaving 397 responses that qualified for statistical analysis; this constituted a qualifying response rate to our survey of 26% (397/1,500).

Breeding soundness evaluation of bulls

The descriptive statistics for producer utilization of BSEs are described in Table 2. After accounting for all modeled factors, producers who had some form of defined breeding season had higher odds of hiring a veterinarian to perform BSEs, as did operations with any seedstock cattle (Table 3).

Pregnancy diagnosis

The descriptive statistics for producer utilization of pregnancy diagnosis are described in Table 4. After testing all other explanatory variables, the only variable associated with hiring a veterinarian to test cattle for pregnancy was having some form of defined breeding season (i.e., not leaving the bull[s] out with the cows all year, see Table 5). We did not detect an association between this outcome and other explanatory variables modeled.

Criteria producers use to choose a veterinarian to perform BSEs

The rankings of criteria producers use to hire a veterinarian to perform BSEs are listed in Table 6, Table 7 and Table 8. The ability of the veterinarian to accurately predict bull fertility and calf output was ranked as overall most important by the largest number of respondents. While relatively few producers indicated that cost was their overall most important criterion, producers who indicated the bull(s) are always out with their cows had higher odds of indicating this was the most important criterion they consider when choosing a veterinarian to perform BSEs (Table 9). We were unable to detect an association between producers indicating cows were a primary/significant source of income and indicating cost was their most important criterion.

Ranking of general service categories

The rankings of aspects of the veterinarian-client-patient relationship that were most important, and least important, to respondents are listed in Table 10.

Distribution of responses by county

There were 387 respondents who indicated their primary county of operation; 19 respondents also indicated secondary counties they operate in. The distribution of responses by county are illustrated in Figure 1.

Discussion

It was not surprising that seedstock producers would have higher odds of hiring a veterinarian to perform BSEs, as this diagnostic test is often performed as part of marketing bulls, especially yearlings.¹⁵ However, of all the variables we assessed, breeding season management, or the lack thereof, is the strongest indicator of how likely a producer is to hire a veterinarian to perform BSEs and/or pregnancy diagnosis. It has been suggested that the standards of the BSE, as defined by the Society for Theriogenology, assess the likelihood of a bull siring ≥ 25 calves in a 65 day breeding period.¹⁶ Herds without a defined calving season may not necessarily need bulls that can meet this standard. At the very least, these producers may not perceive as much value to the service, which could be explained in part by the finding that producers without a managed breeding season had higher odds of ranking cost as their most important criterion for choosing a veterinarian

Table 1: Descriptive statistics for characteristics of cow-calf producers in the state of Mississippi. Fractions represent the number of respondents who indicated a particular response to a question, divided by the total number of respondents who gave any response to that particular question.

Variable	Outcomes	# of Respondents/ # of Qualified responses	Percent of row
Operation type*	Seedstock	52/395	13%
	Commercial	259/395	66%
	Combination seedstock/commercial	84/395	21%
	Any seedstock‡	136/395	34%
Herd size*	49 cows or less	193/397	49%
	59-99 cows	113/397	28%
	100-199 cows	63/397	16%
	200 cows or more	28/397	7%
Motivations for owning cattle†	Enjoy caring for cattle/lifestyle	325/397	82%
	Cattle are part of family's heritage and/or legacy	257/397	65%
	Have land that wouldn't be used otherwise	191/397	48%
	Cattle are not a primary source, but still a significant source of income	161/397	41%
	Have cattle for tax purposes	113/397	28%
	Cattle are primary source of income	31/397	8%
	Other reasons	13/397	3%
	Cattle are either a primary or a significant source of income‡	192/397	48%
Breeding season management†	Turn bull(s) out with cows at a specific time of year	174/396	44%
	Leave bulls out with the cows all year	167/396	42%
	Leave bulls in with cows for longer than 65 days	118/396	30%
	Have two or more breeding seasons (e.g., spring and fall calving)	72/396	18%
	Leave bulls in for 65 days or less	46/396	12%
	Other	27/396	7%
	Artificial insemination and/or embryo transfer§	21/396	5%

* Survey recipients were asked to only indicate one outcome

† Survey recipients were asked to indicate all outcomes that applied

‡ Aggregated outcomes

§ Responses were derived from comments in the "other" category

Table 2: Descriptive statistics for utilization of BSEs by cow-calf producers in the state of Mississippi. Except where indicated, fractions represent the number of respondents who indicated a particular response to a question, divided by the total number of respondents who gave any response to that question.

Outcomes		# of Respondents/ # of Qualified responses	Percent of row
Bulls are evaluated for ability to breed each year prior to use*		220/388	57%
Who performs evaluation and how†	Producer performs their own assessment without evaluating semen	67/218	31%
	Producer performs their own assessment including semen evaluation	14/218	6%
	Producer hires a veterinarian	155/218	71%
	Producer hires a non-veterinarian to perform BSEs	1/218	< 1%
	Producer utilizes some other method	12/218	6%
Respondent hires a veterinarian to perform BSEs, out of all potential respondents		155/385§	40%
Respondent does not hire a veterinarian to perform BSEs		230/385§	60%
Reasons for not hiring a veterinarian†	Not enough time/help	82/202	43%
	Too expensive	62/202	31%
	Don't need the results	53/202	26%
	Inadequate facilities	50/202	25%
	Difficult to find a veterinarian willing/able	46/202	23%
	Don't trust the results	2/202	1%
	Other	18/202	9%
Lack of time, help, and/or facilities‡		109/202	54%
Producer is aware that there are industry standards for veterinarians who perform BSEs*		222/359	62%

* Survey recipients were asked to only indicate one outcome

† Survey recipients were asked to indicate all outcomes that applied

‡ Aggregated outcomes

§ For logistic regression analysis, denominator only included respondents that indicated they did, or did not hire a veterinarian to perform BSEs

Table 3: Multivariable logistic regression model for variables associated with respondents hiring a veterinarian to perform BSEs. The model evaluated the odds that the respondent hired a veterinarian to perform BSEs on their bull(s). Respondents who have a defined breeding season (i.e., do not leave the bull out with the cows all year) and/or have any seedstock cattle had higher odds of hiring a veterinarian to perform BSEs.

Variable		Hires vet	Does not hire vet	Estimate	Standard error	OR	95% C.I.	P-value
Defined breeding season	Yes	128	95	1.92	0.25	6.8	4.1-11.1	< 0.0001
	No	27	135	Ref.				
Operation has any seedstock*	Yes	65	70	0.52	0.24	1.7	1.0-2.7	0.03
	No	90	160	Ref.				
Intercept				-1.80	0.23			

Other variables assessed were herd size, cattle being a primary/significant source of income, and having a breeding season ≤ 65 days.

* Aggregated outcome

Table 4: Descriptive statistics for utilization of pregnancy diagnosis by cow-calf producers in the state of Mississippi. Except where indicated, fractions represent the number of respondents who indicated a particular response to a question, divided by the total number of respondents who gave any response to that question.

Outcomes		# of Respondents/ # of Qualified responses	Percent of row
Cattle are tested for pregnancy*		149/397	38%
Who performs diagnosis [†]	Hire a veterinarian	103/144	72%
	Diagnose pregnancy themselves	46/144	32%
	Hire a non-veterinarian	15/144	10%
Methods Used [‡]	Utilize trans-rectal palpation	134/147	91%
	Utilize a blood test	35/147	24%
	Utilize trans-rectal ultrasonography	18/147	12%
	Utilize some other method	2/147	1%
Respondent hires a veterinarian to test cows for pregnancy		103/390 [§]	26%
Respondent does not hire a veterinarian to test cows for pregnancy		287/390 [§]	74%
Reasons for not hiring a veterinarian [†]	Too expensive	91/248	37%
	Not enough time/help	83/248	33%
	Difficult to find a veterinarian willing/able	69/248	28%
	Don't need the results	61/248	25%
	Inadequate facilities	53/248	21%
	Don't trust the results	4/248	2%
	Other	37/248	15%
	Lack of time, help, and/or facilities [‡]	105/248	42%

* Survey recipients were asked to only indicate one outcome

† Survey recipients were asked to indicate all outcomes that applied

‡ Aggregated outcomes

§ For logistic regression analysis, denominator only included respondents that indicated they did, or did not hire a veterinarian to test cows for pregnancy

Table 5: Univariable logistic regression model for variables associated with respondents hiring a veterinarian to test their cows for pregnancy. After evaluating all variables as multivariable models, the only statistically significant association was respondents who have a defined breeding season (i.e., do not leave the bull out with the cows all year) having higher odds of hiring a veterinarian to perform pregnancy diagnosis.

Variable		Hires vet	Does not hire vet	Estimate	Standard error	OR	95% C.I.	P-value
Defined breeding season	Yes	83	145	1.44	0.28	4.2	2.5-7.3	< 0.0001
	No	20	142	Ref.				
Intercept				-1.98	0.24			

Other variables assessed were herd size, operation type, cattle being a primary/significant source of income, and having a breeding season ≤ 65 days

Table 6: Rankings of criteria Mississippi cow-calf producers use to select a veterinarian to perform BSEs. Survey recipients were asked to rank each criterion within groups of 3 criteria.

Group	Criteria	Most Important	Least Important
1	The ability of the veterinarian to accurately predict a bull's fertility/calf-output	202/220 (92%)	3/220 (1%)
	How fast the veterinarian can test the bulls (i.e., how many they can get through in an hour)	7/202 (3%)	147/202 (73%)
	How accurately the veterinarian can measure scrotal circumference	10/198 (5%)	53/198 (27%)
2	The quality of the working relationship with the veterinarian	195/224 (87%)	4/224 (2%)
	The pass/fail rate of the veterinarian	16/201 (8%)	96/201 (48%)
	How fast the veterinarian can provide test results (i.e., at the time of exam vs. the next day)	14/201 (7%)	99/201 (49%)
3	The cost of the test	38/216 (18%)	116/216 (54%)
	The availability of the veterinarian	151/223 (68%)	14/223 (6%)
	How close the veterinarian is to their location	37/211 (18%)	82/211 (39%)

Criteria were presented to survey recipients in 3 groups of 3 criteria each, and recipients were asked to rank the criteria from most to least important within each group of 3. If a respondent indicated rankings for 2 of the criteria within a group, but not the third, the ranking of the third criterion was inferred; otherwise, any unranked criteria were left blank.

Table 7: Criteria for choosing a veterinarian to perform BSEs ranked as overall most important by at least 1 respondent

Most important criteria	Number of respondents	Percent of qualifying respondents
The ability of the veterinarian to accurately predict a bull's fertility/calf-output	78/180	43%
The quality of the working relationship with the veterinarian	54/180	30%
The availability of the veterinarian	37/180	21%
The cost of the test	8/180	4%
How close the veterinarian is to their location	3/180	2%

Survey recipients were asked to indicate their overall most important criterion from the 9 criteria presented in 3 groups of 3.

to perform BSEs (i.e., if producers perceive the BSE has low value, they will choose a veterinarian to perform the procedure based primarily on having the lowest cost rather than on having the highest predictive value). Regarding pregnancy diagnosis, if we assume one of the main benefits of this service is to enable producers to manage different breeding groups, then it makes sense that producers would not see value in using this service if they do not manage breeding groups at all. During manual forward selection, there was a positive association between herd size and both of these outcomes in the univariable models. However, when the multivariable models accounted for whether the producer leaves their bull(s) out with the cows all year, the effect of herd size was no longer significant. It would seem from these results that having a defined breeding season was a confounding variable in models that evaluated the relationship between herd size and the use of these services. Further research on the economic factors that affect the benefits of BSEs and pregnancy diagnosis in herds with no defined breeding season, or a prolonged breeding season, is warranted.

It was interesting that the most cited reasons for not using these services were a lack of time/help and cost. It is feasible that a lack of time/help may also be a reason for not having a managed breeding season, and therefore could be a confounding factor in why not having a managed breeding season is associated with not hiring a veterinarian to perform these services. Especially if we consider that when lack of time/help was aggregated with lack of facilities, the resulting outcome was the most cited reason for not hiring a veterinarian to perform either service. Unfortunately, only respondents who indicated they did not perform these services answered the questions regarding why they did not hire a veterinarian to perform them, making analysis of responses from these respondents in comparison to respondents who perform these services problematic. Further research is required to determine if lacking time, help, and/or facilities is a primary reason why producers choose to leave the bull(s) out with the cows all year and thereby perceive a lack of need/value in performing BSEs and/or pregnancy diagnosis. While cost was a highly cited reason for not performing these services, it was surprising that few

Table 8: Criteria for choosing a veterinarian to perform BSEs ranked as overall least important by at least 1 respondent.

Least important criteria	Number of respondents	Percent of qualifying respondents
How fast the veterinarian can test the bulls	39/167	23%
The cost of the test	35/167	21%
How close the veterinarian is to their location	29/167	17%
The pass/fail rate of the veterinarian	27/167	16%
How fast the veterinarian can provide test results	19/167	11%
How accurately the veterinarian can measure scrotal circumference	15/167	9%
The quality of the working relationship with the veterinarian	2/167	1%
The ability of the veterinarian to accurately predict a bull's fertility/calf-output	1/167	< 1%

Survey recipients were asked to indicate their overall most important criterion from the 9 criteria presented in 3 groups of 3.

Table 9: Univariable logistic regression model for variables associated with respondents indicating cost was their overall most important criterion for choosing a veterinarian to perform BSEs. After evaluating all variables as multivariable models, the only statistically significant association was respondents who left their bull(s) out with the cows all year having higher odds of indicating cost was their overall most important criterion for hiring a veterinarian to perform BSEs.

Variable		Cost most important	Cost not most important	Estimate	Standard error	OR	95% C.I.	P-value
Bull(s) out with cows all year	Yes	7	41	3.10	1.08	22.2	2.7-185.7	0.004
	No	1	130	Ref.				
Intercept				-4.87	1.00			

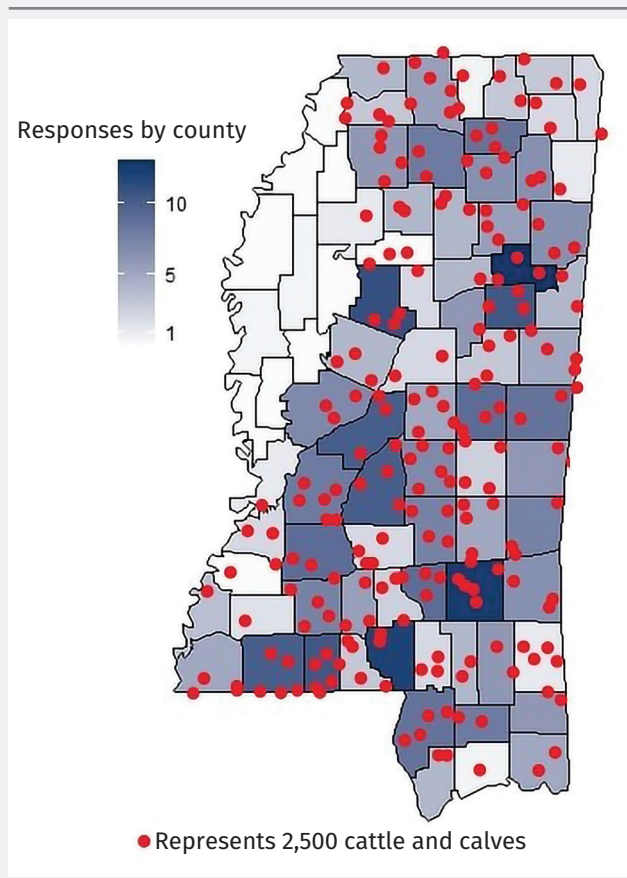
The other variables assessed were cattle being a primary/significant source of income, operation type and herd size.

Table 10: Rankings of the importance of different aspects of the veterinary-client relationship to Mississippi cow-calf producers.

Service category	Most important	Least important
Access to emergency services	212/305 (70%)	39/305 (13%)
Access to prescription veterinary drugs	41/293 (14%)	127/293 (43%)
Access to preventative herd health services	56/290 (19%)	125/290 (43%)

The numerators indicate the number of respondents who ranked a criterion most or least important, the denominators indicate the number of respondents who gave a given criterion any ranking. If a respondent indicated rankings for 2 of the criteria, but not the third, the ranking of the third criterion was inferred; otherwise, any unranked criteria were left blank.

Figure 1: Distribution of 387 cow-calf producer survey responses by county. Producers that indicated they were based in 2 counties were attributed to half a count per county. Dots indicating total number of cattle and calves were adapted from 2017 United States Department of Agriculture, National Agricultural Statistics Service data.



nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Ag_Atlas_Maps/

respondents considered cost to be an important criterion for choosing a veterinarian if they did perform BSEs. This was the primary reason for developing a logistic regression model that examined potential explanatory variables for this outcome.

That the ability of the veterinarian to predict bull fertility (i.e., calf output) was consistently ranked as most important, and rarely ranked as least important, was not surprising. It also bears noting that the one respondent who chose the ability of the veterinarian to predict fertility as their least important criterion had ranked this criterion most important in its group of 3, which may indicate they did not understand the question. Also, no producers indicated that the availability of the veterinarian was their least important criterion. Furthermore, there were 21 respondents that simply wrote “how fast” in response to the overall least important criteria question, which could have been in reference either to the speed of the test or the speed of obtaining results.

The finding that access to emergency services was most often ranked as the most important aspect of the relationship the respondents had with their veterinarian was consistent with the authors’ experience.

A potential weakness of this study was bias toward recurring responses from larger producers. The National Agriculture Statistics Service reported in 2017 that 80% of cow-calf operations in Mississippi had ≤ 49 cows, whereas operations of this size comprised less than half of respondents in this survey.¹³ The NAHMS data showed a trend for increased utilization of these technologies as herd size increased, and it is feasible that administering the survey to members of the Mississippi Cattlemen’s Association biased the data set toward larger producers who are more likely to utilize veterinary services. However, the NAHMS data did not assess for statistical significance of the trends observed, and while utilization of these services seemed to increase with herd size in our early analysis, in the multivariable models, the effect of herd size became insignificant after accounting for management factors. Furthermore, while the herd size distribution of our respondents may not closely match the National Agriculture Statistics Service herd size data, the geographical distribution of the respondents closely matches the distribution of cattle operations reported in the most recent Census of Agriculture (Figure 1).¹⁸

Conclusions

Having a defined breeding season is strongly associated with Mississippi producers hiring veterinarians to perform BSEs on their bulls and pregnancy diagnosis on their cattle. The top 3 criteria ranked most important to producers when choosing a veterinarian to perform BSEs were the ability of the veterinarian to predict bull fertility, the quality of the working relationship they have with their veterinarian, and the availability of the veterinarian; speed of the test, cost and proximity of the veterinarian were ranked as top 3 least important. Access to emergency services was the aspect of the veterinarian-client relationship that respondents ranked as most important to them.

Acknowledgements

This work is a contribution of the Beef Cattle Population Health and Reproduction Program at Mississippi State University. The authors of this study would like to acknowledge and thank the Mississippi Cattlemen’s Association for granting us access to their membership, and the members who took the time to respond to this survey. We would also like to thank Mr. Ron Wilcox and Mr. Roger Clark of Menan, Idaho, Mr. Ralph and Mrs. Fran Salt of Cardston, Alberta, and Mr. Ross Williams of Browning, Montana for taking the time to review the questions on the survey and for their invaluable contributions to the format and content. We would also like to thank Dr. Robert Wills for consulting on the study design and data analysis of this study.

Funding

The funding for this research was provided by a House Officer Grant of Mississippi State University’s College of Veterinary Medicine.

Endnotes

^a Epi Info v7.2.5.0, Center for Disease Control, Atlanta, GA

^b Microsoft Excel, Microsoft Corporation, Redmond, WA

^c PROC LOGISTIC, SAS for Windows v9.4, SAS Institute, Inc., Cary, NC

Conflict of interest

The authors of this study have no conflicts of interest to report.

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