

# Survey of veterinary involvement in cattle health and production record-keeping on U.S. cow-calf operations

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## Abstract

The objective of this study was to identify factors associated with veterinary involvement in cattle health and production record (CHPR) management on U.S. cow-calf operations. We anonymously surveyed 14,294 cow-calf producers across the U.S. Multivariable logistic regression by manual forward variable selection was used to test demographic factors for association with veterinary involvement in CHPR management outcomes. A total of 3,741 (26%) responses were received, with 3,641 (97%) actively involved in cow-calf production. Of these, 2,196 of 3,494 (63%) said a veterinarian was influential in management decisions on their affiliated cow-calf operation, and 2,216 of 3,486 (64%) said local veterinarians were their primary source of cattle health, treatment and vaccination information. If available, 1,067 of 3,382 (32%) respondents would pay a veterinarian to analyze CHPR and provide management advice based on that information. Factors associated with willingness to pay a veterinarian for CHPR-keeping services include region (midwest: OR = 1.5, 95% C.I. = 1.1-2.1; mountain: OR = 1.3, 95% C.I. = 0.9-2.0; northeast: OR = 1.4, 95% C.I. = 0.9-2.1; northern plains: OR = 1.8, 95% C.I. = 1.1-2.7; southern plains: OR = 1.7, 95% C.I. = 1.2-2.4; southeast: OR = 1.9, 95% C.I. = 1.3-2.7; compared to west), cow-calf operation is not respondent's primary income source (OR = 1.4, 95% C.I. = 1.2-1.6; compared to cow-calf operation being respondent's primary income source), respondent records antibiotic treatments (OR = 1.4, 95% C.I. = 1.1-1.7; compared to not recording antibiotic treatments), respondent education level (post-graduate or professional degree: OR = 1.4, 95% C.I. = 1.1-1.8; some college up to completed Bachelor's degree: OR = 1.1, 95% C.I. = 0.9-1.3; compared to high-school diploma or less). A meaningful number of respondents were willing to pay a veterinarian for CHPR management services depending on region, income source, antibiotic record use and education level.

**Key words:** beef, survey, veterinarian, cow-calf, VCPR

## Introduction

Veterinarians play an integral role in the health and productivity of cattle on many cow-calf operations. Today, veterinarians provide a variety of services to their beef cow-calf producer clients including emergency services (e.g., treatment of dystocia, acute injury or illness, etc.), herd work (e.g., pregnancy detection, vaccination, deworming, etc.), regulatory work (e.g., certificates of veterinary inspection, brucellosis vaccinations, tuberculosis and trichomoniasis testing,

etc.), and other nutrition, forage, biosecurity, pharmaceutical and welfare consultation.<sup>1-6</sup> Veterinary services such as pregnancy diagnosis and emergency management often act as the introduction of the veterinarian to the client and their operation, thereby facilitating the development of the veterinarian-client-patient relationship (VCPR). Over time, the VCPR is strengthened by the concurrent growth of the veterinarian's knowledge of the operation's resource availability (e.g., human, environmental, financial, etc.), goals, efficiency, and productivity, and the client's trust in the veterinarian's input in animal health, management, and operational decisions. A well-developed VCPR offers many cattle health and production benefits to the cow-calf producer; however, not all cow-calf producers have a valid VCPR. A 2016 survey of cow-calf producers in the U.S. and Canada found only 23% of respondents had a written, documented and signed VCPR.<sup>1</sup> However, many cow-calf producers may have an effective VCPR without formal documentation. Even if a valid VCPR exists, cow-calf producers may not be utilizing their relationship with a veterinarian to its fullest extent, particularly for cattle health and production record (CHPR)-keeping purposes. The 2017-2018 United States Department of Agriculture (USDA) National Animal Health Monitoring System (NAHMS) Beef Study found about 53% of all cow-calf operations consulted a veterinarian for disease diagnosis or treatment, disease prevention, information on nutrition, information on production management practices other than health, production or financial analysis such as Standardized Performance Analysis (SPA), obtaining a veterinary feed directive, or obtaining a veterinary prescription for antibiotics placed in drinking water. Of these, only 1.5% consulted a veterinarian for production or financial analysis such as SPA.<sup>7</sup> In a 2021 survey of cow-calf producers in Mississippi, 23.2% of respondents said their veterinarian used CHPR to provide management recommendations, and 26.5% of respondents were willing to pay a veterinarian to provide CHPR management services.<sup>3</sup>

Maintaining patient records is a critical component of the VCPR for the veterinarian.<sup>8,9</sup> These records often include individual patient diagnoses, treatment, and outcomes, but may be expanded to include herd-level health and production data that is useful for measuring and monitoring production, as well as investigations of disease or decreased production.<sup>10-14</sup> For example, an individual pregnancy diagnosis may affect the outcome of an individual cow (e.g., culling), but may not be sufficient to investigate reproductive efficiency in the herd. Collated whole-herd pregnancy data, however, can be used

for calculations such as 21-day incidence of conception when investigating herd-level reproductive problems. Similarly, assessing antimicrobial or other treatment data at the population level can be useful to the cow-calf producer and veterinary practitioner for measuring the efficacy of interventions (e.g., pharmaceutical, management, etc.). Involvement of the bovine practitioner in CHPR-keeping on the cow-calf operation not only allows the veterinarian a more detailed understanding of the operation's production and efficiency, but also provides the bovine practitioner with opportunities to increase practice revenue. For example, herd reproductive records may indicate a problem with heifer conception rates. Assessment of heifer development protocols as well as reproductive tract exams are services, in addition to professional time spent analyzing data, that could generate revenue for the veterinarian.

If available, data describing cattle health and productivity may be investigated for associations with factors (e.g., management, environmental, nutritional, etc.) that can be altered or manipulated to the greatest overall effect on operational production and efficiency. Lowering disease risk and improving cattle production through better management and husbandry may lead to healthier cattle leaving the cow-calf operations for the feeding sector. These cattle may need less antimicrobial therapy to combat diseases related to management (e.g., bovine respiratory disease), thereby reducing antimicrobial use, as well as the risk of carcass residues and antimicrobial resistance. As society becomes increasingly concerned with the use of antimicrobials in food animal production, veterinarians have an opportunity to leverage cattle health and production data to impact antimicrobial stewardship in the cow-calf sector, in order to safeguard their use and availability to producers when needed. Data describing reasons why cow-calf producers do not utilize veterinarians for CHPR-keeping purposes is lacking. Therefore, the objective of this study was to describe veterinary involvement in CHPR-keeping on U.S. cow-calf operations, and identify factors related to cow-calf producer use of veterinarians for CHPR-keeping purposes.

## Materials and methods

Data reported in this study was collected as part of a survey of CHPR-keeping practices on U.S. beef cow-calf operations. A complete description of study design, survey implementation, data collection, and data analysis is reported elsewhere.<sup>15</sup> A brief description of data collection and analysis of data describing veterinary involvement in the cow-calf operation is provided here.

### Sample

The target population of this study was U.S. beef cow-calf producers who are familiar with CHPR-keeping topics. The National Cattlemen's Beef Association (NCBA) promotes the use of CHPR among its members through the National Beef Quality Assurance (NBQA) program, making cow-calf producer members of the NCBA an audience of interest for the study. The NBQA program also encourages members of the NCBA to develop and maintain a valid veterinary-client-patient relationship, as well as work alongside their veterinarian to maintain records of antimicrobial and other treatments. In total, 14,294 NCBA cow-calf producer members were included in the study population.

## Sample size calculations

Sample size calculations determined 2,860 responses would be adequate to detect a difference between a 10% prevalence of a respondent characteristic (e.g., willingness to pay a veterinarian to provide CHPR-keeping services) among 1 group of respondents (e.g., non-seedstock producers) and a 15% prevalence of the same characteristic among another group of respondents (e.g., seedstock producers), if the ratio of 1 group to the next (i.e., non-seedstock to seedstock producers) was 6:1. This number of responses would also provide 97% confidence with a margin of error of 2% around a probability estimate of 50% for a respondent characteristic (e.g., willingness to pay a veterinarian to provide CHPR-keeping services).

## Questionnaire development

The survey packet mailed to each NCBA cow-calf producer member included a 1-page letter of introduction, a 2-page questionnaire consisting of 44 multiple choice and fill-in-the-blank questions, and a self-addressed, metered business reply #9 envelope. The questionnaire consisted of 4 sections: 1) producer demographic information, 2) current veterinary involvement in the cow-calf operation, 3) current record-keeping methods, and 4) challenges to record-keeping. The section describing veterinary involvement in the cow-calf operation included questions regarding the role of the veterinarian in CHPR-keeping on the cow-calf operation with which the respondent was affiliated, and other more general questions regarding animal health information sources and veterinary services utilized by the respondent. Only data pertaining to veterinary involvement in the cow-calf operation is reported here. Following submission of the letter of introduction and the questionnaire to the Mississippi State University Institutional Review Board (MSU-IRB), the study was deemed "Not Human Subjects Research" due to anonymity of the respondents, exempting the study from the requirement for IRB approval.

## Survey implementation

Survey responses were collected for 90 days following mail distribution of survey packets. Recipients of the survey packet could choose to respond by any one of the following methods: 1) return the paper survey using the included metered #9 business reply envelope, 2) use their smartphone to scan the QR code printed in the letter of introduction, or 3) use a web browser to visit the web link (URL) included in the letter of introduction. The study was promoted by an article in the August 2020 edition of the *National Cattlemen* magazine describing the study and encouraging NCBA members to participate. No other reminders, incentives, or repeat mailings were used to enhance response rate due to budget constraints.

## Outcomes

Outcomes of interest in this study include: 1) whether a veterinarian is influential in management decisions on the cow-calf operation, and 2) respondent willingness to pay a veterinarian to provide CHPR-keeping services. Explanatory variables tested for association with outcomes of interest included: 1) survey method of response, 2) operation type, 3) if the cow-calf operation is the respondent's primary income source, 4) respondent age, 5) respondent gender, 6) respondent herd size, 7) respondent education level, 8) region of the U.S. where the cow-calf operation is located, 9) and whether the respondent kept a record of antibiotic treatments on the cow-calf

operation. A description of states included in each U.S. region is provided elsewhere.<sup>15</sup>

The outcome of respondent willingness to pay a veterinarian to provide CHPR-keeping services was formed based on responses to 3 separate questions in the questionnaire. The questionnaire included 3 questions specifically addressing the CHPR-keeping services the recipient is or would be willing to pay a veterinarian to provide. These questions were as follows: “Is a veterinarian paid to collect/record cattle health and production information (weaning weights, pregnancy rates, treatment records, etc.) on the cow-calf operation?”, “Is a veterinarian paid to analyze cattle health and production information in order to provide management advice from that information?”, and “If the service was available, would you pay a veterinarian to analyze cattle health and production information (body condition scores, pregnancy rates, treatment rates, etc.) and provide management advice based on that information?”. Investigators believed that responses to these questions represented a general willingness to involve a veterinarian in the CHPR-keeping process, therefore investigators created a new variable representing those respondents who said “Yes” to at least 1 of the previously mentioned questions, and those who said “No” to all 3 of the questions. This variable was then used as the outcome representing producer willingness to pay a veterinarian to provide CHPR-keeping services.

### Statistical analysis

Data collation and descriptive statistics were performed in spreadsheet software.<sup>a</sup> Inferential statistics were performed using commercially available statistics software.<sup>b</sup> Correlation among explanatory variables was assessed using Spearman Correlation Coefficients in PROC CORR, with no highly correlated variable combinations identified. Explanatory variables were further assessed for collinearity using variance inflation factors and collinearity diagnostics within PROC REG. No collinearity was detected, making all explanatory variables eligible for inclusion in multivariable models.

If a respondent voluntarily identified themselves as a veterinarian, or voluntarily indicated that they had a veterinarian in their immediate family (i.e., spouse, parents or children), their responses were censored from the inferential analysis of the two outcomes of interest. Contingency tables of responses were used to identify explanatory variables with few or no responses in some levels. Univariable models were assembled using PROC LOGISTIC for the outcomes of 1) if a veterinarian is influential in management decisions on the cow-calf operation, and 2) respondent willingness to pay a veterinarian to provide CHPR-keeping services. For each univariable model containing a significant explanatory variable, the LSMEANS statement and Tukey’s HSD test were used to examine differences in least square means between variable levels for those explanatory variables with more than 2 levels. If an explanatory variable with more than 2 levels had few responses in a particular variable level, or when Tukey’s test revealed variable levels that did not differ statistically, variable levels were collapsed. Explanatory variables with more than 2 levels were modified as follows: respondent age levels collapsed to  $\leq 54$  years, 55–64 years, 65–74 years, and  $\geq 75$  years; herd size levels collapsed to  $\leq 49$  head, 50–199 head, and  $\geq 200$  head; education level collapsed to high-school diploma or less, some college up to completed Bachelor’s degree, and post-graduate or professional degree.

Manual forward variable selection was used to assemble multivariable models, with Wald Type III p-values and Akaike’s Information Criterion (AIC) values used to determine variable inclusion or exclusion from the model at each step in the model building process. Upon conclusion of the model building process, least square means among explanatory variables with more than 2 levels were evaluated using the LSMEANS statement and Tukey’s HSD test in each multivariable model. Within the model of whether a veterinarian is influential in management decisions on the cow-calf operation, the following 2-way interactions were tested: respondent herd size and cow-calf operation is the primary income source, region and respondent herd size, respondent education level and respondent age, and respondent records antibiotic treatments and respondent education level. Within the model of respondent willingness to pay a veterinarian to provide CHPR-keeping services, the following 2-way interactions were tested: region and cow-calf operation is primary income source, and respondent records antibiotic treatments and respondent education level. For all analyses and variable inclusion decisions during the model building process, statistical significance was defined a priori as  $\alpha = 0.05$ .

### Results

Data regarding veterinary involvement in CHPR-keeping on the cow-calf operations is reported here. Additional descriptive statistics for respondent demographics, current CHPR-keeping methods, and respondent access to and use of technology for CHPR-keeping are reported elsewhere.<sup>15,16</sup> Of the 14,294 survey packets mailed, 3,741 (26.2%) responses were received, with 3,641 (97.3%) meeting the study inclusion criteria of being actively involved in cow-calf production. Table 1 displays descriptive survey results for veterinary involvement in respondent-affiliated cow-calf operations. About two-thirds (62.9%) of respondents indicated a veterinarian was influential in management decisions on the cow-calf operation with which they were affiliated (Table 1). Respondents indicated that they paid veterinarians most frequently to provide emergency call services (e.g., calf pulls, down cows, etc.) (77.2%) followed by herd work (e.g., pregnancy checks, vaccines, etc.) (68.4%). Few respondents (3.8%), indicated a veterinarian was paid to collect or record CHPR (e.g., weaning weights, pregnancy rates, treatment records, etc.) on their affiliated cow-calf operation, while 13.3% indicated a veterinarian was paid to analyze their CHPR and provide management advice from the information. About one-third (31.5%) of respondents indicated that if the service was available, they would pay a veterinarian to analyze CHPR and provide management advice based on that information. When asked who was collecting and recording CHPR without specifying whether the respondent was paying for these services, 9.4% of respondents indicated their local veterinarian was collecting and recording CHPR on their affiliated cow-calf operation. Two-thirds of respondents (68.2%) indicated that the local veterinarian was their primary source of cattle health, treatment and vaccination information (Table 1). The two most commonly written-in answers by respondents for primary source of cattle health, treatment and vaccination information were “Co-op or feed store” (33 of 3,486; 0.9%) and “Other cattle producers” (51 of 3,486; 1.5%). Although not directly asked in the questionnaire, 113 of 3,641 (3.1%) respondents voluntarily identified themselves as veterinarians, or as having a veterinarian in the immediate family (i.e., spouse, parents or children).

**Table 1:** Descriptive results for veterinary involvement on cow-calf operations. Results do not include respondents who indicated they were a veterinarian or had a veterinarian in their immediate family (i.e., spouse, parents, or children).

Question	Number of responses	Percent, %
<b>Is a veterinarian influential in management decisions on the cow-calf operation?</b>	3494	
Yes	2196	62.9
No	1298	37.1
<b>What services is a veterinarian paid to provide to the cow-calf operation?*</b>	3517	
Emergency calls (calf pulls, down cows, etc.)	2714	77.2
Herd work (pregnancy checks, vaccines, etc.)	2404	68.4
Pharmaceutical sales (vaccines, antibiotics, etc.)	2200	62.6
Regulatory work (brucellosis vaccines, interstate health certificates, etc.)	1915	54.4
None of the above – I do not use a veterinarian	77	2.2
<b>Is a veterinarian paid to collect/record CHPR (weaning weights, pregnancy rates, treatment records, etc.) on the cow-calf operation?</b>	3511	
Yes	135	3.8
No	3376	96.2
<b>Is a veterinarian paid to analyze cattle health and production information in order to provide management advice from that information?</b>	3503	
Yes	467	13.3
No	3036	86.7
<b>If the service was available, would you pay a veterinarian to analyze CHPR and provide management advice based on that information?</b>	3382	
Yes	1067	31.5
No	2315	68.5
<b>Do any of the following currently collect or record CHPR on the cow-calf operation?*</b>	3438	
Local veterinarian	322	9.4
Consulting veterinarian (i.e., not a local veterinarian)	46	1.3
Embryologist or reproductive technician	93	2.7
Extension agent	87	2.5
Nutritionist	105	3.1
Breed association representative	94	2.7
None of the above	2947	85.7
<b>Which of the following is your primary source of cattle health, treatment, and vaccination information?</b>	3486	
Drug company representative	258	7.4
Internet	106	3.0
Livestock media (e.g., magazines, etc.)	276	7.9
Local veterinarian	2216	63.6
Consulting veterinarian (i.e., not a local veterinarian)	183	5.2
Extension agent or university	212	6.1
Other <sup>†</sup>	235	6.7

\* = Respondents could select more than 1 answer; responses total >100%

† = the most prevalent “other” responses were “Other cattlemen” (1.5%) and “Co-op or feedstore” (0.9%)

Multivariable logistic regression model results for the outcomes of whether a veterinarian is influential in management decisions on the cow-calf operation, as well as whether the respondent was willing to pay a veterinarian to provide CHPR-keeping services, are reported in Tables 2 and 3, respectively. No significant 2-way interactions were detected within either multivariable model. Factors associated with whether a veterinarian is influential in management decisions on the cow-calf operation include respondent records antibiotic treatments (OR = 1.6, 95% C.I. = 1.3-1.9; compared to respondent does not record antibiotic treatments), region (midwest: OR = 1.7, 95% C.I. = 1.2-2.4; mountain: OR = 1.3, 95% C.I. = 0.9-2.0; northeast: OR = 1.9, 95% C.I. = 1.2-2.9; northern plains: OR = 2.4, 95% C.I. = 1.5-3.9; southern plains: OR = 1.2, 95% C.I. = 0.9-1.7; southeast: OR = 0.9, 95% C.I. = 0.7-1.3; compared to west), respondent herd size ( $\geq 200$  head: OR = 1.6, 95% C.I. = 1.2-2.0; 50-199 head: OR = 1.3, 95% C.I. = 1.1-1.6; compared to  $\leq 49$  head), respondent education level (post-graduate or professional degree: OR = 1.6, 95% C.I. = 1.2-2.1; some college up to completed Bachelor's degree: OR = 1.3, 95% C.I. = 1.1-1.6; compared to high-school diploma or less), respondent age ( $\leq 54$  years: OR = 1.1, 95% C.I. = 0.9-1.5; 55-64 years: OR = 1.0, 95% C.I. = 0.8-1.2; 65-74 years: OR = 1.3, 95% C.I. = 1.0-1.6; compared to  $\geq 75$  years), and the cow-calf operation is the respondent's primary income source (OR = 1.2, 95% C.I. = 1.0-1.5; compared to the cow-calf operation is not the respondent's primary income source).

Factors associated with willingness to pay a veterinarian to provide CHPR-keeping services include region (midwest: OR = 1.5, 95% C.I. = 1.1-2.1; mountain: OR = 1.3, 95% C.I. = 0.9-2.0; northeast: OR = 1.4, 95% C.I. = 0.9-2.1; northern plains: OR = 1.8, 95% C.I. = 1.1-2.7; southern plains: OR = 1.7, 95% C.I. = 1.2-2.4; southeast: OR = 1.9, 95% C.I. = 1.3-2.7; compared to west), cow-calf operation is not respondent's primary income source (OR = 1.4, 95% C.I. = 1.2-1.6; compared to the cow-calf operation is the respondent's primary income source), respondent records antibiotic treatments (OR = 1.4, 95% C.I. = 1.1-1.7; compared to respondent not recording antibiotic treatments), and respondent education level (post-graduate or professional degree: OR = 1.4, 95% C.I. = 1.1-1.8; some college up to completed Bachelor's degree: OR = 1.1, 95% C.I. = 0.9-1.3; compared to high-school diploma or less).

## Discussion

The results of this study provide information regarding factors that influence veterinary involvement in CHPR-keeping and management on U.S. cow-calf operations. The sample population of NCBA members may not represent the opinions of all U.S. cow-calf producers regarding veterinary involvement in their affiliated operations. However, because the NCBA advocates for veterinary involvement in cattle health-care on cow-calf operations, as well as the collection and use of CHPR, the opinions of NCBA members were of interest to investigators. Membership of the NCBA, as well as other producer advocacy groups, is empirically believed by investigators to demonstrate a progressive nature of the producer, as well as their dedication to the business of cattle production. Investigators speculate that a larger proportion of NCBA members may be early adopters of innovations, such as improved record-keeping methods and veterinary involvement in the collection and analysis of these records, compared to non-NCBA members. Members of the NCBA also likely have access to record-keeping educational opportunities that may

not be available to non-NCBA members. For these reasons, members of the NCBA may have different opinions of veterinary involvement in decision-making on their operations, compared to producers who are not members of the NCBA.

Budget constraints and the anonymous nature of responses prevented investigators from contacting or assessing recipients of the questionnaire packet who chose not to respond. Because of this, the potential for response bias exists, as those producers who feel strongly about working with a veterinarian for their herd health needs may have been more likely to respond compared to those producers without strong feelings related to veterinary involvement in their cow-calf operations.

Although investigators did not directly ask recipients of the questionnaire if they were a veterinarian or had a veterinarian in their immediate family (i.e., spouse, parents or children), many respondents volunteered this information. Because investigators did not explicitly ask questionnaire recipients for this information in the questionnaire, some respondents who were veterinarians or had a veterinarian in their immediate family may not have voluntarily provided this information. As a result, the 3.1% of respondents who were veterinarians or had a veterinarian in their immediate family reported may be low. Investigators empirically believe that veterinarians and respondents with veterinarians in their immediate family may have fundamentally different viewpoints on veterinary involvement in CHPR-keeping compared to those respondents who were not veterinarians or did not have a veterinarian in their immediate family, necessitating the sorting out of responses from veterinarians or respondents with veterinarians in their immediate family for descriptive and inferential statistics.

The approximately 63% of respondents in the present study who indicated a veterinarian was influential in management decisions on their affiliated cow-calf operations is greater than a previous study by the investigators. A 2021 study of cow-calf producers in Mississippi found 41.1% of respondents had regular veterinary involvement in management decision on their affiliated cow-calf operation.<sup>3</sup> This difference may be due to the larger sample population used in the present study, as well as the expanded geographic region. As can be seen in Table 2, regional differences in veterinary involvement in management decision on cow-calf operations likely contribute to the differences seen in the present study and the 2021 study of Mississippi cow-calf producers. Involvement in management decisions requires the veterinarian to have an in-depth knowledge of the management and operational goals of the producer, as well as the veterinary services required by the producer. Developing an accurate knowledge of the latter may be a challenge that many veterinarians face unknowingly. Several studies have shown that, in general, veterinarians do not have a good understanding of producers' management goals, and the veterinary services needed from the perspective of the producer.<sup>17-19</sup> Results from the present study indicate respondents were not always motivated to be in the beef industry for financial reasons.<sup>15</sup> However, veterinarians are uniquely positioned to offer input on a variety of topics within the cow-calf production system. A 1996 survey of cow-calf producers in Idaho, Montana, Oregon, Washington and Wyoming determined that veterinary input in management decisions around bull management, biosecurity and infectious disease control, forage and nutrition management, and record-keeping would be beneficial to the cow-calf producer.<sup>20</sup> Therefore, involvement in management decisions on cow-calf operations

may require veterinarians to consider the perspective of the producer, as well as their operational goals and motivations, when assessing their animal health and veterinary needs.

It is not surprising that emergency calls and herd work were the most common, and second most common services, respectively, that respondents paid a veterinarian to provide for their cow-calf operation (Table 1). Emergency services such as management of dystocia and urogenital prolapse reductions have been identified as some of the most important competencies for new veterinarians engaged in food animal practice.<sup>21</sup> Emergency services, herd work and pharmaceutical sales are all important sources of revenue for veterinarians, depending on their practice model.<sup>6</sup> As a result, veterinarians may prefer to use their on-farm time performing services that are perceived as greater revenue-generating, compared to spending time on services that may not be perceived as revenue-generating (e.g., collecting and analyzing CHPR). Few respondents indicated they currently pay a veterinarian to collect, record, or analyze CHPR in order to provide management advice from that information. Reasons for this may include 1) producers do not perceive these as beneficial services to their affiliated cow-calf operation, or 2) veterinarians are not offering these services to their beef cow-calf producer clients. The latter option may be the case for the approximately one-third of respondents who indicated that they would pay a veterinarian to analyze CHPR and provide management advice based on that information (Table 1). When asked if anyone was currently collecting or recording CHPR on their affiliated cow-calf operation, the most prevalent response was the local veterinarian (9.4%). There may be other individuals who are not included in the list of options provided in the questionnaire that are collecting or recording CHPR on respondent affiliated cow-calf operations, however, investigators speculate that if records are being kept, this task is being conducted by individuals affiliated with the cow-calf operation, not outside of it. This finding suggests there is potential for veterinarians to expand practice revenue by offering CHPR-keeping services to their beef cow-calf clients.

Encouragingly, the local veterinarian was identified most commonly by respondents as their primary source of cattle health, treatment and vaccination information. This finding is similar to other studies that identified the local veterinarian as the primary source of animal and herd health information.<sup>5,22</sup> Being the primary source of cattle health, treatment and vaccination information to their clients allows veterinarians to participate in discussions of animal health management on their clients' cow-calf operations; these discussions may lead to strengthening of the VCPR, further involvement of the veterinarian in management decisions, and increased revenue-generating services for the veterinarian.

The association observed between recording antibiotic treatments and veterinary influence in management decisions likely stems from the nature of the relationship with the veterinarian on the cow-calf operation. This association has been observed before with cow-calf producers in Mississippi.<sup>3</sup> It may be that because a veterinarian is influential in management decisions on the operation, the veterinarian has instituted the practice of recording antibiotic data. Conversely, producers who allow veterinarians influence in management decisions may have an increased level of concern for animal health topics, leading them to record data such as antibiotic treatments. Regional differences in veterinary influence in management decisions likely represents the diversity of

cow-calf operations across the U.S., as well as differing levels of cow-calf producer access to veterinary care. Respondents from the northern plains region, for example, may place more emphasis on the cost-benefit of veterinary involvement in their cow-calf operations. A study of beef cow-calf producers in Saskatchewan, a region near and geographically similar to the northern plains of the U.S., found 76.8% considered the cost-benefit ratio before deciding to contact a veterinarian.<sup>5</sup> Similarly, larger herd sizes likely indicate a larger financial investment from the producer. An association between herd size and veterinary involvement in management decisions has been observed previously in a survey of Mississippi cow-calf producers.<sup>3</sup> Investigators speculate that in these cases, producers with large herd sizes see greater benefit to veterinary involvement in management decisions that may help increase herd profitability or efficiency. Producer education level has been shown to affect veterinary use on small-scale food animal operations.<sup>23</sup> The association seen between education level and veterinary influence in management decisions may be due to education level affecting the producer's ability to communicate effectively with veterinarians, or a lack of belief by producers with lower education levels that a veterinarian, or the knowledge and skillset provided by the veterinarian, was beneficial to their affiliated cow-calf operation. The association seen between producer age and veterinary influence in management decisions on the cow-calf operation may have been due to experiences of the respondent during their career in the cattle industry. Older respondents (65-74 years) may have more experience working with a veterinarian, and as a result, value the services and insight provided by veterinarians more than younger producers. Similarly, older producers may more readily recognize and be willing to accept when they need advice on a particular issue related to their affiliated cow-calf operation compared to younger producers. Although no statistical differences existed among levels of respondent ages  $\leq 54$  years, this may have been due to the sample population used, or too few responses in younger age levels to detect statistical differences. Respondents whose primary income source is the cow-calf operation may be more concerned with using every opportunity to improve animal health and production, thus they are more willing to involve their veterinarian in management decisions.

Interestingly, respondent willingness to pay a veterinarian to provide CHPR-keeping services was independent of operation type or size (Table 3). Rather, region of the U.S. where the cow-calf operation is located and the cow-calf operation not being the respondent's primary source of income were better indicators of the respondent's willingness to pay a veterinarian for CHPR-keeping services. Therefore, respondents of varying herd sizes engaged in seedstock and commercial production may be interested in CHPR-keeping services from their veterinarian. Curiously, respondents whose primary income source was the cow-calf operation had greater odds of saying a veterinarian was influential in management decisions on the cow-calf operation (Table 2), but lower odds of being willing to pay a veterinarian for CHPR-keeping services (Table 3), compared to those producers whose primary income is not derived from the cow-calf operation. This indicates a mindset among producers who derive their primary income source from the cow-calf operation that veterinary input is beneficial to their operation's success, but they do not see the benefit of, and are not willing to pay for, veterinary involvement and input in CHPR-keeping. Overall, respondents willing to pay a veterinarian for CHPR-keeping services

**Table 2:** Multivariable logistic regression model for the outcome of a veterinary influence on management decisions on the cow-calf operation. Outcome modeled as the probability that the respondent said “Yes”, a veterinarian is influential in management decisions on the cow-calf operation.

Explanatory variable	Level	Responses*	Parameter	Standard error	Odds ratio	95% C.I.		P-value
<b>Intercept</b>			-0.62	0.23				0.0061
<b>Respondent records antibiotic treatments</b>								
	Yes	2358	0.44	0.1	1.6	1.3	1.9	<.0001
	No	571	Ref.	Ref.	1.0	Ref.		
<b>Region</b>								
	Midwest <sup>a</sup>	693	0.56	0.17	1.7	1.2	2.4	<.0001
	Mountain <sup>abc</sup>	281	0.30	0.20	1.3	0.9	2.0	
	Northeast <sup>ac</sup>	184	0.62	0.22	1.9	1.2	2.9	
	Northern Plains <sup>a</sup>	185	0.90	0.24	2.4	1.5	3.9	
	Southern Plains <sup>bc</sup>	655	0.19	0.17	1.2	0.9	1.7	
	Southeast <sup>b</sup>	729	-0.09	0.17	0.9	0.7	1.3	
	West <sup>bc</sup>	202	Ref.	Ref.	1.0	Ref.		
<b>Respondent herd size</b>								
	≥200 head <sup>a</sup>	855	0.44	0.12	1.6	1.2	2.0	0.0010
	50-199 head <sup>a</sup>	1313	0.29	0.10	1.3	1.1	1.6	
	≤49 head <sup>b</sup>	761	Ref.	Ref.	1.0	Ref.		
<b>Respondent education level</b>								
	Post-grad or Prof. degree <sup>a</sup>	580	0.47	0.14	1.6	1.2	2.1	0.0023
	Some college up to completed Bachelor's degree <sup>a</sup>	1883	0.27	0.11	1.3	1.1	1.6	
	High-school diploma or less <sup>b</sup>	466	Ref.	Ref.	1.0	Ref.		
<b>Respondent age</b>								
	≤54 years <sup>ab</sup>	801	0.13	0.13	1.1	0.9	1.5	0.0374
	55-64 year <sup>a</sup>	795	-0.04	0.13	1.0	0.8	1.2	
	65-74 year <sup>b</sup>	884	0.25	0.12	1.3	1.0	1.6	
	≥75 years <sup>ab</sup>	449	Ref.	Ref.	1.0	Ref.		
<b>Cow-calf operation is respondent's primary income source</b>								
	Yes	1019	0.19	0.1	1.2	1.0	1.5	0.0484
	No	1910	Ref.	Ref.	1.0	Ref.		

\* = 2,929 total responses were used in this model

<sup>a,b,c</sup> = levels with a common letter were not statistically different by Tukey's HSD test for multiple comparisons among variable levels

may represent producers with an acuity for monitoring and measuring animal health. This behavior is likely responsible for the association with recording antibiotics seen for both outcomes of interest (Tables 2 and 3). Similar to the outcome presented in Table 2, respondents with greater levels of education likely have a greater understanding of the value of CHPR in decision-making on their affiliated cow-calf operations, compared to those producers with a high-school diploma or less. This understanding may be the direct result of their educational experiences. In many cases, individuals with a

completed Bachelor's degree or higher education were likely exposed to data collection and analysis at some point in their educational career, making them familiar with the concept of collecting data to enhance the accuracy and confidence of management decisions.

Veterinarians play an important role in ensuring the health and productivity of cattle on cow-calf operations in the U.S. There appears to be significant potential for veterinarians to provide CHPR-keeping services to their beef cow-calf clients, both from the perspective of producer interest in

**Table 3:** Multivariable logistic regression model for respondent willingness to pay a veterinarian to provide CHPR-keeping services. Outcome modeled as the probability that the respondent indicated “Yes”, they were willing to pay a veterinarian to provide CHPR-keeping services.

Explanatory variable	Level	Responses*	Parameter	Standard error	Odds ratio	95% C.I.		P-value
<b>Intercept</b>			-1.63	0.21				<.0001
<b>Region</b>								0.0063
	Midwest <sup>ab</sup>	694	0.41	0.18	1.5	1.1	2.1	
	Mountain <sup>ab</sup>	283	0.28	0.21	1.3	0.9	2.0	
	Northeast <sup>ab</sup>	187	0.31	0.22	1.4	0.9	2.1	
	Northern plains <sup>ab</sup>	185	0.57	0.22	1.8	1.1	2.7	
	Southern plains <sup>ab</sup>	665	0.52	0.18	1.7	1.2	2.4	
	Southeast <sup>b</sup>	739	0.64	0.18	1.9	1.3	2.7	
	West <sup>a</sup>	203	Ref.	Ref.	1.0	Ref.		
<b>Cow-calf operation is respondent’s primary income source</b>								0.0002
	No	1926	0.33	0.09	1.4	1.2	1.6	
	Yes	1030	Ref.	Ref.	1.0	Ref.		
<b>Respondent records antibiotic treatments</b>								0.0009
	Yes	2379	0.34	0.10	1.4	1.1	1.7	
	No	577	Ref.	Ref.	1.0	Ref.		
<b>Respondent education level</b>								0.0190
	Post-grad. or Prof. degree <sup>a</sup>	586	0.32	0.13	1.4	1.1	1.8	
	Some college up to completed Bachelor’s degree <sup>b</sup>	1901	0.08	0.11	1.1	0.9	1.3	
	High-school diploma or less <sup>b</sup>	469	Ref.	Ref.	1.0	Ref.		

\* = 2,956 responses were used by this model

<sup>a,b,c</sup> = levels with a common letter were not statistically different by Tukey’s HSD test for multiple comparisons among variable levels

CHPR-keeping services, as well as from the existence of a void in the availability of these services. Local veterinarians are considered the primary source of cattle health, treatment, and vaccination information. Interest in paying a veterinarian to provide CHPR-keeping services was not limited to any type of operation, or by herd size. Region, respondent education level, whether respondents record antibiotic treatments, and whether the cow-calf operation is the respondent’s primary source of income influenced both veterinary involvement in management decisions on cow-calf operations, as well as in producer willingness to pay a veterinarian to provide CHPR-keeping services.

## Conflict of interest

The sampling frame for this study was provided by the National Cattlemen’s Beef Association (NCBA). The authors declare no conflict of interest.

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## Endnotes

<sup>a</sup>Microsoft Excel, Microsoft Corporation, Redmond, WA

<sup>b</sup>SAS for Windows v9.4, SAS Institute, Inc., Cary, NC



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