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Survey of the cattle health and production record-keeping methods and opinions of cow-calf producers in Mississippi

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Abstract

The objective of this study was to identify characteristics of Mississippi cow-calf producers associated with their use of cattle health record-keeping systems. Anonymous surveys were mailed to 1,275 cow-calf members of the Mississippi Cattlemen's Association. Multivariable logistic regression using manual forward variable selection was used to test factors for association with cattle health and production record-keeping outcomes. Significance was defined at alpha=0.05. Three-hundred eight surveys (24%) were returned. Of these, 292 (95%) were actively involved in cow-calf production, with 221 (75.7%), 29 (9.9%), and 42 (14.4%) being commercial, seedstock, or both, respectively. Two-hundred nineteen of 290 (75.5%) owned <100 head, and 207 of 292 (70.9%) were >55 years old. Two-hundred forty-five of 289 (84.8%) used individual animal identification. Two-hundred fifteen (73.6%) and 76 (26%) of 292 used hand-written and electronic records, respectively. Using electronic cattle records was associated with computer access (OR=7.6, 95%CI=2.3 to 25.8), smartphone ownership (OR=6.9, 95%CI=2.0 to 23.6), and Bachelor's degree or higher (OR=2.0, 95%CI=1.1 to 3.7). Producer interest in using a smartphone-based cattle record-keeping system was associated with smartphone ownership (OR=6.0, 95%CI=2.1 to 16.6), and being ≤55 years old (OR=2.9, 95%CI=1.5 to 5.4). Access to technology and producer demographics influence the record-keeping practices of Mississippi cow-calf producers.

Key words: technology, data, demographics, smartphone, records, cow-calf, cattle

Introduction

It is widely believed that cow-calf producers underutilize cattle health and production records. The 2007-2008 National Animal Health Monitoring Service (NAHMS) Beef Study found 83% of cow-calf producers in the US regardless of herd size kept some form of cattle records. Of those producers who kept some form of cattle records, only 19.9% did so on a computer located either on or off the operation, whereas 78.6% of producers kept handwritten records.[23] Handwritten records are effective at capturing data, but can be time consuming to maintain and are not easily queried for analysis. Electronic records are more amenable to analysis to evaluate the effectiveness of treatment or management interventions, determine causal relationships during disease outbreaks, or monitor production metrics for the herd or individual.[16,20,21] Technologies such as personal computers, tablets, and smartphones have become widely available and affordable. Reasons why these technologies are not widely used for electronic cattle health and production record-keeping are not well understood. Potential reasons for not using electronic records may include cost, lack of time, labor, infrastructure, or equipment necessary, uncertainty regarding the use of the data when it is collected, lack of efficient or standardized methods of recording and analyzing data, and lack of belief that electronic cattle health and production data is more beneficial to their operation's productivity than handwritten records.

A record-keeping system that is easy to use, efficient, affordable, and convenient for the producer may offer cow-calf producers the ability to measure the effects of management decisions and interventions,[22] improve methods of measuring individual animal performance and productivity,[1,7] access premium markets and enhance animal traceability,[19] improve cattle health by reducing incidence of disease, and decrease antibiotic use.[14,15]

The smartphone holds promise as a flexible and convenient platform for electronic cattle health and production record-keeping. However, to develop a smartphone-based record-keeping system, information from cow-calf producers is needed to determine what data are most important to them,

how they are currently using cattle health and production data, and perceived barriers they encounter in capturing and using cattle health and production data. The objective of this study was to survey cow-calf producers in Mississippi to identify factors that influence their methods and opinions regarding cattle health and production record-keeping.

Materials and Methods

Sample – The target population of this study was cow-calf producer members of the Mississippi Cattlemen's Association (MCA). Survey recipients (n=1,275) were selected from the membership mailing list of the MCA using computer-generated random numbers. Commercial businesses were excluded from the mailing list.

Sample size calculation – A power analysis indicated that 255 responses would be sufficient to provide 95% confidence, ±4%, in an estimate of 10% prevalence of a producer characteristic (e.g. producer willingness to utilize an electronic health record-keeping system).[a] This number of completed surveys was also sufficient to detect the difference between 5% and 17.5% prevalence of a producer characteristic (e.g. willingness of producers to utilize an electronic health record-keeping system) if the ratio of individuals with or without the factor (e.g. age ≤55) was 3:1, respectively. Recent cow-calf producer surveys on a state and nation-wide level have elicited a response rate of 15 to 30%.[18,28] Therefore, we anticipated receiving at least 255 surveys from 1,275 mailed surveys (20% response rate).

Questionnaire development – The survey packet consisted of a 1-page letter of introduction to the study, a 2-page questionnaire, and a business reply #9 envelope. The questionnaire was developed by 1 investigator (WIJ) and all other investigators participated in reviewing question structure and wording. When all investigators agreed on length, structure, and word selection, 6 cow-calf producers were selected to pilot the questionnaire and provide feedback on wording, question structure, and potential points of confusion. Final revisions were made based on feedback from those test recipients who completed the pilot questionnaire. The final version of the questionnaire included 29 questions divided into 4 sections: 1) producer demographics, 2) cattle health and production record-keeping methods, 3) level of veterinary involvement in the cow-calf operation, and 4) current data collected by the producer. Data regarding level of veterinary involvement in the cow-calf operation is reported elsewhere.[9] Questions were presented in multiple choice, matrix, descriptive rating scale, and open-ended formats. The Beef Improvement Federation Guidelines on recommendations for individual animal data collection were used as a standard when questioning producers regarding the specific types of cattle health and production data they currently collect.[2] Recipients of the survey packet were informed in the letter of introduction that their participation in the survey was anonymous, and no personally identifying information was requested in the questionnaire. The letter of introduction also included contact information for investigators. The questionnaire was deemed by the Mississippi State University Institutional Review Board (IRB) for the Protection of Human Subjects to be exempt from IRB approval due to the anonymity of respondents.

Survey implementation - Survey packets were mailed by standard bulk rate in February 2019, and responses were accepted for up to 2 months after mailing. Recipients of the questionnaire could respond by either: 1) completing the paper copy of the questionnaire and returning it in the included self-addressed, postage-paid envelope, 2) completing the survey electronically using a web address (URL), or 3) using their smartphone to scan a quick response (QR) code. An online, commercially available survey software was used to create an electronic form of the questionnaire, as well as generate a unique QR code and web address that would direct recipients to the electronic form of the questionnaire and compile answers into a downloadable spreadsheet format.[b] Once each respondent had completed the survey by either of the electronic methods, the respondent was restricted by the survey software from completing the survey by the same method a second time. Instructions were included in the letter of introduction to complete the survey by 1 method only. Authors believed that the risk of non-response to the survey was greater than the risk of a producer willingly completing 2 different methods of the survey, therefore, no further efforts were made to prevent duplication of paper and electronic responses. No reminders, repeat mailings, or incentives for completion of the survey were used due to budget constraints.

Outcomes – Outcomes of interest in this study included the following: 1) producer use of any form of cattle health and production records, 2) producer use of electronic cattle health and production records, 3) producer use of individual animal identification, 4) producer willingness to use a confidential, centralized data storage system for cattle health and production data, 5) producer interest in keeping cattle health and production records from a smartphone, and 6) whether or not the producer regularly records antibiotic treatments. Each of these outcomes was tested for association with the following categorical explanatory variables: 1) type of cow-calf production (seedstock, commercial, or both), 2) if the cow-calf operation was greater than 50% of total producer income, 3) herd size, 4) age of producer, 5) sex of producer, 6) number of years of experience in cow-calf production, 7) highest level of education obtained by respondent, 8) use of any form of individual animal identification on the cow-calf operation, 9) ownership of a smartphone, and 10) readily-available access to a computer for record-keeping purposes on the cow-calf operation.

Statistical analysis – Both paper and electronic responses were compiled into 1 dataset using spreadsheet software.[c] Descriptive statistics were used to evaluate the dataset for errors as well as for reporting producer demographics and currently recorded health and production

records. Response percentage reported for each question was calculated using the total number of responses for each individual question. Statistical software was used for multivariable analysis.[d] Multivariable logistic regression by manual forward variable selection was performed using the PROC LOGISTIC procedure. Wald type 3 P-values, and Akaike's Information Criterion (AIC) model fit statistics were used to determine variable inclusion or exclusion from the model.

When an explanatory variable had more than 2 levels (i.e. age of producer, years of experience, etc.), the LSMEANS statement and Tukey's test were used to make multiple comparisons among the variable levels during the univariable analysis. In cases where an explanatory variable had few or no responses in 1 or more levels, or when no statistical differences were detected between multiple levels of the variable using Tukey's test, variable levels were collapsed prior to multivariable analysis, in order to improve overall model fit. Variables were collapsed as follows: age of producer was collapsed to ≤55 years and >55 years, years of experience in cow-calf production was collapsed to ≤25 years and >25 years, level of education was collapsed to less than a Bachelor's degree and Bachelor's degree or greater, and herd size was collapsed to ≤49 head, 50-99 head, ≥100 head.

Explanatory variables thought to be collinear were evaluated using the variance inflation factor option in PROC REG. Explanatory variables with a variance inflation factor value of greater than 10 were considered highly correlated, tested in the models separately, and the most significant variable with the best model fit was retained.[17] Results of each model analysis were reported as odds ratios with 95% confidence intervals for producer support of each outcome. Outcomes with multivariable models were tested for 2-way interaction among explanatory variables. For all analyses, statistical significance was set *a priori* at alpha = 0.05.

Results

Of the 1,275 producers who were mailed a survey, 308 (24%) total responses were received, with 283 (91.9%) of these responses being questionnaires returned by mail (Table 1). Of the 308 total respondents, 292 (95%) met the study inclusion criteria of being actively involved in cow-calf production. The results of producer demographic questions are listed in Tables 1 and 2. Producers over the age of 55 constituted 70.9% of respondents, and 75.7% of respondents were involved with only commercial cow-calf production. The herd size category with the most responses was 1 to 49 head (51.4%). The most commonly identified motivation for being in the cattle business by respondents was personal enjoyment (82.4%). Table 3 summarizes the current cattle health and production record-keeping characteristics of respondents. Most respondents (73.6%) kept hand-written cattle health and production records. Two-hundred and seventeen (74.8%) of respondents owned a smartphone, while 140 (58.3%) of respondents said they were interested in using a cattle health and production record-keeping system from their smartphone. Figures 1 through 3 summarize percentage of respondents who collect various types of cattle health and production data. Calving dates, year of birth, and sex of calf, respectively, were the top three most commonly recorded types of data by respondents (Figure 1), while calving dates was considered most often by respondents as among the

Table 1. Descriptive statistics for survey results of Mississippi cow-calf producer demographics.

Question	Number of responses	Percent
Method of response to survey	308	
Paper survey	283	91.9
QR code	4	1.3
URL response	21	6.8
Type of cow-calf production	292	
Seedstock	29	9.9
Commercial	221	75.7
Both	42	14.4
Primary decision maker for cow-calf operation?	290	
Yes	281	96.9
No	9	3.1
Is cow-calf operation primary (>50%) source of income?	291	
Yes	35	12.0
No	256	88.0
Adult beef cow inventory as of January 1, 2019?	290	
1-49 head	149	51.4
50-99 head	70	24.1
100-149 head	35	12.1
150-200 head	16	5.5
Greater than 200 head	20	6.9
Sex of producer	292	
Male	270	92.5
Female	22	7.5

Table 2. Descriptive statistics for survey results of Mississippi cow-calf producer demographics

Question	Number of responses	Percent
Age of Producer	292	
35 years or younger	19	6.5
36-45 years	20	6.8
46-55 years	46	15.8
56-65 years	85	29.1
66-74 years	80	27.4
75 years or older	42	14.4
Years of experience in cow-calf production	291	
5 years or less	22	7.6
6-15 years	42	14.4
16-25 years	42	14.4
26-35 years	43	14.8
36-45 years	53	18.2
45 years or more	89	30.6
Highest level of education	292	
Middle school	2	0.7
High school	65	22.3
Some college	64	21.9
Associate's degree	26	8.9
Bachelor's degree	82	28.1
Post-graduate degree (Master's, PhD, DVM, MD, etc.)	53	18.2
Motivation for being in the cattle business*	279	
I have land that would be unused otherwise	86	30.8
Cattle are my retirement plan	150	53.8
I have cattle for my enjoyment	230	82.4
Cattle have always been in my family	148	53.0
I have cattle primarily as a source of income	79	28.3

* = each respondent could select more than one answer

top three most important types of data to collect (Figure 3). Respondents commonly identified weaning weights, mature cow weights, and birth weights, respectively as the top 3 data types they are not recording, but are interested in recording (Figure 2).

Significant univariable model results are shown in Table 4. Access to technology such as computers and smartphones, use of individual animal identification, and type of operation were consistently associated with cattle health and production record-keeping outcomes. Many of these associations were maintained in the multivariable models shown in Tables 5 through 10.

A variance inflation factor of 1.05 was measured between the explanatory variables ownership of a smartphone and age of producer, and the outcome of using a cattle health and production record-keeping system from their smartphone. Similarly, a variance inflation factor of 1.0 was measured between the explanatory variables age of producer and ownership of a smartphone. These variance inflation factors were below the collinearity threshold of 10. Therefore, both explanatory variables age of producer and ownership of a smartphone were retained in the model of producer interest in using a cattle health and production record-keeping system from their smartphone. For each multivariable model, no significant 2-way interactions were detected for all explanatory variable combinations tested.

Discussion

Results of this study describe the record-keeping methods and opinions of cow-calf producer members of the MCA. The target audience of the survey was cow-calf producers who likely have experience with cattle health and production record-keeping. Membership of the MCA may not be representative of all cow-calf producers in Mississippi, or cow-calf producers in other states. However, investigators empirically believe that cow-calf producer members of the MCA are more likely to have experience with cattle health and production records, compared to cow-calf producers who are not members of the MCA, making their opinions and methods of cattle health and production records of interest to the authors. Membership of the MCA offered a convenient sample of producers whose methods and opinions were of most interest to the authors. Further efforts to reach non-MCA member producers were not made because these producers may not be as familiar with cattle health and production records, and may not be capturing any data on their cattle. The authors speculate that producers with some experience collecting and recording cattle health and production data (e.g. producers who keep handwritten records) would be more interested or willing to adopt electronic record-keeping practices compared to those producers who currently collect no cattle health and production records.

Table 3. Descriptive statistics for record-keeping methods of Mississippi cow-calf producers.

Question	Number of responses	Percent
Current methods of cattle health and production record-keeping*	292	
Hand-written (notebook, notepad, etc.)	215	73.6
Commercially available or breed association software (e.g. CattleMax, Cow Sense, AIMS, etc.)	22	7.5
Microsoft Excel or similar program	38	13.0
Smartphone Applications	16	5.5
I do not keep any animal health and production records	32	11.0
Level of satisfaction with current record keeping methods	290	
Extremely satisfied	52	17.9
Somewhat satisfied	155	53.4
Neither satisfied nor dissatisfied	47	16.2
Somewhat dissatisfied	30	10.3
Extremely dissatisfied	6	2.1
Do you own a smartphone (phone with internet access and application download capabilities)?	290	
Yes	217	74.8
No	73	25.2
Do you have readily available access to a computer on your operation?	286	
Yes	209	73.1
No	77	26.9
Do you use any form of individual animal identification on your cattle?	289	
Yes	245	84.8
No	44	15.2
Would you put your cattle health and production information into a confidential, centralized data storage system?	281	
Yes	137	48.8
No	144	51.2
Are you interested in using a cattle health and production record keeping system from your smartphone?	240	
Yes	140	58.3
No	100	41.7
How beneficial do you see cattle health and production records to be to the success of your operation?	288	
Very beneficial	172	59.7
Somewhat beneficial	107	37.2
Not beneficial at all	9	3.1
Do you routinely record antibiotic treatments?	287	
Yes	160	55.7
No	127	44.3

* = each respondent could select more than one answer

The 24% response rate obtained by this study is typical of mail surveys.[3,10] Sample size calculations were exceeded for this study, with 292 respondents meeting the study's inclusion criteria of being actively involved in cow-calf production. Increased response rates have been achieved when mail surveys of cow-calf producers used incentives or repeat mailings;[5,6] however, incentives or repeat mailings do not always produce response rates greater than those in the present study.[8] The large discrepancy between paper and electronic responses was unexpected. It is surprising that although many respondents owned smartphones and had access to computers (Table 3), very few used them to answer the survey, preferring to answer the paper survey. This phenomenon has been recognized in other studies with differing respondent demographics as well.[3] The authors speculate that if the initial contact was made by electronic means, rather than paper, results of the study may differ. Using only an electronic form of the survey may select for producers who are familiar with the electronic survey medium (i.e. internet, email, smartphones, etc.), and exclude those producers who do not have access to such forms of communication. One survey of beef US beef producers conducted exclusively by email found a similar percentage of respondents 55 to 70 years of age to the present study, but fewer respondents had less than 50 head than in the present study.[12] Although determinants of response method are not well understood, investigators speculate that age of respondent population and convenience of answering the paper survey may have influenced method of response. Method of response was not tested as an outcome, or for association with any outcomes in this study, due to concerns regarding the validity of potential results when so few electronic responses, relative to paper responses, were received. Also, the authors believed other explanatory variables (e.g. access to a computer and ownership of a smartphone) better described both producer characteristics and resources available to the producer that may influence cattle health and production record-keeping, rather than whether the producer answered the survey with a computer or smartphone.

The number of respondents in the present study over the age of 45 (86.7%) is consistent with national and state cow-calf producer demographics. According to the 2012 US

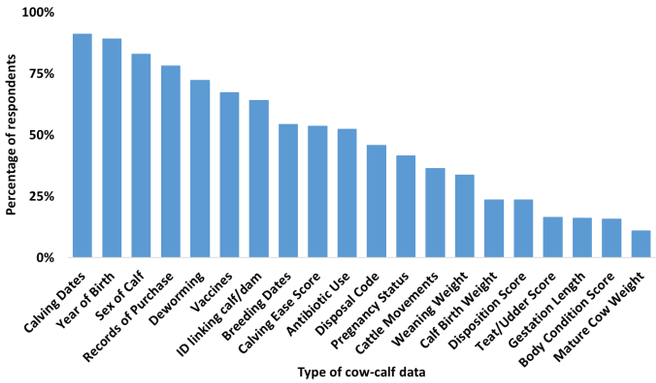

Figure 1. Percentage of respondents who currently collect and record each type of cattle health and production data.

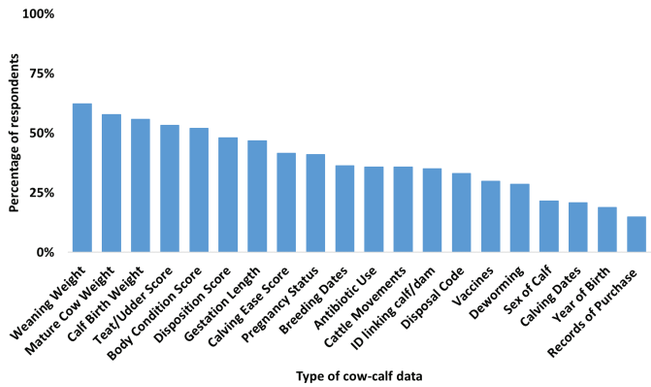

Figure 2. Percentage of respondents who are not currently collecting, but are interested in potentially collecting each type of data.

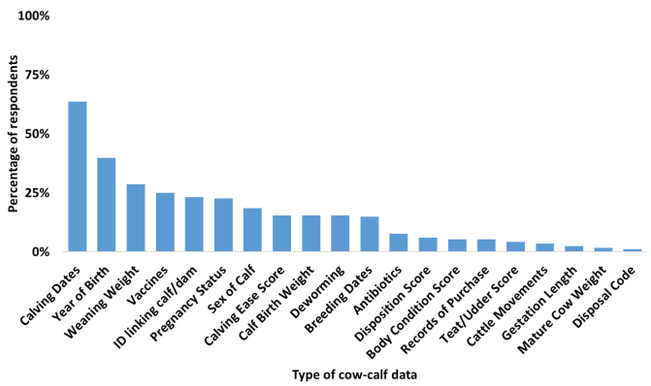

Figure 3. The percentage of respondents who ranked each type of cow-calf data in their top three for most important types of data to a cow-calf operation.

Census of Agriculture, 84% of beef cattle producers, excluding feedlot operators, were greater than 45 years of age.[26] In a 2000 study examining attitudes of cow-calf producers in Mississippi towards alternative production and marketing practices, 66.9% of beef producers in the state were over the age of 50.[11] The 2017 NAHMS Beef Study found 77.3% of all respondents described their breeding herd best as a commercial herd.[24] This closely matches the 75.7% of respondents in the present study who identified their herds as commercial (Table 1).

Off-farm jobs are important sources of income to many beef producers, and percentage of income derived from the cow-calf operation may influence how the operation is managed. In 1999, 53% of Mississippi beef producers indicated they had off-farm employment, with 84% percent of that employment being full-time.[11] A similar trend is seen with beef producers across the nation, as 55% of U.S. beef producers indicated their primary occupation was something other than the beef operation, and 87% indicated that the beef operation was less than 50% of their total income in 2012.[26]

Herd size of respondents to the present survey was also consistent with historical US and Mississippi data. The 2017 Census of Agriculture found that 590,529 of 768,542 (76.8%) beef operations with cow herds consisting of mature cows and heifers that calved had less than 50 head total.[27] A previous study in Mississippi found the overall average herd size including mature cows, replacement heifers, and bulls to be 48 head.[11]

Some of the cattle health and production data being collected least frequently (e.g. teat/udder score, mature cow weight, body condition score, weaning weight; Figure 1) are those types that respondents reported being most interested in recording (Figure 2). These data can be useful in measuring and improving productivity of cattle in a cow-calf operation. We speculate that producers may capture these types of data if they could do so easily and conveniently.

Prior to this study, little information was available regarding the methods and opinions of Mississippi cow-calf producers on cattle health and production record-keeping. The percentage of respondents in the present survey who kept some form of records (Table 3) is consistent with the NAHMS 2007-2008 Beef survey which indicated that 83.3% of all operations nationwide regardless of size kept some form of records.[23] The number of producers who indicated they keep handwritten records in the NAHMS 07-08 Beef survey (79%) closely matched the percentage of producers in the present study who said they kept handwritten cattle health and production records (73.6%). The NAHMS 07-08 Beef survey indicated 17% of producers kept records by way of a computer on their operation, while the present study found that slightly more (Table 3) cow-calf producers in Mississippi keep records electronically.[23] This difference is likely because the NAHMS survey targeted all cow-calf producers, while the present study targeted cow-calf members of the MCA who may be more familiar with cattle health and production record-keeping concepts.

Interestingly, the primary motivation for being in the cattle business among respondents to this study does not

Table 4. Significant univariable model results for each outcome.

Model Information	Responses	Variable Level	Odds Ratio	95% CI		P-value
Use of any form of cattle health and production records						
Operation type	71	Seedstock	3.4	1.0	11.6	0.0481
	221	Commercial	1.0		Ref.	
Individual animal ID	245	Yes	11.4	5.1	25.6	<.0001
	44	No	1.0		Ref.	
Owns a smartphone	217	Yes	4.1	1.9	8.7	0.0003
	73	No	1.0		Ref.	
Computer access	209	Yes	3.4	1.6	7.3	0.0017
	77	No	1.0		Ref.	
Use of electronic cattle health and production records						
Operation type	68	Seedstock	2.4	1.3	4.2	0.0044
	192	Commercial	1.0		Ref.	
Herd size	128	≤49 head	0.4	0.2	0.8	0.0444
	64	50-99 head	0.6	0.3	1.2	
	67	≥100 head	1.0		Ref.	
Age of producer	79	≤55 years	2.0	1.1	3.6	0.0152
	181	>55	1.0		Ref.	
Years of experience	96	≤25 years	2.0	1.1	3.4	0.0165
	164	>25 years	1.0		Ref.	
Level of education	136	< Bachelor's degree	0.4	0.2	0.8	0.0035
	124	≥ Bachelor's degree	1.0		Ref.	
Owns a smartphone	202	Yes	9.2	2.8	30.4	0.0003
	56	No	1.0		Ref.	
Computer access	194	Yes	10.7	3.2	35.3	0.0001
	61	No	1.0		Ref.	
Use of individual animal identification						
Operation type	70	Seedstock	8.1	1.9	34.2	0.0047
	219	Commercial	1.0		Ref.	
Herd size	148	≤49 head	0.2	0.1	0.6	0.0020
	68	50-99 head	0.6	0.2	2.3	
	71	≥100 head	1.0		Ref.	
Owns a smartphone	216	Yes	2.4	1.2	4.7	0.0110
	73	No	1.0		Ref.	
Computer access	209	Yes	2.0	1.0	4.0	0.0410
	76	No	1.0		Ref.	
Interest in a confidential, centralized data storage system						
Operation type	68	Seedstock	6.0	3.2	11.6	<.0001
	213	Commercial	1.0		Ref.	
Age of producer	85	≤55 years	1.8	1.1	3.0	0.0270
	196	>55 years	1.0		Ref.	
Individual animal ID use	238	Yes	5.0	2.2	11.3	<.0001
	42	No	1.0		Ref.	
Owns a smartphone	212	Yes	2.8	1.5	4.9	0.0006
	69	No	1.0		Ref.	
Computer access	203	Yes	2.2	1.3	3.8	0.0055
	74	No	1.0		Ref.	
Interest in using smartphone to keep records						
Age of producer	80	≤55 years	3.6	2.0	6.7	<.0001
	160	>55 years	1.0		Ref.	
Years of experience	96	≤25 years	2.1	1.2	3.6	0.0080
	144	>25 years	1.0		Ref.	
Individual animal ID use	207	Yes	2.3	1.1	5.0	0.0297
	32	No	1.0		Ref.	
Owns a smartphone	212	Yes	8.065	2.947	22.071	<.0001
	28	No	1.0		Ref.	
Regularly records antibiotic treatments						
Operation type	69	Seedstock	3.1	1.7	5.7	0.0003
	218	Commercial	1.0		Ref.	
Age of producer	84	≤55 years	1.9	1.1	3.2	0.0174
	203	>55 years	1.0		Ref.	
Sex of producer	21	Female	18.0	2.4	136.0	0.0051
	266	Male	1.0		Ref.	
Individual animal ID use	245	Yes	6.7	3.0	15.2	<.0001
	41	No	1.0		Ref.	

Table 5. Multivariable logistic regression model for factors associated with use of any form of cattle health and production records by cow-calf producers in Mississippi.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			-0.32	0.40			0.4207
Individual animal identification	Yes	245	2.3	0.42	10.1	4.4 23.2	<.0001
	No	44	Ref.	Ref.	1.0	Ref.	
Owns a smartphone	Yes	216	1.2	0.42	3.3	1.5 7.6	0.0043
	No	73	Ref.	Ref.	1.0	Ref.	

* = 285 total response were used by this model

Table 6. Multivariable logistic regression model for factors associated with use of electronic cattle health and production records by cow-calf producers in Mississippi.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			-4.7	0.84			<.0001
Access to a computer	Yes	194	2.03	0.62	7.6	2.3 25.8	0.0011
	No	61	Ref.	Ref.	1.0	Ref.	
Owns a smartphone	Yes	201	1.93	0.63	6.9	2.0 23.6	0.0021
	No	54	Ref.	Ref.	1.0	Ref.	
Level of education	Bachelor's degree or more	123	0.72	0.31	2.0	1.1 3.7	0.0190
	Less than Bachelor's degree	132	Ref.	Ref.	1.0	Ref.	

* = 255 total responses were used by this model.

Table 7. Multivariable logistic regression model for the outcome of producer use of individual animal identification on their cow-calf operation in Mississippi.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			0.89	0.21			<.0001
Herd size	≥100 head[b]	71	1.6	0.56	5.1	1.7 15.1	0.0013
	50-99 head[b]	68	1.2	0.48	3.5	1.4 8.8	
	≤49 head[a]	148	Ref.	Ref.	1.0	Ref.	
Operation type	Seedstock	70	2.2	0.74	8.8	2.1 37.9	0.0034
	Commercial	217	Ref.	Ref.	1.0	Ref.	

* = 287 total responses were used by this model

[a,b] = Different letters denote statistical differences as determined by the Tukey adjustment for multiple comparisons among each herd size category

Table 8. Multivariable logistic regression model for the outcome of cow-calf producer interest in using a confidential, centralized data storage system for cattle health and production records in Mississippi.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			-2.1	0.46			<.0001
Operation type	Seedstock	68	1.5	0.34	4.7	2.4 9.2	<.0001
	Commercial	212	Ref.	Ref.	1.0	Ref.	
Individual animal identification	Yes	238	1.3	0.43	3.5	1.5 8.1	0.0033
	No	42	Ref.	Ref.	1.0	Ref.	
Owns a smartphone	Yes	211	0.8	0.32	2.2	1.2 4.0	0.015
	No	69	Ref.	Ref.	1.0	Ref.	

* = 280 total responses were used by this model

Table 9. Multivariable logistic regression model for the outcome of producer interest in keeping cattle health and production records from a smartphone.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			-1.6	0.50			
Owns a smartphone	Yes	212	1.8	0.52	6.0	2.1 16.6	0.0006
	No	28	Ref.	Ref.	1.0	Ref.	
Age of producer	≤55 years	80	1.1	0.32	2.9	1.5 5.4	0.0009
	>55 years	160	Ref.	Ref.	1.0	Ref.	

*= 240 total responses were used by this model

Table 10. Multivariable logistic regression model for the outcome of producers regularly recording antibiotic treatments on their cow-calf operations in Mississippi.

Variable	Level	Responses*	Parameter	Standard Error	Odds Ratio	95% CI	P-value
Intercept			-1.44	0.40			0.0003
Individual animal identification	Yes	245	1.71	0.42	5.5	2.4 12.7	<.0001
	No	41	Ref.	Ref.	1.0	Ref.	
Operation type	Seedstock	69	0.88	0.32	2.4	1.3 4.5	0.0057
	Commercial	217	Ref.	Ref.	1.0	Ref.	

* = 286 total responses used by this model

appear to be financial. When given the choice of several motivations for being involved in the cattle business, respondents infrequently selected "I have cattle primarily as a source of income," compared to other motivations (Table 2). This infrequent selection of a primary financial motivation occurred even though question structure allowed respondents to select more than 1 motivation. This suggests that approximately three-quarters of respondents identified with other motivations for being in the cattle business more strongly than cattle primarily being a source of income. Other answer choices such as "cattle are my retirement plan" or "I have land that would be unused otherwise" have some indirect financial implications, but do not support the cattle as a primary source of income. Furthermore, among members of the MCA, relatively few producers identified the cow-calf operation as greater than 50% of the income (Table 1). Similar to results from the present study, the 2017 NAHMS Beef Study found 15.8% of respondents identified their cow-calf operation was their primary source of income.[24] Authors speculate that some respondents to the present study may have cattle as part of a diversified agricultural farm or ranching operation, therefore, not all respondents for whom the cow-calf operation made up less than 50% of their total income had cattle for hobby or enjoyment purposes. However, the relative proportion of income derived from any branch of a diversified farming or ranching operation likely dictates resources (e.g. time, human labor, financial resources, etc.) that are devoted to that branch. So even if respondents derive a significant, although less than 50%, amount of their income from the cow-calf operation, authors speculate that respondents may not be willing to allocate additional resources to the cow-calf operation simply because of its proportion of total income. It may be difficult to convince a producer to collect cattle health and production data if they are not strongly motivated by the profitability of the cow-calf operation.

Seedstock producers often record various pieces of animal health and production data. This data may be reported to online breed association databases, or be required for participation in animal registries. Compared to commercial producers, seedstock producers are likely more accustomed to collecting cattle health and production data for use in individual animal performance metrics and predictive progeny values (i.e. Expected Progeny Differences). Also, profit generated from selling the product of seedstock production (e.g. herd sires, replacement females, etc.) is often dependent on data collected to demonstrate genetic merit, whereas commercial producers generate profit by selling calves on a weight basis. For these reasons, use of individual animal identification (Table 7), interest in using a confidential, centralized data storage system (Table 8), and regularly recording antibiotic treatments (Table 10) are all likely outcomes familiar to producers involved in seedstock production. Type of operation was not associated with all outcomes, however. Although operation type often produced a significant univariable model (Table 4), the outcomes in Tables 5, 6, and 9 were more accurately described by other explanatory variables.

Operation type and access to a computer both produced significant univariable models for use of any form of cattle health and production records, but neither of these variables remained in the multivariable model (Table 5). Producer interest and willingness to invest in individual animal identification likely stems from a desire to measure some level of cattle productivity or health, rather than type of operation. Ownership of a smartphone may represent characteristics of producers not directly measured in this study. Characteristics such as being detail-oriented, interested in learning new technology, and interest in using data to make decisions in other areas of their lives may describe producers who own smartphones, and as a result, may be driving factors behind the association seen between owning a smartphone and several record-keeping outcomes in this study (Tables 5, 6, 8, and 9).

Use of electronic cattle health and production records was better described by variables associated with access to technology, rather than other variables such as operation type, herd size, or producer age (Table 6). This information may disprove the idea that only producers with large cow-calf herds, or producers who derive a large portion of their income from the cow-calf operation are interested in electronic methods of cattle health and production record-keeping. The association between use of electronic records and level of education may be explained by previous experiences. Producers with at least a Bachelor's degree may have been exposed to various types of data during their education, as well as the technology and techniques needed to collect and use the data, making them more likely to be interested in and comfortable using electronic data collection methods for their cattle health and production records.

Individual animal identification is essential to any cattle health and production record-keeping system. Without the ability to identify animals individually, it is difficult to assess individual animal production and health. The NAHMS 07-08 Beef survey found that 66.1% of operations used some form of individual animal identification on at least some cows. This value was increased in the NAHMS Beef 2017 survey, as 80.4% of operations were found to use some form of individual animal identification on at least some cows.[24,25] Compared to the most recent NAHMS data, a slightly higher percentage of respondents in the present study reported use of individual animal identification (Table 3). This difference may be due to the nation-wide scope of the NAHMS data, whereas the present study only surveyed producers who were members of the MCA. Overall, producers with larger herd sizes and seedstock producers likely depend on individual animal identification (Table 7) in order to maintain or improve herd performance and efficiency. Seedstock producers require individual animal identification for reasons already discussed, while large herd sizes make distinguishing individuals and measuring individual production and health difficult if they are not identified individually. The 2007-2008 NAHMS Beef study reports the percent of operations using any form of individual animal identification increased as herd size increased.[25] A similar trend is seen in Table 7, although no statistical difference was detected between the odds of respondents with a herd size of ≥100 head and 50-99 head using individual animal identification.

Confidential, centralized data storage systems are common methods of data storage today. These systems are often web-based, and are readily available through smartphone applications (e.g. iCloud, Google Drive, Microsoft OneDrive, etc.). A willingness to use this type of data storage for cattle health and production records (Table 8) is likely dependent on familiarity with such a data storage system. It is likely that many smartphone users already use some form of a confidential, centralized data storage system for other types of personal information. Seedstock producers may already be familiar with this type of storage by submitting data to and storing data with breed associations. Implementing this type of data storage in livestock production is not unprecedented, as precision agriculture techniques have revolutionized the collection and analysis of data for weed and pest control, and plant production and yield.[4] Evidence-based precision animal agriculture is often hindered by the availability of data, but offers potential for improvements in animal production and health surveillance.[13] There may be opportunity for increased utilization of electronic cow-calf record-keeping if producers are provided the appropriate smartphone application tools. A growing acceptance of this type of data management may be occurring among cow-calf producers. The NAHMS 07-08 Beef survey found that only 2.9% of all operations stored records on computers located off of their operations, and cited beef improvement associations and other private firms as the location of this data storage.[23] Respondents to the present study were much more willing to use such a data storage system (Table 3). This type of storage system would allow cattle producers to provide their veterinarians, nutritionist, or other industry professionals, access to their cattle health and production records for purposes of research and the evaluation of health, efficiency, and productivity of their operation.

The smartphone is a relatively new tool available to beef producers, and holds potential to enhance data collection in the cow-calf industry. The current study indicates many respondents owned a smartphone, but few are using their smartphone for cattle record-keeping purposes (Table 3). Investigators speculate that the association between age of producer and interest in using a cattle health and production record-keeping system from a smartphone is due to an overall greater familiarity of younger producers with the utility of a smartphone for such purposes (Table 9). One obstacle to using a smartphone for cattle health and production recording-keeping purposes is deficiencies in cellular service in rural areas. In these instances, data that is stored locally (i.e. on the device) remains accessible, however, any data stored in an external, internet-based electronic storage system may not be accessible until the user regains cellular service. The authors speculate that this problem may be addressed by the development of smartphone applications designed to store essential data locally for easy retrieval regardless of cellular service, with more extensive data retrieval being available when cellular service is restored. Data entry is likely not hindered by deficiencies in cellular service, as data entered may be stored locally, then backed-up to a confidential, centralized data storage system when cellular service is available.

Antibiotic use data is potentially high-leverage information when considering both human and animal health outcomes. Characteristics of producers in Mississippi currently recording antibiotic treatments on the cow-calf operation (Table 10) are similar to those producers who would be willing to use a confidential, centralized data storage system for their cattle health and production data. Investigators speculate that if a producer is willing to use a confidential, centralized data storage system, they are likely collecting cattle health and production data, and part of this data is likely information on antibiotic usage in the herd.

Conclusion

The results of this study provide insight to the bovine practitioner on the cattle health and production record-keeping methods and opinions of cow-calf producer members of the MCA. These results may be useful to the practitioner in designing record-keeping systems for their clients or assisting clients in collecting cattle health and production data. Although cow-calf producers in Mississippi commonly have access to the electronic tools (e.g. computer on operation, internet access, smartphone) necessary to keep electronic cattle health and production records, these tools are not commonly being used for those purposes. Access to technology

such as computers and smartphones, operation type, and use of individual animal identification are driving factors in cow-calf record-keeping outcomes for members of the MCA.

Endnotes

[a] Epi Info 7.2.2.6, CDC, 2018
[b] Qualtrics Online, Mississippi State University, Starkville, MS
[c] Microsoft Excel, Microsoft Corporation, Redmond, WA
[d] SAS for Windows v9.4, SAS Institute, Inc., Cary, NC

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