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CASE STUDY: Producer concerns and perceptions regarding the effect of methane on cattle production and the environment: A survey of Nebraska producers¹

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ABSTRACT

Enteric methane production from cattle and its effect on climate change has been a topic of debate. Multiple studies have explored methods to reduce cattle enteric methane production while simultaneously improving performance. However, most strategies developed have not been widely implemented by cattle producers. Knowledge of producer concerns and perceptions on methane production from cattle and its effect on the environment may be limited. Therefore, the objectives of this survey were to determine what Nebraska producers know about methane production by cattle and how it affects performance and to determine

whether different age groups, regions of Nebraska, and production size and type affects producer opinions on enteric methane production and climate change. The survey had a response rate of 22%. Regarding climate change, approximately 39% of producers disagreed, 33% were neutral, and 28% agreed they were concerned. However, producers in central and eastern Nebraska were closer to neutral than producers in western Nebraska ($P < 0.05$). Younger producers perceived cattle to have a more positive effect on the environment and reported that they were more likely to adopt new management techniques that have been shown to improve animal performance than older producers ($P < 0.05$). Most producers reported receiving production-related information from veterinarians (47.6%), followed by the “other” category (34.9%), the University of Nebraska (15.6%), and state and federal governments, which were the lowest (1.4 and 0.6%, respectively). In the last 3 yr, approximately

57% of producers attended one or fewer extension meetings, but 37% had not attended any extension meetings.

Key words: cattle, climate change, environment, methane, producer concerns

INTRODUCTION

Recently, the environmental impact of beef cattle production and associated methane emissions has been a topic of interest. Methane is a greenhouse gas, with a global warming potential 28 times that of CO₂ (Myhre et al., 2013). Ruminants account for 97% of the total methane produced by domesticated animals, and 75% of the methane produced by ruminants is produced by cattle (Crutzen et al., 1986). Current estimates suggest that 20% of the methane released into the atmosphere comes from domesticated ruminants (Mangino et al., 2007). Al-

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though cattle produce a large amount of methane, the contribution by cattle to any global warming that may occur within the next 50 to 100 yr is estimated to be less than 2% (Johnson and Johnson, 1995).

Methane emission from cattle is coupled with a significant loss in the GE intake of the animal (Johnson and Ward, 1996). Studies have shown that methane losses can vary from 2 to 12% of total gross energy intake (Johnson and Johnson, 1995). Over the life of an animal, this loss can potentially add up to a substantial decrease in production for the producer. Many studies have been conducted to identify strategies to minimize methane production. In a review, Hristov et al. (2013) stated that feeding tannins has often shown up to a 20% decrease in methane emissions. Other strategies, such as processing corn as steam flaked rather than dry rolled has been shown to decrease methane emissions in beef cattle (Hales et al., 2012). However, although these strategies exist, they have not been widely implemented by producers in Nebraska.

The effect of livestock production on the environment is thought to be a topic that many producers overlook. However, with an increase in social media and popular press addressing climate change and methane issues, this may not be true. Therefore, the objectives of this survey were to determine what Nebraska producers know about methane production by cattle and how it affects animal performance and to determine whether Nebraska producer age groups, regions of Nebraska, or production size and type affects Nebraska producers' opinions on climate change and methane.

MATERIALS AND METHODS

This survey was conducted by the Nebraska Agricultural Statistics Service. The Nebraska Agricultural Statistics Service used its cow-calf and feedlot database from the 2007 census to determine operation size and the total number of operations

in Nebraska. The feedlot operations were selected from the population for sampling first and were then removed from the sampling population before sampling beef cow operations. The sample was taken in this manner to eliminate survey response duplication. This resulted in an overall sampling goal of 6,000 operations, with a sampling rate of 33%. However, because of budgetary restrictions, only 3,337 surveys of randomly selected producers were sent out. A follow-up reminder was then sent out 2 wk after the first mailing to increase response to the survey.

The survey consisted of 24 multiple-choice and agree or disagree questions regarding the operation (area of Nebraska, operation size and type), the producer (age, sex, years in production), and perceptions and knowledge about methane production and climate change. Surveys returned were entered into a database and compiled. Ninety percent of respondents were male, and 99% were white. Approximately 95% were producers and had been practicing their occupation for 15 yr or more. Twenty-seven percent of respondents resided in western Nebraska, 52% in central Nebraska, and 21% in eastern Nebraska. About 65% of producers in the sample were 50 to 69 yr old, 18% were between 25 to 49 yr old, and 17% were 70 yr old or older. When asked what types of operations they were a part of, respondents reported 68% were cow-calf, 38% were farm, 20% were feedlot, and 3% were identified as "other."

To analyze producer perceptions and knowledge about methane production and climate change, responses were coded numerically. Responses for the agree or disagree questions were coded on a 5-point Likert scale as 1 = strongly disagree to 5 = strongly agree. Responses for questions regarding confidence level were coded using a 4-point scale as 1 = not at all confident, 2 = not very confident, 3 = somewhat confident, and 4 = very confident.

To determine whether surveys were valid, the surveys were first analyzed for completeness. After the valid

surveys were identified, they were analyzed using SPSS (IBM Corp., Armonk, NY). To determine whether data were normally distributed, the Kolmogorov-Smirnov test of normality was performed. Data were not normally distributed, so nonparametric tests were used for comparisons and correlations. The survey responses were grouped and analyzed for differences by area of Nebraska (western, central, and eastern) and age of producer (25–49, 50–59, 60–69, and 70+ yr old). A nonparametric correlation analysis was also performed to determine whether producer responses to the statement "I am concerned about climate change" were associated with how they responded to other questions in the survey. Surveys were not analyzed for differences according to sex, occupation, or race because these data were too skewed for an accurate analysis.

RESULTS AND DISCUSSION

The survey return rate was 22%, with 725 surveys returned out of the 3,337 sent out. This return rate is similar to previous surveys done with agricultural producers. In a survey of Midwest farmers conducted by Prokopy et al. (2014), a return rate of 26% was observed, which was similar to the current survey in terms of type of people surveyed and response rate. Similarly, in a survey conducted by Moyes et al. (2014), a 31% return rate was achieved when dairy producers across multiple states were surveyed.

Survey responses related to producer concerns about the effects of methane production by cattle on the environment and climate change were significantly different by area within the state of Nebraska (western, central, and eastern; Table 1). Producers in western Nebraska had lower responses on the Likert scale ($P < 0.05$) regarding concern about methane production on the environment compared with eastern Nebraska, with responses of central Nebraska producers being intermediate to western and eastern Nebraska. Producers in western Nebraska also had lower

Table 1. Concern about climate change by area of Nebraska¹

Statement	Area of Nebraska (mean ± SD)		
	Western (n = 191)	Central (n = 373)	Eastern (n = 151)
I am concerned with the effects of methane production on the environment.	2.30 ± 0.99 ^a	2.41 ± 1.0 ^{ab}	2.63 ± 0.95 ^b
I am concerned about climate change.	2.55 ± 1.13 ^a	2.79 ± 1.19 ^b	2.86 ± 1.15 ^b

^{a,b}Values within the same row with unique superscripts differ $P < 0.05$.

¹A 5-point Likert scale was used with question, with 1 = strongly disagree to 5 = strongly agree.

responses on the Likert scale ($P < 0.05$) regarding concern about climate change compared with both central and eastern Nebraska.

Most producers either strongly disagreed to disagreed (39%) or were neutral (33%) with the statement “I am concerned about climate change.” This finding is supported by Prokopy et al. (2014), who reported that the majority of surveyed farmers believed that climate change was due to natural changes in the environment or that there is not sufficient evidence to know with certainty whether climate change is occurring or not. These data suggest that agricultural producers were not very concerned with climate change. Furthermore, Leiserowitz et al. (2011) reported that most of the United States population was either slightly concerned or not concerned at all about climate change, supporting the results of the current survey of Nebraska producers. Conversely, Hibbs et al. (2014) found that producers surveyed in Kansas were concerned about climate change, although producers surveyed made the distinction between climate variability and anthropogenic climate change. This suggests that producers were more concerned with year-to-year variability in the weather rather than long-term changes in the climate.

Responses to questions on methane production by cattle and its effect on the environment, separated by age of the producer, are presented in Table 2. Younger producers were more neutral about the statement that methane production affects animal performance ($P < 0.05$) than older

producers, who were more likely to disagree with this statement. However, across all age groups, the majority of producers either disagreed or were neutral with this statement. Eighty-four percent of the population sampled fell within the disagree or neutral category, suggesting that current research in this area has not been well translated to producers. Younger producers agreed with the statement that cattle diet influences methane production to a greater extent than older producers ($P < 0.05$), who tended to slightly disagree with this statement. This suggests that younger producers seemed to be more aware that diet can influence methane production but did not necessarily equate it to affecting animal performance.

Producers in the youngest 3 age groups tended to agree concerning the likelihood of adopting new management practices that research has shown to improve animal performance. Although approximately 60% of the entire sample agreed or strongly agreed to this statement, producers over 70 yr of age were closer to neutral ($P < 0.05$) than the other age groups. This could suggest that older producers are reluctant to adopt new management strategies for various reasons. The responses between producer age groups for the statement “government should take steps to limit greenhouse gas emissions” were not different ($P > 0.05$). About 63% of respondents disagreed or strongly disagreed with the statement that the government should take steps to limit greenhouse gas emissions, with another 25% neither agreeing nor

disagreeing. This finding is consistent with findings by Hibbs et al. (2014), who found that a serious concern of producers was government regulation of agricultural practices.

There was no difference between age groups for the statement “I am concerned about the effects of methane production on the environment” ($P > 0.05$), with 50% selecting disagree or strongly disagree and 37% neither agreeing nor disagreeing with the statement. The majority of producers were in the disagree or neutral categories for this statement, suggesting that producers are not very concerned about cattle methane production and its contribution to climate change. This lack of concern was further verified by the producer’s comments left at the end of the survey. The challenge for research and extension efforts in the future is to find methods of educating producers about climate change and methane production by cattle in a manner that will be accepted by the producer groups.

Younger producers were generally more neutral about the statement “I am concerned about climate change” than were older producers, with significant differences ($P < 0.05$) existing for producers in the youngest and oldest age categories. This could potentially suggest a change in cultural beliefs with younger generations. Producers under 70 yr of age felt that cattle have a positive impact on the environment, whereas older producers were of the opinion that cattle have neither a positive nor negative impact ($P < 0.05$). The perception of younger producers that cattle have a positive

Table 2. Response based on age of producer

Statement	Producer age (mean ± SD)			
	25–49 (n = 129)	50–59 (n = 251)	60–69 (n = 219)	70+ (n = 114)
Methane production affects animal performance. ¹	2.86 ± 0.99 ^a	2.72 ± 0.86 ^{ab}	2.66 ± 0.88 ^{ab}	2.47 ± 0.90 ^b
Cattle diet influences methane production. ¹	3.64 ± 0.88 ^a	3.45 ± 0.91 ^{ab}	3.36 ± 0.89 ^b	2.93 ± 1.12 ^c
Concerned with the effects of methane production on the environment ¹	2.53 ± 1.00 ^a	2.50 ± 0.98 ^a	2.36 ± 1.02 ^a	2.30 ± 0.96 ^a
I am likely to adopt management practices that research has shown to improve animal performance. ¹	3.67 ± 0.94 ^a	3.76 ± 0.96 ^a	3.66 ± 0.91 ^a	3.16 ± 1.12 ^b
I am concerned about climate change. ¹	3.08 ± 1.12 ^a	2.82 ± 1.12 ^{ab}	2.59 ± 1.21 ^{bc}	2.44 ± 1.11 ^c
The industry should take steps to limit greenhouse gas emissions. ¹	2.97 ± 1.03 ^a	2.78 ± 1.04 ^{ab}	2.61 ± 1.11 ^{bc}	2.45 ± 1.07 ^c
The government should take steps to limit greenhouse gas emissions. ¹	2.19 ± 1.21 ^a	2.18 ± 1.12 ^a	2.10 ± 1.09 ^a	1.96 ± 1.09 ^a
Rank your perception of the effect cattle have on the environment. ²	4.14 ± 0.98 ^a	3.83 ± 1.17 ^a	3.74 ± 1.28 ^a	3.01 ± 1.62 ^b
Confidence in knowledge of methane production in cattle ³	2.53 ± 0.73 ^a	2.51 ± 0.76 ^a	2.60 ± 0.82 ^a	2.74 ± 0.86 ^a
How often did you attend extension meetings in the past 3 yr? ⁴	2.43 ± 1.51 ^a	2.48 ± 1.36 ^a	2.47 ± 1.45 ^a	2.37 ± 1.47 ^a

^{a-c}Values within rows with unique superscripts differ $P < 0.05$.

¹A 5-point Likert scale was used with questions, with 1 = strongly disagree to 5 = strongly agree.

²A 5-point scale was used, with 1 = negative impact to 5 = positive impact.

³A 4-point scale was used, with 1 = not confident at all to 5 = very confident.

⁴A 5-point scale was used, with 1 = never attended a meeting to 5 = attended a meeting more than 5 times.

impact on the environment could suggest several things. With improved grazing practices used today, younger producers may see environmental concerns about soil erosion, water pollution, and range deterioration as being managed, while seeing growing public interest in natural systems and carbon sequestration by perennials. However, regardless of their age, cattle producers appear to be unaware of how cattle production contributes to greenhouse gas emissions and ultimately climate change.

Across age groups, no significant differences were detected in producer confidence in their knowledge about methane production in cattle ($P > 0.05$). Approximately 44% of producers surveyed fell into the not at all to not very confident category, 45% were somewhat confident, and only 11% of producers indicated they were very confident in their knowledge of methane production in cattle. Given the low confidence levels regarding knowledge of methane production,

this suggests a need for more education addressing this topic for Nebraska producers.

About 45% of respondents, regardless of age, obtain information about animal agriculture from their veterinarian (Table 3), stressing the importance of sharing current research with veterinarians so they can pass it on to producers. The second most popular source of information fell into the “other” category (36%). If producers marked the “other” category, they were asked to comment on where they received their information. This category consisted of magazines (n = 41), followed by consultants (n = 21); friends, family, and neighbors (n = 8); feed companies or representatives (n = 6); and the Internet (n = 5). A survey of producers conducted by Kelsey and Mariger (2003) indicated the majority of producers received production-related information from friends, family, and other producers. Although this was not the case for this survey, several of the respondents

who marked the “other” category indicated that friends, family, and neighbors were their main source of production-related information. Producers also commented that they used feed companies or representatives and magazines to obtain production-related information. This is supported by Kelsey and Mariger (2003), who also found feed companies and magazines to be a popular source of producer information.

Very few producers stated that they obtain information about animal agriculture from either state or federal governments (2%). Additionally, only 16% of Nebraska producers indicated that they obtain production-related information from the University of Nebraska–Lincoln (UNL). This low number of Nebraska producers obtaining information directly from UNL was surprising because it was hoped that Nebraska producers turned to UNL first, as the state land-grant university, when looking for credible information; however, this was not the

Table 3. Where producers obtain information about animal agriculture by age

Where producers go for animal information (% of producers within age category)	Producer age			
	25–49 (n = 129)	50–59 (n = 251)	60–69 (n = 219)	70+ (n = 114)
Federal government	0.8	0.8	0.0	0.9
State government	2.4	0.4	0.9	1.8
University of Nebraska	14.2	18.5	18.4	11.9
Veterinarian	51.2	43.0	43.8	52.3
Other	31.5	38.6	36.9	33.0

case. Although not many producers reported going directly to UNL for information, it is likely that the consultants and feed company representatives who are providing information to producers are obtaining their information from UNL, although this has not been studied. Even though producers are not directly receiving information from UNL, the research is likely still getting to the producer indirectly.

Across all age groups, extension meeting attendance was the same ($P > 0.05$), with about 50% of Nebraska producers attending 1 to 3 meetings in the past 3 yr (Table 4). This low extension meeting attendance rate could be a factor contributing to producer lack of confidence in their knowledge about methane production by cattle. Across age groups, 37% of producers in Nebraska never attended an extension meeting in the past 3 yr (Table 4). This number is high when compared with a survey conducted by Dahlen et al. (2014), sampling producers through the National Agricultural Statistics Service,

who found that only 17.5% of North Dakota producers did not attend an annual extension meeting. The most common reason given for not attending extension meetings was a lack of time, and the second most common reason was extension meetings not being offered in the producer's area (Dahlen et al., 2014). Concerns about time and travel limitations highlight the importance of making extension meeting information available online and using technology to reach producers and to ensure producers can access meeting information at times that are convenient for them. Even though the percent of producers never attending an extension meeting was higher than desired, 63% of Nebraska producers attended at least one meeting in the past 3 yr, which suggests some extension education is being provided to the majority of producers in Nebraska.

The frequency of attending extension meetings was positively associated with likelihood to adopt management practices that research has

shown to improve animal performance ($P < 0.01$), producer perception that cattle diet influences methane production ($P < 0.05$), confidence in knowledge of methane production and management practices that affect methane production in cattle ($P < 0.01$), and confidence in knowledge of climate change ($P < 0.01$). These positive associations provide evidence that extension meeting attendance increased the knowledge level of Nebraska producers, or at least producer perception of their knowledge level, on methane production, cattle performance, and climate change.

Correlations between how producers responded to the statement "I am concerned about climate change" and their responses to other questions in the survey are presented in Table 5. There was a positive association ($r = 0.711$, $P < 0.01$) between how producers answered if they were concerned about climate change and the statement "I should take steps to limit greenhouse gas emissions." This suggests that producers who were

Table 4. Extension meeting attendance

Number of extension meetings attended in past 3 yr (% of producers within age category)	Producer age			
	25–49 (n = 129)	50–59 (n = 251)	60–69 (n = 219)	70+ (n = 114)
Never	38.8	31.5	37.8	45.5
Once	23.3	25.9	18.0	8.2
Twice	11.6	17.5	18.0	23.6
3 Times	8.5	13.1	12.4	9.1
More than 3 times	17.8	12.0	13.8	13.6

Table 5. Correlations between the statement “I am concerned about climate change” and answers to other survey questions

Positively associated	r value	Negatively associated	r value
Methane production affects animal performance.* ¹	0.294	On a scale from 1 to 5, rank your perception of the impact cattle have on the environment. ²	-0.154
Cattle diet influences methane production.* ¹	0.197	Please indicate how confident you are in your knowledge of methane production of cattle.* ³	-0.290
I am concerned with the effects of methane production on the environment.* ¹	0.546	Please indicate how confident you are in your knowledge of management practices that affect methane production in cattle.* ³	-0.274
I am likely to adopt management practices that research has shown improve animal performance.* ¹	0.148	Please indicate how confident you are in your knowledge of climate change.* ³	-0.310
I should take steps to limit greenhouse gas emissions.* ¹	0.711	Which of the following describes your current age?* ⁴	-0.181
The industry should take steps to limit greenhouse gas emissions.* ¹	0.690		
The government should take steps to limit greenhouse gas emissions.* ¹	0.564		

¹A 5-point Likert scale was used with questions, with 1 = strongly disagree to 5 = strongly agree.

²A 5-point scale was used, with 1 = negative impact to 5 = positive impact.

³A 4-point scale was used, with 1 = not confident at all to 5 = very confident.

⁴Age range options were 25 or younger, 26–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 yr or older.

*Correlation is significant, $P < 0.01$.

concerned about climate change were also likely to consider taking steps to limit greenhouse gas emissions and vice versa. There were also positive correlations ($P < 0.01$) between concern about climate change and agreement that the industry ($r = 0.690$) and government ($r = 0.564$) should take steps to limit greenhouse gas emissions, as well as concern with the effects of methane on the environment ($r = 0.546$). Producer age, however, was negatively associated ($P < 0.01$) with being concerned about climate change ($r = 0.181$), suggesting that older producers tend to be less concerned about climate change than younger producers. There were also negative associations ($P < 0.01$) between producer confidence in their knowledge of methane production in cattle and climate change ($r > 0.29$). This suggests that producers who are unconcerned with climate change also tend to be confident in their knowledge about methane production and climate change.

IMPLICATIONS

The survey results show that methane production by cattle and climate change are not major concerns for Nebraska producers. Producers feel methane production has little effect on animal performance but are not very confident in their knowledge on this subject, suggesting universities and extension educators need to find more effective methods of reaching producers with the results of current research. Most Nebraska producers received information related to animal agriculture from veterinarians; therefore, veterinarians should be a major target for extension efforts. Extension meeting attendance is low in Nebraska; increased use of technology to reach more producers and provide information at their convenience could be beneficial. Educational providers need to consider that producers tend to be more receptive to production topics than environmental issues. Also, younger producers and those

who express some concern about climate change are likely more open to learning about methane production and practices for managing methane.

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