A National Assessment of Beef Cattle Producers' Educational Needs Regarding Pre-Harvest Food Safety

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Abstract

Food safety is an important issue facing the beef cattle industry (Meeker, 1999). Each year there are an estimated 76 million cases of food borne illness, 325,000 hospitalizations, and 5,000 deaths from food-borne diseases (Mead et al., 1999). One of the primary organisms causing food borne illness is E.coli *0157:H7, therefore, food scientists have developed interventions to reduce the prevalence of* E. coli *0157:H7 in live beef cattle. This study identified five primary interventions and conducted a needs assessment of beef cattle producers and their educational needs regarding these five interventions. Data were collected using a convenience sampling method limited to a desired population at the 2006 National Cattlemen's Beef Association (NCBA) conference in Denver, Colorado on February 1-2, 2006. The researcher-developed instrument was used to collect the sample (n = 391) and was representative of beef cattle producers from 43 states. Researchers found two of the interventions classified as successful programs and three of the interventions classified as low-level needs (Witkin, 1984).*

Introduction

For centuries, evolutionary changes have contributed to the success of the beef cattle industry. Throughout these years, the existence of cattle and their production have supported many other industries that add billions of additional dollars to the United States' economy. The beef industry includes breeding, feeding, and marketing cattle with the eventual processing and merchandizing of retail products to the consumers (Taylor & Fields, 1999). According to the most recent facts, the U.S. beef industry is currently worth an estimated $175 billion with cattlemen conducting business in all 50 states and operating 800,000 individual farms and ranches (NCBA, 2005). According to the 2003 United States Department of Agriculture consumption data, beef is the number one source of protein in America, and the demand for beef continues to grow (NCBA, 2004).

With the high demand for beef comes the responsibility of the American beef industry to provide a safe product for consumers. Unfortunately, each year there are an estimated 76 million cases of food borne illness, 325 thousand hospitalizations, and five thousand deaths from food-borne diseases (Mead et al., 1999).

One of the primary organisms causing food borne illness is commonly referred to as *E. coli*. *E. coli* 0157:H7 is a pathogenic strain of *E. coli* that causes serious illness including: hemorrhagic colitis, hemolytic uremic syndrome, and possible death (Kaper, 1994). *E. coli* was first recognized as a food borne illness in 1982 (Riley et al., 1983). Outbreaks of *E. coli* 0157:H7 have been attributed to the following: raw or undercooked meat, contaminated fruits or vegetables, unpasteurized milk and juice, swimming in and drinking contaminated water, and direct contact with animal feces (Bowman & Lindstrom, 2005).

Although this pathogen is life threatening to humans, it causes no overt disease in cattle. The primary reservoir of *E. coli* 0157:H7 in beef cattle is the bovine intestinal tract, with the cecum and colon being the most common sites of colonization (Grauke et al., 2002). In addition to being colonized within the bovine intestinal tract, *E. coli* 0157:H7 is also readily recovered from body surfaces of cattle such as the hide and oral cavity (Elder et al., 2000). Research by Brashears, Jaroni, and Trimble (2003) showed that *E. coli* 0157:H7 was present on 66.7% of conventionally fed feedlot cattle on at least one occasion. Research by Elder et al. showed that when systematically sampled in multiple locations, including the hide, feces, and mouth, 99.3% of cattle within 10 days of harvest were positive for *E. coli* 0157:H7 in at least one sampled site.

However, the shedding of *E. coli* occurs in all stages of the bovine's life. Research indicates that calves are initially exposed to *E. coli* within a couple weeks of birth, indicating that the shedding of *E. coli* 0157:H7 by cows may be impacting the exposure of calves to *E. coli* (Gannon et al., 2002). Research has indicated that by weaning, 83% of calves have been exposed to *E. coli* 0157:H7 (Laengreid et al, 1999).

The shedding of *E. coli* 0157:H7 in all stages of a bovine's maturity may be cause for concern for beef cattle producers. Pathogens are typically thought to enter the food supply from dust in the processing environment or through direct contact with the bovine feces due to unsanitary conditions during the harvest of animals. However, beef cattle can also shed pathogens prior to entering the food supply. The shedding of feces containing *E. coli* 0157:H7 can contaminate the food supply when feces are used as fertilizer or runoff enters the water supply. Reducing harmful pathogens in the live animal should have a positive impact upon reducing the number of outbreaks associated with beef products, as well as those outbreaks associated with fruit and vegetable contamination, water contamination, and live animal contact.

Due to recent outbreaks of *E.coli* 0157:H7, pre-harvest food safety has been more researched. Because of this research, scientists are becoming more knowledgeable concerning the epidemiology and are developing interventions that beef cattle producers can implement in their own practices to control potentially harmful pathogens. Today, some scientists believe that pre-harvest feeding and management practices can control the prevalence of *E. coli* 0157:H7 shedding prior to harvest and during harvest. Although these interventions are available, there appears to be a knowledge gap between the researcher and the beef cattle producer.

Theoretical Framework

Needs Assessment

In the perspective of Witkin and Altschuld (1995), a needs assessment may be broadly defined as, "a systematic set of procedures undertaken for the purpose of setting priorities and making decisions about program or organizational improvement and allocation of resources. The priorities are based on identification of needs." (p. 4) Needs studies are not designed for individual diagnosis, but are used to provide group data (Witkin, 1984). There are multiple methods and philosophies on conducting needs assessments.

> Witkin (1984) stated:
> …there is no one right way to conduct a needs assessment that is applicable to all cases; that the data should be related to the purposes of the assessment, the organization's present knowledge, and the decisions that will be made; that needs assessment is not an isolated activity but part of a broad planning or development effort. (p. 32)

A needs assessment should focus on the people within the system. According to Witkin & Altschuld (1995), there are three levels of need. The first or primary level represents the service receivers. These are the people for which the system ultimately exists such as students, clients, information users, commuters, or potential customers. In this study, the service receivers are those who consume beef.

Level two, or the secondary level, represents the service providers and policymakers. Those in level two have some direct relationship to those in level one. They may provide information, services, and training; perform planning; provide technical assistance; or oversee functions that affect others in level two as well as indirectly affect those in level one (Witkin & Altschuld, 1995). Beef cattle producers are representative of level two in this study.

The final level is the tertiary level. This level represents the resources or solutions. This includes the examples: buildings, facilities, equipment, supplies, technology, programs, class size, and surgical procedures (Witkin & Altschuld, 1995). Level three is representative of the pre-harvest food safety interventions in this particular study.

Figure 1 shows how the levels inter-relate and that the system is subject to various external forces. Although the prime target for needs assessments is level one, needs assessments can also be performed at level two, principally for training needs (Witkin & Altschuld, 1995). Level two needs assessments may be performed to serve the information needs of an emerging field or technology, to perform a task analysis in a changing field, or for policy reasons in a specific context (Witkin & Altschuld, 1995). This study focuses on the level two needs of beef cattle producers and their knowledge of an emerging technology, pre-harvest food safety techniques, for the purpose of developing educational information.

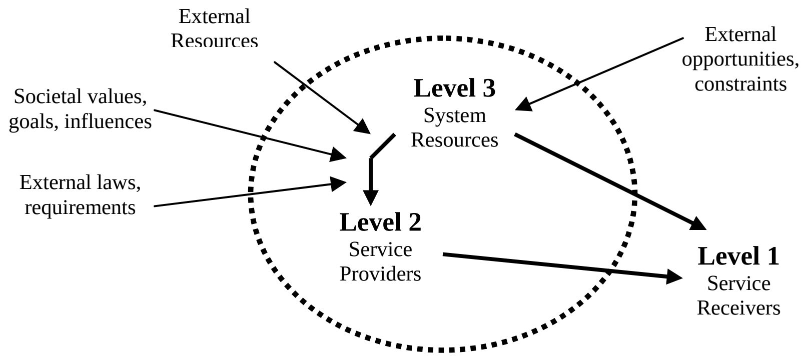

Figure 1: Relationships of three levels of target groups to the system and to external influences, service receivers outside the system (Witkin & Altschuld, 1995).

A matrix analysis (Herkotitz's matrix analysis as cited in Witkin, 1984) can be used to determine the level of need. The Herkotitz matrix analysis uses a calculation of the grand mean scores for importance and a mean score for inclusion. The scores are plotted using the "X" and "Y" axis as a point on a four-quadrant graph. The mean of importance and inclusion should be plotted for each of the individual areas. Each point will be categorized as one of the following: a critical need, a low-level need, a low-level successful program, and a successful program (Figure 2).

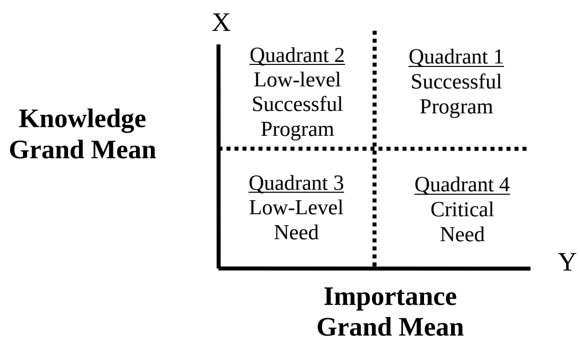

Figure 2: Needs assessment matrix for knowledge and importance (Herkotitz's matrix analysis as cited in Witkin, 1984).

Critical needs should be given top priority in program development and interventions. Low-level needs should be given second priority; they may require action at a later time. Successful programs should be monitored to ensure continued excellence and knowledge in that area. Lastly, items classified as low-level accessibility should be re-examined (Witkin, 1984).

Age of Beef Cattle Producers

Little, Lacy, and Forrest (2002) surveyed 134 Mississippi beef cattle producers. The research collected demographic information on only large operation beef cattle producers with herds of 250 or more. Of these producers surveyed, 64% were 50 years or older, 25% were between 41 and 50 years old, and only 11% were under 40 years old. Survey participants had been raising cattle an average of 31 years (Little, Lacy, and Forrest). Little, Lacy, and Forrest concluded from this research that there is an approaching turnover period for producers in the cattle industry.

Kistler, Cummings, and Briers (2002) conducted a descriptive-correlative study of the Texas A&M University Ranch to Rail Program of 382 program participants enrolled from 1990-2001. Participants from across the state of Texas were involved in the study. Of these participants, it was discovered that 56.4% of producers were between 55 and 65 years old (Kistler, Cummings, and Briers). It was reported that 60.3% of these producers had been involved in the beef cattle industry for 26 or more years.

Data reported from the NCBA is consistent with the previous two reports. According to the NCBA (2004), 80% of cattle businesses have been in the same family for over 25 years; 10% have been in the same family for more than 100 years.

Education Level of Beef Cattle Producers

Rowan and White (1994) found that the education level of beef cattle producers did not appear to positively impact the ranchers' practices, but it did have a negative impact on the percent of the total family income from livestock production. This implies that ranchers receiving a higher education obtain non-ranch employment to supplement family income (Rowan & White).

In the Ranch to Rail Program evaluation by Kistler, Cummings, and Briers (2002), an overwhelming 75% of participants had received a bachelor's degree, graduate degree, and/or professional degree (Kistler, Cummings, and Briers). This sample does appear to be biased toward a more highly educated group of beef cattle producers. Many producers indicated their main reason for enrolling in this feed-out program was to find out more about cattle and production practices. Seventy-seven percent of respondents indicated they received most of their education resources, in addition to the Ranch to Rail Program, from their local county extension office, and they participated in an average of 5.83 other educational programs or activities (Kistler, Cummings, and Briers).

The degree of participation in producer education programs by beef cattle producers in the Ranch to Rail Program differed from Mississippi producers' participation in educational programs. In the study conducted by Little, Lacy, and Forrest (2002), only 45% of the large cattle producers surveyed indicated they had ever attended any type of beef cattle short course seminar.

Food Safety Interventions

Food safety encompasses many kinds of potential hazards in food and has been receiving an increasing amount of attention in recent years. Unnevehr (2001) attributes this attention to the following: (1) Science is now better able to trace many food-borne illnesses to specific pathogens, (2) As consumers live longer and become more affluent, they demand higher levels of quality and safety in food, (3) Changes in production practices and new sources of food present new risks in the food system.

Most economic studies estimate an annual cost of illness associated with food borne disease in the United States between $5 to $10 billion, although some estimates are higher (Antel, 1998). *E. coli* 0157:H7 was the number one reason for beef recall from 1982-1999 according to USDA statistics (Schroeder & Mark, 1999).

Beef carcasses can become contaminated with *E. coli* 0157:H7 during slaughter through the puncturing of the intestinal tract or by fecal material on hide (Brashears et al., 2003). Because of this knowledge, Brashears, Jaroni, and Trimble (2003) wrote, "Considering the high prevalence of the pathogen in the feces and the potential contamination of carcasses during processing, appropriate measures to reduce or eliminate the carriage of *E. coli* 0157:H7 in cattle should begin at the farm." (p. 355) The use of pre-harvest interventions should reduce the amount of *E. coli* 0157:H7 carried by animals at slaughter, thus reducing the failure rate of in-plant interventions (Loneragan & Brashears, 2005).

E. coli 0157 pre-harvest control can be categorized into two areas. The first area is the modification of management practices. This includes the manipulation of feed ingredients or the frequency of washing troughs. The second area of control is the use of specific intervention technologies (Loneragan & Brashears, 2005). The second method of control would be preferable to the first method as management practices are often difficult to change and implement without encountering high costs (Loneragan & Brashears, 2005).

Purpose and Objectives

The process of providing a safe product begins at the ranch and continues through the food chain. The purpose of this study was to assess the current educational needs of beef cattle producers regarding pre-harvest food safety in the United States. The research objectives of this study were to:

1. Determine the demographics of the occupational subgroup, beef cattle producers, attending the 2006 NCBA annual conference.
2. Determine the self-perceived knowledge and importance of pre-harvest food safety practices by solicited beef cattle producers attending the 2006 NCBA annual conference and assess the educational needs for each pre-harvest food safety technique.

Procedures

This was a quantitative, descriptive correlational study designed as a needs assessment. Primarily, this study sought to determine the relationship between beef cattle producers and pre-harvest food safety interventions.

The data for this research study were collected at the 2006 NCBA's annual conference in Denver, Colorado, on February 1-2, 2006. This conference was selected because it represented a nationwide group of beef cattle producers who were representative of all segments of the beef cattle industry.

Researchers used a convenience sample limited to a desired population to obtain data. In research, it is sometimes difficult or even impossible to select a random or systematic non-random sample. When this occurs, Fraenkel and Wallen (2006) acknowledge that researchers may be forced to use a convenience sample to obtain data. Members of the accessible population were those attendees of the 2006 NCBA conference who attend the tradeshow exhibits.

According to NCBA conference officials, 5,500 (N = 5,500) people attended the conference (M. Rossman, personal communication, September 16, 2006). Conference planners estimated 100% of conference attendees visited the tradeshow during the conference. Krejcie and Morgan (1970) recommended a sample size of 381 for a population of 5,500. A sample size of 391 beef cattle producers was obtained.

The administered survey was a researcher-developed instrument. Construct one pertained to demographics. This construct determined the following general information of respondents: gender, age, ethnicity, education level, and state of residency. Construct two was developed using the matrix analysis proposed by Hershkotitz (as cited in Witkin, 1984) to determine the level of need. This section included an operational definition of pre-harvest food safety. The response format for this written questionnaire was similar to many needs assessment studies; it was a categorical scale with four points and anchored with descriptors at each end (Witkin, 1984).

According to Witkin (1984), a two-response or multiple-response discrepancy survey asks for an opinion on existing conditions and an opinion on desired conditions and may repeat items in two sections. In this instrument, a two-response survey was used. Respondents were instructed to rank their knowledge of each pre-harvest food safety technique. Respondents were asked, in a separate question, to rank the importance of each pre-harvest food safety technique.

The content and face validity of this instrument were controlled by having a panel of experts review the instrument. For this study, a panel composed of industry, food safety experts reviewed the instrument for scientific content and a group of agricultural educators reviewed the instrument for face validity. Minor changes were made to the instrument based upon the panel's recommendations.

A score of .80 or better is sufficient for an instrument to be considered as having adequate reliability (Gall et al., 1996, p. 254). To determine the reliability of this research-developed instrument it was pilot tested on a group of 30 agriculture-focused adults. None of these individuals attended the NCBA conference. The calculation of the reliability was performed using the coefficient alpha within SPSS.

Construct one contained questions regarding occupation and current beef production practices. Reliability coefficients were not calculated on this construct. Construct two had two sections with five questions each. These sections pertained to the knowledge and importance of pre-harvest food safety techniques. These sections had a Cronbach's Alpha of .95 and .98, respectively.

The researchers distributed the survey to attendees in the tradeshow. Attendees of the 2006 NCBA conference stopped, completed the instrument using a complimentary pen, returned survey to the researcher, and received a complimentary black portfolio as an incentive for completing the instrument. The instrument took approximately five minutes to complete. Non-response error was not considered in this study because there was no future opportunity for non-respondents to complete the survey or for the researchers to contact them. The returned surveys were considered representative of the 2006 NCBA's annual conference.

All collected data was entered into a Microsoft Excel® spreadsheet using a researcher developed Web site with target points. On individual questionnaire items when respondents chose not to provide an answer, the coding was treated as missing data. The data were then transferred into SPSS. All data was evaluated using the statistical software program, SPSS/PC for Windows (Version 13).

Demographic information was reported in construct one. For the interval variables, the mean, standard deviation, and range was calculated. Frequencies were calculated on the categorical variables. The data pertaining to knowledge and importance of pre-harvest food safety techniques was evaluated by calculating the grand means and item means. Each question was plotted and the matrix analysis developed by Hershkowitz was used to determine the level of need and the amount of inclusion. Importance for each of the five pre-harvest food safety techniques was plotted on the Y-axis and knowledge was plotted on the X-axis.

Findings

Objective One

The first objective of this study was to determine the demographics of the occupational subgroup, beef cattle producers, attending the 2006 NCBA annual conference. Figure 3 illustrates the differences in gender of the solicited beef cattle producers. The majority (65.6%, n = 255) of the sample was male. The remainder of the sample were either female (29.3%, n = 114) or did not report their gender (5.1%, n = 20).

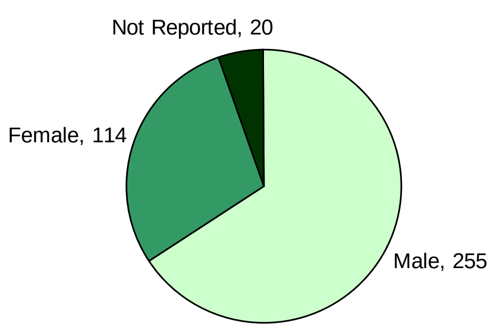

Figure 3: Gender of solicited beef cattle producers attending the 2006 National Cattlemen's Beef Association conference (n = 389).

The respondents were asked how many years of education they had past high school. The responses ranged from zero to 30 years. There was a mean of 4.23 years of education with a standard deviation of 2.89 (*n* = 339).

The age of the respondents ranged from a minimum of 19 to a maximum of 75 years of age. The mean age was 47.47 years old with a standard deviation of 13.18. Thirty respondents did not report their age. Figure 4 represents the frequency of the sample's age by groupings.

Figure 4: Age of solicited beef cattle producers attending the 2006 National Cattlemen's Beef Association conference (*n* = 359).

The ethnicity of respondents is described in Table 1. The majority of the sample was Caucasian (86.9%, *n* = 338). The remaining of the reported ethnicities were comprised of the following: Hispanic (3.9% *n* = 15), Native American (2.6%, *n* = 10), Other (1.5%, *n* = 6), and Asian (0.3%, *n* = 1).

Table 1
Ethnicity of solicited beef cattle producers attending the 2006 National Cattlemen's Beef Association conference (n = 389).

Ethnicity	Frequency	Frequency Percent
Caucasian	338	86.9
Not Reported	19	4.9
Hispanic	15	3.9
Native American	10	2.6
Other	6	1.5
Asian	1	.3

Table 2 describes the solicited beef cattle producer's reported state of residency. Texas was the most frequently reported state (14.4%, *n* = 56) followed by Colorado (12.9%, *n* = 50), and Nebraska (4.9%, *n* = 19). Solicited beef cattle producers represented 43 of the 50 states in the United States of America.

Table 2
Reported state of residency for beef cattle producers attending the 2006 National Cattlemen's Beef Association conference (n = 389).

State	Frequency	Frequency Percent
Texas	56	14.4
Colorado	50	12.9
All other states	251	62.6
Not reported	32	8.2

Objective Two

The second objective of this study was to determine the self-perceived knowledge and importance of pre-harvest food safety practices by solicited beef cattle producers attending the 2006 NCBA annual conference and assess the educational needs for each pre-harvest food safety technique.

The content areas that were evaluated in this objective were the following pre-harvest food safety techniques: seedwead/Tasco, sodium chlorate, neomycin sulfate, direct-fed microbials, and vaccines.

By using the matrix analysis developed by Hershkotitz (as cited in Witkin,1984), a needs assessment was constructed as shown in Figure 5. This was completed by using the grand mean for importance (GM_i = 2.76) and the grand mean for knowledge (GM_k = 2.15). The grand mean for importance was plotted on the X-axis and the grand mean for knowledge was plotted on the Y-axis. The intersection of the grand means was used to define the four quadrants. After plotting the grand means, the five content areas for pre-harvest food safety techniques were plotted using each of the content area's means for knowledge and importance.

After plotting the content areas on the matrix, the pre-harvest food safety techniques were classified according to the quadrant in which they were plotted. All techniques were either classified as low-level needs or high-level accessibility.

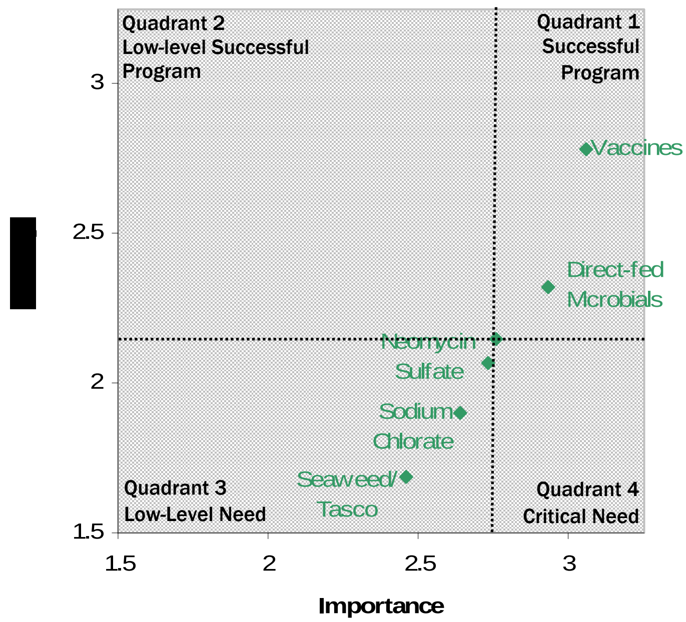

Figure 5: Needs assessment matrix for pre-harvest food safety techniques (Herkotitz's matrix analysis as cited in Witkin, 1984).

Table 3 indicates the content areas and means of each of the pre-harvest food safety techniques that were identified as being low-level needs. These content areas were comprised of the following: seaweed/Tasco, sodium chlorate, and neomycin sulfate.

Table 3
Low-level needs for beef cattle producers regarding pre-harvest food safety techniques.

	Importance			Knowledge		
Content	*M*	*SD*	*n*	*M*	*SD*	*n*
Seaweed/Tasco	2.46	1.01	325	1.69	.928	366
Sodium chlorate	2.64	.96	325	1.90	.933	368
Neomycin sulfate	2.73	.94	324	2.07	.96	362

Note. 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree.

Table 4 indicates the content areas and means of each of the pre-harvest food safety techniques that were identified as having high-level accessibility. These content areas were direct-fed microbials and vaccines.

Table 4
High-level accessibility needs for beef cattle producers regarding pre-harvest food safety techniques.

	Importance			Knowledge		
Content	*M*	*SD*	*n*	*M*	*SD*	*n*
Direct-fed microbials	2.93	.91	335	2.32	1.01	365
Vaccines	3.06	.99	350	2.78	1.05	379

Note. 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree.

Conclusions

The average beef cattle producer attending the conference was a Caucasian male who was 47 years of age. The average beef cattle producer attending the conference was slightly lower than other regional studies (Kistler et. al, 2002 Little et. al, 2002) that showed the average beef cattle producer was between 55 and 65 years old. It was concluded that beef cattle producers attending the conference were younger than the average beef cattle producer.

The average education level of the beef cattle producer attending the conference was 4.23 years beyond high school. (*M* = 4.23, *SD* = 2.89). This is consistent with information reported by Kistler, Cummings, and Briers (2002), who reported that 75% of participants in the Ranch to Rail Program had received a bachelor's degree, graduate degree, and/or professional degree. It was concluded that this sample, just as Kistler, Cummings, and Briers may have been biased toward a more highly educated group because the survey was administered at a conference that may attract the more highly educated.

Two of the food safety techniques, direct-fed microbials and vaccines, were classified as successful programs. The successful programs should be monitored to ensure continued success (Witkin, 1984). Researchers recommend that as new research is conducted and educational materials be distributed to beef cattle producers so they continue to maintain a high self-perceived knowledge level of these techniques.

Although none of the techniques were identified as critical needs, three were considered low-level needs; these included seaweed/Tasco, sodium chlorate, and neomycin sulfate. For all three of the low-level needs, the mean for importance was consistently higher than self-perceived knowledge. While these interventions do not require immediate education materials to be developed, they will require action at a later time (Witkin, 1984). Researchers recommend that educational materials for pre-harvest food safety be focused on increasing the knowledge for these three interventions.

Recommendations

The results of this study identified a need, although not critical, for the future education of beef cattle producers regarding pre-harvest food safety. It is recommended that additional research be conducted to identify the most effective information delivery methods for beef cattle producers. Some of the possible delivery methods include: food safety short courses, educational brochures, and electronic media kits.

The researchers recommend that additional research be conducted to validate the findings of this study and to continue monitoring the pre-harvest food safety interventions educational needs. In future research, researchers recommend that a more random sampling method be used to survey the beef cattle producers. By drawing the sample from other beef cattle producers besides those who attended the NCBA conference, the sample will be more representative of the entire population of beef cattle producers.

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