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ORIGINAL ARTICLE

Knowledge and attitudes towards food safety and reported use of good production practices among a sample of cattle producers in Santa Fe, Argentina[#]

Conocimiento y actitudes hacia seguridad alimentaria y buenas prácticas de producción adoptadas en productores ganaderos de Santa Fe, Argentina

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RESUMEN

La implementación de buenas prácticas de producción (BPP) en establecimientos pecuarios y la traducción efectiva de conocimiento sobre inocuidad de los alimentos a productores agropecuarios se recomienda para un suministro de alimentos más seguros. Un estudio piloto fue realizado durante 2009-2010 para evaluar el conocimiento y las actitudes hacia la inocuidad de los alimentos y el uso de BPP entre 930 ganaderos en Santa Fe, Argentina. El porcentaje de respuestas de las encuestas fue 31,8% (n = 296). Varios encuestados indicaron que raramente o nunca aislaban al ganado enfermo (25,8%), mantenían registros de enfermedades (32,5%) o del uso de antibióticos (43,3%), y aseguraban que los visitantes y los empleados del establecimiento se lavaran las manos (79,2% y 31,2%) y usaran ropa de protección (79,0% y 31,3%). La mediana de las respuestas de las 13 BPP encuestadas fue evaluada en un modelo ordinal de regresión logística. Capacitación previa sobre inocuidad de los alimentos (OR = 2,59), discusión frecuente (OR = 5,89) o siempre (OR = 6,33) de inocuidad de los alimentos con el veterinario, y ser productor de leche comparado a un productor de cría (OR = 3,86) fueron asociados con un mejor uso de BPP. Un 40% de la variación total en el uso de BPP se debió a factores relacionados a veterinarios, indicando que deberían tener un papel importante en la educación de los productores ganaderos sobre inocuidad de los alimentos. Estos resultados iniciales se deben utilizar para apoyar la toma de decisiones sobre la inocuidad de los alimentos en la producción de ganado en Santa Fe.

Key words: knowledge, attitudes, practices, cattle producer.

Palabras clave: conocimiento, actitudes, prácticas, productor ganadero.

INTRODUCTION

Foodborne and gastrointestinal disease cause significant morbidity and mortality in the human population and result in an important economic burden worldwide (Kosek *et al* 2003, Scallan *et al* 2011). For example, the mean annual incidence of human gastrointestinal illness in a region of Santa Fe, Argentina, was estimated to range from 0.46 to 1.68 episodes per person-year (Thomas *et al* 2010). Argentina also has a high incidence rate of haemolytic uremic syndrome, a life-threatening complication of Shiga toxin-producing *Escherichia coli* (STEC) infection (Rivas *et al* 2006). Beef and dairy cattle are important sources of STEC and other foodborne pathogens such as *Brucella spp.*, *Salmonella spp.* and *Listeria monocytogenes* (Samartino 2002, Fossler *et al* 2005, Vilar *et al* 2007, Fernandez *et al* 2009). STEC has been isolated with various frequencies from cattle feces, the cattle farm environment and retail beef products in Argentina (Meichtri *et al* 2004, Fernandez *et al* 2009, Etcheverria *et al* 2010, Tanaro *et al* 2010), which is a concern given that the consumption of undercooked beef is an important source of sporadic STEC infections (Rivas *et al* 2008).

The implementation of on-farm good production practices (GPP) by food-animal producers can help to minimize the risks of pathogen contamination throughout the food chain by using a farm-to-fork approach (OIE Animal Production Food Safety Working Group 2006). "GPP" are defined as a collection of on-farm management and biosecurity practices that can be implemented by producers to prevent the risk of contamination or infection of their animals with microbial, chemical or physical food safety hazards (Young 2010). To ensure successful implementation of GPP, producers should understand the importance of implementing GPp and they should have knowledge of

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the food safety hazards that GPp are designed to control. Previous surveys have investigated cattle producers' knowledge and attitudes towards food safety and use of GPp in the United States of America (USA), Canada and the United Kingdom (Hoe and Ruegg 2006, Gunn *et al* 2008, Young *et al* 2010[a], Young *et al* 2010[b]). However, information on these factors has not been previously investigated in Argentina, a leading cattle-producing country without formal on-farm food safety programs for cattle production. This information could be used to develop and measure the effectiveness of such programs. In addition, there is a need to investigate the role of veterinarians in the use of GPp among producers in Argentina, because previous studies have indicated that producers view veterinarians as trusted and important sources of information about food safety and GPp (Gunn *et al* 2008, Young *et al* 2010[a]).

An exploratory, pilot study was conducted to determine preliminary information about the knowledge and attitudes towards food safety and use of GPp among a sample of cattle producers in Santa Fe, Argentina. A secondary objective was to explore whether the reported use of GPp among producers in this study was associated with the frequency of veterinarian visits to the farm and frequency of discussing food safety and GPp with the veterinarian. The Province of Santa Fe was selected as the site for this study because it is the second largest producer of beef cattle, with over 6,900,000 head of cattle in 2009, and it is one of the largest milk-producing provinces in Argentina (Instituto Nacional de Tecnología Agropecuaria 2010, Taverna 2010).

MATERIAL AND METHODS

QUESTIONNAIRE DEVELOPMENT

We developed a 12-page questionnaire based on similar questionnaires that were administered to producers in North America (Hoe and Ruegg 2006, Young *et al* 2010[a], Young *et al* 2010[b]). The questionnaire was developed in English and translated to Spanish, and then it was reviewed and discussed with 12 local veterinarians of the Colegio de Médicos Veterinarios de Santa Fe (CMVSF) during a knowledge-exchange workshop about food safety and GPp in Santa Fe, Argentina (September, 2009). A more detailed review, pre-test and finalization of the questionnaire was conducted during the second day of the workshop, which included the study authors and three selected veterinarians. Unfortunately, we were not able to pre-test the questionnaire with a sample of producers due to limited resources and logistical constraints.

The final questionnaire consisted of three broad sections: demographics, management practices, and food safety. The 'demographics' section contained 11 multiple choice and yes/no questions about the farm operator's age (n = 1 question), type of animals produced (n = 1), organic status (n = 1), use of antimicrobials and feed supplements (n = 3), interactions with the veterinarian (n = 2), and previous training and interest in learning more about food safety (n = 3). This section also included one open-ended question about the number of animals produced. The 'management practices' section consisted of seven multiple choice and yes/no questions about pest control (n = 1 question), dead cattle disposal (n = 1), purchase of replacement cattle (n = 4) and on-farm slaughter and processing (n = 1). It also contained two questions about the use of 13 different GPp on a five-point scale (from "never" to "always"). The 'food safety' section consisted of three multiple choice questions about antimicrobial resistance (AMR) (n = 2) and knowledge of foodborne pathogens (n = 1), and one question about stakeholder knowledge of food safety measured on a five-point scale (from "not" to "very" knowledgeable). Additional questions (n = 12) were asked in the questionnaire but are not reported here for brevity reasons. A copy of the questionnaire is available as supplementary material.

QUESTIONNAIRE ADMINISTRATION

The target population for this pilot study was cattle producer clients of veterinarians from the CMVSF. Veterinarians must be registered with the CMVSF in order to practice in Santa Fe. The target population was not intended to represent all producers in Santa Fe, but to obtain preliminary baseline information about the range of knowledge, attitudes and use of GPp in the province. A total of 930 questionnaires were distributed to a convenience sample of 58 of 600 (9.7%) large-animal veterinarians from the CMVSF. Each veterinarian received approximately 5-10 questionnaires by mail or email from September to November, 2009, to distribute to producers. Veterinarians were contacted by study authors from the CMVSF by telephone before being sent questionnaires to explain the study purpose and give instructions on administration. Veterinarians administered the questionnaires during their regularly scheduled client farm visits. They were given instructions not to complete the questionnaires on behalf of the producers, but they were not blinded to the results. They introduced the study to producers and, among those who agreed to participate, provided a questionnaire for completion during the farm visit. Veterinarians collected the completed questionnaires and returned them in-person to the CMVSF office in Santa Fe. Follow-up telephone calls were made with veterinarians in February, 2010, to remind them to complete and return the questionnaires. This study received ethics approval from the University of Guelph Research Ethics Board (protocol #09AU020).

STATISTICAL ANALYSIS

Questionnaires were entered into an Access database (Microsoft Corporation, Redmond, WA). Descriptive tabulations and summaries were conducted for each variable

with missing values excluded. The proportion of cattle farms stratified by herd size (total number of cattle) for beef cattle respondents was compared to the provincial average in 2009 using a chi-square goodness-of-fit test (INTA 2010). Dairy respondents' herd size (number of milking cows) was compared to the provincial average for 2005 using a one-sample t-test (Gobierno de Santa Fe 2006). Descriptive analyses were performed in Stata 10.0 (Stata Corporation, College Station, TX).

A multilevel ordinal regression model was used to identify predictors associated with respondents' median use of GPP. The model was estimated with the GLLAMM command in Stata 10.0 using adaptive quadrature (Rabe-Hesketh and Skrondal 2008). The model outcome was an index variable representing respondents' median use of 13 different GPp measured on a five-point scale (never, rarely, sometimes, often, always). For example, if a respondent indicated that they "rarely", "sometimes", and "often" use six, one, and six of the 13 GPP, respectively, their median use of GPp would be "sometimes" because it is the middle value. Two levels of variation were included in the model: level one was the producer (i.e. respondent) and level two was the producer's veterinarian. Ordinal regression models assume that the outcome represents categories of an underlying continuous latent variable with a logistic distribution (Rabe-Hesketh and Skrondal 2008). Therefore, if σ_{vet} represents the variance due to the producer's veterinarian, the proportion of the total variance in the outcome attributable to veterinarians (ρ) was calculated as follows (Rabe-Hesketh and Skrondal 2008):

$$\rho = \sigma_{vet} / (\sigma_{vet} + \pi^2/3) \quad (1)$$

Eight variables were pre-selected as predictors of interest and included in the model-building process: cattle producer type (cow-calf, feedlot, dairy, mixed production); herd size (total number of cattle); farm operator age (< 40, 40-49, 50-59 and ≥ 60 years); production of other food animals (yes/no); organic status (yes/no); previous completion of a course or seminar about GPp and food safety (yes/no); frequency of veterinarian visits to the farm (≤ 4, 5-8 or > 8 times/year); and frequency of discussing food safety and GPp with the veterinarian (never, rarely, sometimes, often or always). The latter two variables were our primary predictors of interest, while the other six variables were included because they were considered to be potential confounding variables based on causal reasoning and previous research (Hoe and Ruegg 2006, Young *et al* 2010[a], Young *et al* 2010[b]). Spearman correlations and chi-square tests were used to investigate collinearity and associations between each pair of predictors. The predictors were screened in univariable ordinal regression models and were entered into a multivariable model if $P \leq 0.20$. A manual backwards-selection process was used to achieve the final model. Significance was assessed using likelihood-ratio tests and predictors were retained if $P \leq 0.05$. All variables were re-evaluated for significance and assessed for evidence of confounding (changes of > 20% in the coefficients of other predictors) in the final model. Two-way interactions were investigated between all predictors in the final model.

The ordinal regression model estimates only one coefficient for each predictor, which assumes that the coefficients do not depend on the outcome level. This is referred to as the proportional-odds assumption, and it was assessed by comparing the final model to a model with an estimated coefficient for each level of the outcome variable using a likelihood-ratio test. $P > 0.05$ was selected to indicate that this assumption is not violated (Dohoo *et al* 2003). The influence of veterinarians on the model was investigated by examining predicted probabilities stratified by veterinarian.

RESULTS

DEMOGRAPHICS

A total of 313 questionnaires were returned, 17 of which were removed from the dataset because of incomplete responses (n = 11) or because respondents were not cattle producers (n = 6), leading to a final response of 31.8% (296/930). A median of three questionnaires was returned per veterinarian (SD = = 5, range = 1-26). Of the 296 respondents, 58.8% were cow-calf producers, 23.0% were dairy producers, 7.1% were feedlot producers and 11.2% produced multiple cattle types. The median herd size was 249 (SD = 548, 25-75th percentile = 124-550) among beef cattle producers and 173 (SD = 152, 25-75th percentile = 100-247) among dairy cattle producers. The beef-cattle producers in this survey had a larger farm size compared to the provincial average ($P < 0.001$; table 2), while dairy producers had a similar number of milking cows compared to the provincial average ($P = 0.875$; mean = 190 vs. 187, respectively).

FARM CHARACTERISTICS, KNOWLEDGE AND ATTITUDES TOWARDS FOOD SAFETY, AND USE OF GPP

Respondents' farm characteristics and attitudes towards food safety are shown in table 1. Their rating of the level of knowledge about food safety and GPp among different stakeholders is shown in figure 1, and their knowledge of different foodborne pathogens is shown in figure 2. Respondents' use of general farm-management practices is shown in table 3 and their use of GPp measured on a five-point scale is shown in table 4.

MULTILEVEL ORDINAL REGRESSION

Results from the final multivariable ordinal regression model are shown in table 5. The likelihood ratio test indicated that the proportional-odds assumption was

Table 1. Respondents' farm characteristics and attitudes towards food safety, Santa Fe, Argentina.
Características y actitudes hacia la inocuidad de los alimentos entre entrevistados, Santa Fe, Argentina.

Question	Nº of respondents	Nº	(%)
Farm operator age:	293		
< 40 years		70	(23.9)
40-49 years		67	(22.9)
50-59 years		81	(27.7)
≥ 60 years		75	(25.6)
Animal species other than cattle on farm:	296		
No		253	(85.5)
Yes		43	(14.5)
Organic farm	296		
No		289	(97.6)
Yes		7	(2.4)
Frequency of veterinarian visits to the farm:	296		
≤ 4 times/year		79	(26.7)
5-8 times/year		67	(22.6)
> 8 times/year		150	(50.7)
Frequency of discussing GPp and food safety with the veterinarian:	293		
Never		29	(6.8)
Rarely		57	(19.5)
Sometimes		90	(30.7)
Often		75	(25.6)
Always		51	(17.4)
Have previously taken a continuing education course or seminar about GPp and food safety	296		
No		252	(85.1)
Yes		44	(14.9)
Want to learn more about GPp and food safety	296		
No		31	(10.5)
Yes		265	(89.5)
Preferred ways to learn more about GPp and food safety:			
Veterinarian	265	206	(77.7)
Feed or product salesman	265	30	(11.3)
Farm newspapers	265	58	(22.9)
Newsletters	265	62	(23.4)
Courses or seminars	265	82	(30.9)
Internet or email	265	91	(34.3)
Think that AMR is making it harder to treat sick animals	296		
No		70	(23.6)
Yes		226	(76.4)
Think that AMR in humans is linked to antimicrobial use in food animals	296		
No		144	(48.6)
Yes		152	(51.4)

valid (P = 0.279). No significant interactions were identified. Respondents that were dairy producers were more likely to report a higher median use of GPp compared to cow-calf producers, while feedlot and mixed cattle producers were not significantly different. Respondents that often or always discussed GPp and food safety with their veterinarian and that had previously taken a course or seminar about these topics were also more likely to report a higher median use of GPp (table 5). The odds ratios in table 5 indicate the odds of respondents having a median use of GPp above any given level compared to being at or below that level. For example, respondents that previously completed a course or seminar about GPp and food safety were 2.59 times more likely to have a median use of GPp of "sometimes" compared to "rarely or never", "often" compared to "sometimes, rarely or never", and "always" compared to any other response. Veterinarians contributed to 40.5% of the total variation in respondents'

Table 2. Comparison of herd size strata among respondents and the provincial average for beef cattle producers, Santa Fe, Argentina.

Comparación de estrato tamaño de hato entre los entrevistados y promedio provincial para los productores ganaderos, Santa Fe, Argentina.

	Respondents[a]		Province (2009)	
Herd size strata	N	%	N	%
≤ 100	43	19.4	10,193	42.0
101-250	70	31.5	6,552	27.0
251-500	48	21.6	4,168	17.2
501-1,000	36	16.2	2,156	8.9
> 1,000	25	11.3	1,202	5.0
Total	222	100.0	24,271	100.0

[a] Survey respondents were significantly different than the provincial average ($P < 0.001$).

median use of GPp ($\sigma_{vet} = 2.24$). The model was recalculated with only "cattle producer type" included to examine its influence on the variation attributable to veterinarians, but only small changes were noted (43.0%). To highlight the influence of different veterinarians on producer's use of GPP, figure 3 shows the predicted probabilities of the model stratified by veterinarian identification number. The veterinarian with the lowest predicted probabilities (ID = 38) had four producer responses, all of whom had never completed training in food safety, rarely (n = 3) or sometimes (n = 1) discussed food safety with the veterinarian and had a median use of GPp of rarely (n = 1) or never (n = 3). The veterinarian with the most producer responses (ID = 9, n = 26) had very high predicted probabilities.

DISCUSSION

The response percentage (31.8%) was lower than in similar surveys of dairy and beef cattle producers in the USA (Hoe and Ruegg 2006, Brandt *et al* 2008), but higher than in a recent Canadian survey (20.9%) (Young *et al* 2010[a]). Due to the low response, selection bias is a potential limitation of this study. For example, respondents to the questionnaire could have had a higher use of GPP, a greater knowledge of food safety or a stronger relationship with their veterinarian compared to non-respondents. In addition, veterinarians that participated in this study might have had a stronger relationship with their clients and might have been stronger advocates and educators about food safety and GPp to their clients compared to veterinarians that did not participate. Unfortunately, due to logistical constraints we could not determine the characteristics of producers and veterinarians that chose not to participate. Therefore, we cannot determine the true extent and impact of potential non-responses biases on the study findings, and the results should be interpreted with caution.

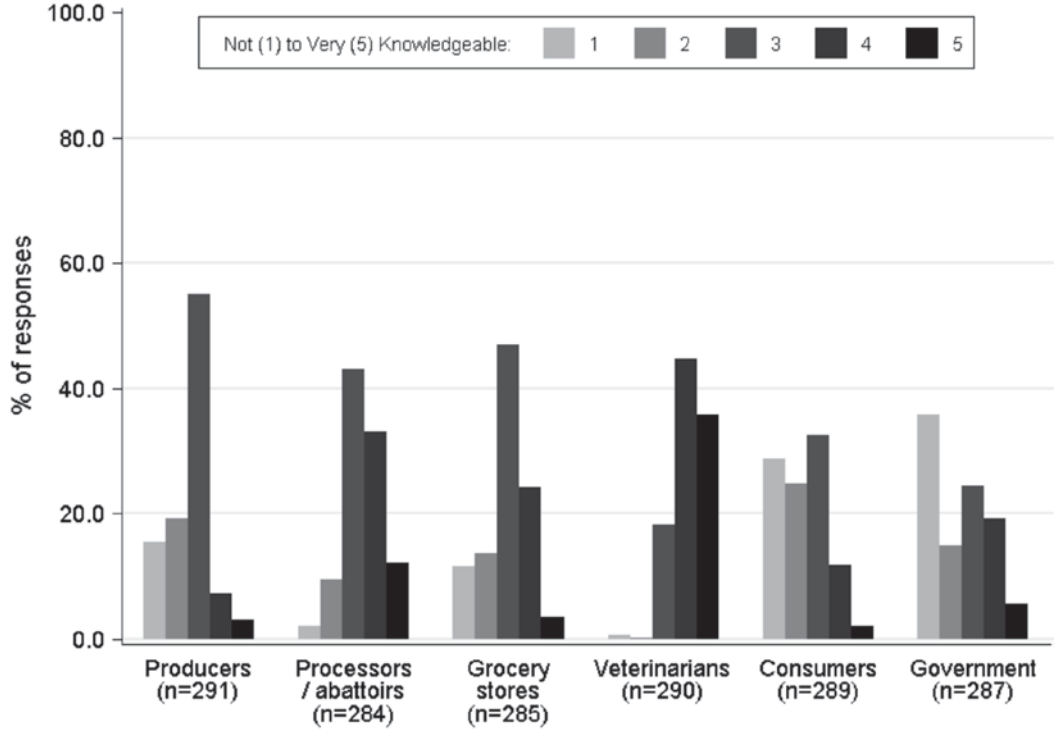

Figure 1. Stakeholder knowledge about GPp and food safety as rated by respondents, Santa Fe, Argentina.

El conocimiento de interesados acerca de buenas prácticas de producción y seguridad de los alimentos tan tasado por los entrevistados, Santa Fe, Argentina.

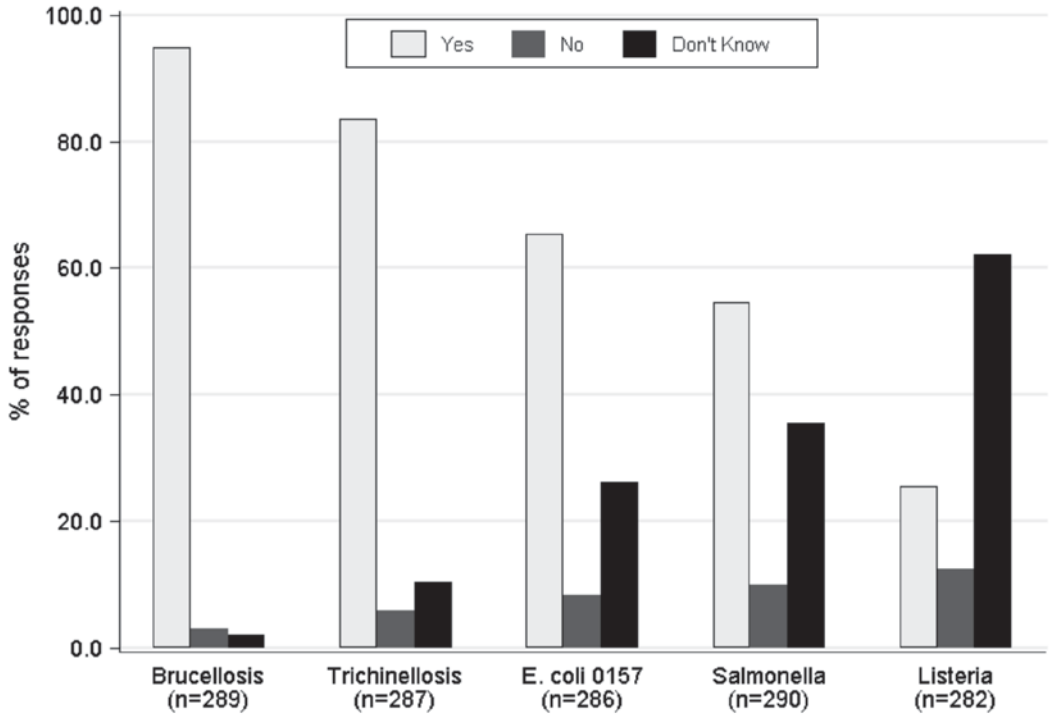

Figure 2. Respondents' knowledge of whether foodborne pathogens can be transmitted from contaminated food to humans and cause disease, Santa Fe, Argentina.

El conocimiento de entrevistados de ya sea los agentes patógenos transmitidos por los alimentos pueden transmitirse de los alimentos contaminados a los seres humanos y causar enfermedad, Santa Fe, Argentina.

The target population for this study was not intended to represent all producers in Santa Fe, and the comparisons of respondents' herd size to the provincial average were conducted for illustration purposes only. However, they indicate that beef cattle producer respondents may have had a larger herd size than the provincial average. In addition, dairy producers might have been over-represented in this sample, as the approximate proportion of cattle producers in Santa Fe that produce beef and dairy cattle is 84% and 16%, respectively (Gobierno de Santa Fe 2006, INTA 2010). Therefore, the results of this study might be less applicable to producers with smaller herds. Despite these limitations, we believe that the results still provide useful information that can be used to inform larger surveys of cattle producers in Santa Fe and for targeting areas for future education and knowledge transfer.

Most respondents (73.3%) indicated that their veterinarian visited their farms more than four times a year, and nearly 75% indicated that they sometimes, often or always talk about GPp and food safety with their veterinarian. These results suggest that cattle producers in this study have regular interactions with their veterinarian. In addition, most respondents viewed veterinarians as the most knowledgeable stakeholder and preferred source to learn about food safety and GPP, which corresponds with results from previous research (Vanbaale *et al* 2003, Gunn *et al* 2008, Young *et al* 2010[a]). Veterinarians in Santa Fe should continue to discuss food safety and GPp issues regularly with their producer clients.

Respondents' knowledge of *Brucella spp.*, *Trichinella spp.* and *E. coli* 0157 as foodborne pathogens is not surprising given that they cause endemic disease in humans in Argentina. In addition, these responses might be reflective of Argentina's brucellosis control program in cattle and public education about *E. coli* 0157 (Samartino 2002). In contrast, many respondents were not familiar with *Listeria spp.* (62.1%) or *Salmonella spp.* (35.5%). Cattle are an important reservoir for these pathogens, which they can shed in their faeces or milk with or without showing clinical signs of illness (Oliver *et al* 2005). Neither listeriosis nor non-typhoidal salmonellosis are nationally notifiable diseases in Argentina, so most human cases of these diseases are likely not detected. Future education with cattle producers in Santa Fe should highlight the importance of *Listeria* and *Salmonella* as foodborne pathogens.

Most respondents believed that AMR is affecting their treatment of sick cattle and that AMR in humans is linked to antimicrobial use in food animals. These results correspond to high concern about AMR expressed by dairy producers in North America (Raymond *et al* 2006, Young *et al* 2010[a]). Almost all respondents indicated that they use antimicrobials to treat sick cattle, although no data were collected about the amount of antimicrobials typically used for this purpose. The importance of judicious antimicrobial

Table 3. Respondents' reported use of general farm-management practices, Santa Fe, Argentina.
El uso informado de las prácticas de manejo generales entre entrevistados, Santa Fe, Argentina.

Practice	Nº of respondents	Nº	(%) yes
Use antimicrobials on the farm:			
To promote cattle growth	291	2	(0.7)
To prevent disease in cattle	291	32	(11.0)
To treat sick cattle	291	284	(97.6)
Add the following products to cattle feed:			
Probiotics	296	7	(2.4)
Organic acids	296	2	(0.7)
Hormones	296	3	(1.0)
Animal protein	296	4	(1.4)
Pest control methods used:			
Pest control company	296	16	(5.4)
Traps	296	35	(11.8)
Poison bait	296	166	(56.1)
Farm cats	296	148	(50.0)
Dead cattle disposal methods used:			
Removal service	296	9	(3.0)
Bury	296	20	(6.8)
Incinerate	296	60	(20.3)
Leave in cemetery area of farm	296	237	(80.1)
Purchase replacement cattle from another herd	296	135	(45.6)
Review the animal's vaccination status before purchasing replacement cattle	135	106	(78.5)
Cattle purchased from:			
Market	135	26	(19.3)
Another herd	135	66	(48.9)
Both	135	43	(31.9)
Use the following measures when adding replacement cattle to the herd:			
Quarantine	135	47	(34.8)
Vaccination	135	71	(52.6)
Serological evaluation	135	49	(36.3)
Nothing	135	30	(22.2)
Conduct any of the following activities on-farm:			
Animal slaughter	296	23	(7.8)
Processing	296	77	(25.0)

use should be promoted to producers and veterinarians in Santa Fe to minimize the potential for AMR selection pressure in pathogens associated with cattle. The use of other feed supplements was rarely reported among respondents (< 2.5%), although evidence suggests that some feed and water additives, such as probiotics and certain organic acids, may be effective in reducing cattle shedding of pathogens such as STEC (Sargeant *et al* 2007). The use of feed supplements other than antimicrobials should be considered as part of a comprehensive on-farm food safety strategy for cattle production in Santa Fe.

More than 20% of respondents indicated that they don't take any preventive measures when adding replacement cattle to their herd. This is a concern given that the introduction of purchased cattle into a herd is an identified risk factor for herd infection with infectious disease agents such as STEC (Schouten *et al* 2004). Cattle producers in Santa Fe should be informed about the potential risks of introducing replacement cattle into their herd without proper screening for pathogens or animal quarantine. Additionally, most respondents (> 80%) indicated that they leave their dead cattle in a cemetery area of the farm, which could lead to the possible transmission of infectious disease agents between wild scavenger animals and cattle. On-farm processing of meat was reported by 25% of respondents. However, the questionnaire did not distinguish between on-farm meat processing for personal use or sale to the public. Veterinary and food safety officials

Table 4. Respondents' reported use of GPP, Santa Fe, Argentina.
El uso informado de buenas prácticas de producción entre entrevistados, Santa Fe, Argentina.

Practice	Total	% Responses in each category				
		Never	Rarely	Some-times	Often	Always
Isolate sick cattle in an area separate from healthy cattle	295	14.9	10.9	32.9	19.0	22.4
Use disposable treatment equipment or clean and disinfect the equipment after each use	295	7.5	5.1	18.6	24.8	44.1
Use special places and procedures for disposal of needles, gloves, bottles, etc.	290	15.5	2.4	7.9	16.6	57.6
Use animal health products according to label instructions	294	0.3	0	4.4	16.0	79.3
Ensure appropriate drug withdrawal times are met before milking and/or shipping cattle	284	2.8	1.1	9.2	11.6	75.4
Keep production records on the farm	291	10.3	5.8	21.3	18.6	44.0
Keep records of diseases on the farm	295	19.3	13.2	25.4	19.7	22.4
Keep records about antimicrobial use on the farm	293	30.0	13.3	23.6	15.4	17.8
Use restricted access signs or locked gates/doors to control entry to the farm	294	46.6	7.8	10.2	9.2	26.2
Ensure visitors wash their hands before and after farm entry	292	70.6	8.6	11.0	6.9	3.1
Ensure visitors wear protective clothing and boots	290	70.7	8.3	11.7	4.8	4.5
Ensure farm employees wear protective clothing and boots	291	23.6	7.6	21.7	19.9	27.2
Ensure farm employees frequently wash their hands	285	23.2	8.1	20.7	21.4	26.7
Median use of GPP[a]	292	8.9	9.3	29.8	28.1	24.0

[a] Calculated from the median of the above 13 GPp variables and used as the outcome in the multilevel ordinal regression model.

Table 5. Final multivariable ordinal regression model of predictors associated with respondents' median use of GPP, Santa Fe, Argentina.
Modelo final de regresión ordinal multivariable de los factores predictivos asociados con la mediana de las respuestas de buenas prácticas de producción entre entrevistados, Santa Fe, Argentina.

Variable[a]	OR	SE	95% CI		P value
Cattle producer type					0.024
Cow-calf	1				
Feedlot	2.17	1.40	0.61	7.67	
Dairy	3.86	1.76	1.58	9.42	
Mixed production	1.57	0.87	0.53	4.62	
Frequency of discussing GPp and food safety with the veterinarian:					0.005
Never	1				
Rarely	1.49	0.84	0.49	4.48	
Sometimes	2.58	1.46	0.85	7.83	
Often	5.89	3.57	1.80	19.29	
Always	6.33	4.28	1.68	23.80	
Have previously taken a continuing education course or seminar about GPp and food safety:					0.024
No	1				
Yes	2.59	1.11	1.12	6.02	

[a] Model characteristics: N = 247; variance attributable to veterinarians, 2.24; likelihood ratio test of the proportional-odds assumption, P = 0.279. OR, odds ratio; SE, standard error; CI, confidence interval.

in Santa Fe should monitor on-farm meat processing by cattle producers to ensure that establishments that sell processed meat products to the public follow appropriate food safety standards and requirements.

Some areas for improvement were identified in respondents' reported use of GPP, such as isolating sick animals in an area separate from healthy animals. This practice is important, particularly in dairy cattle production, because sick cattle are more likely to shed pathogens such as *Salmonella* and could be a source of infection for other cattle in the herd (Fossler *et al* 2005). Respondents' record-keeping practices could also be improved to help ensure appropriate monitoring of disease occurrences and judicious antimicrobial use on the farm. Restricting

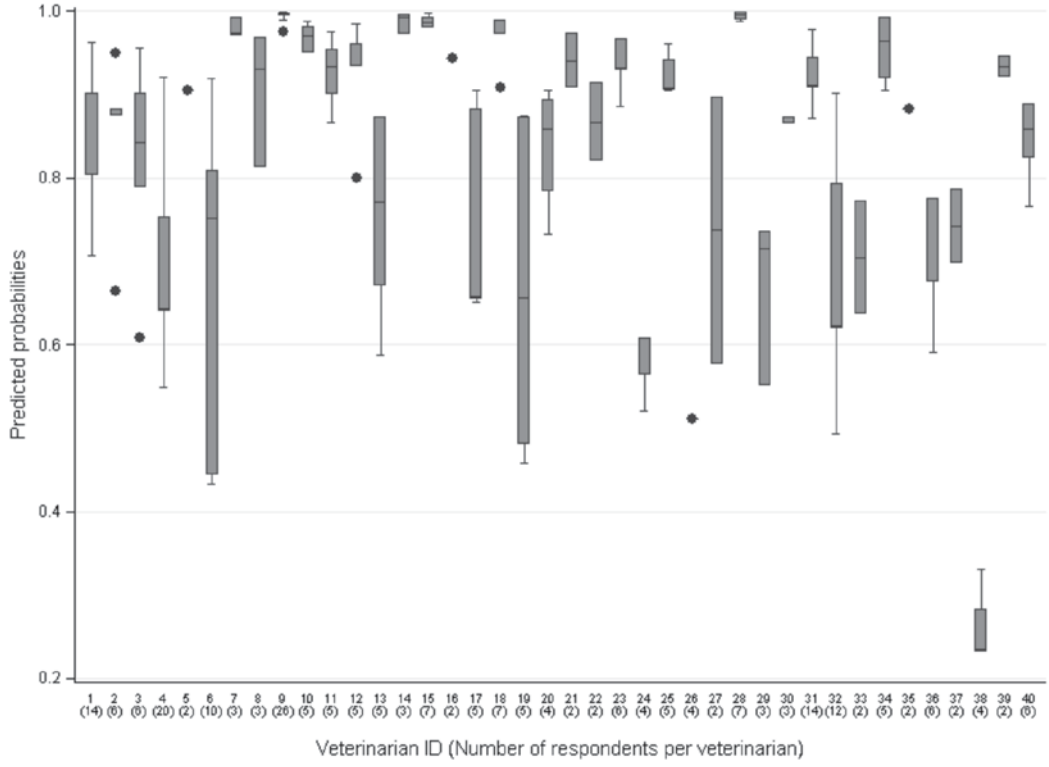

Figure 3. Box plot of predicted probabilities from the final multivariable ordinal regression model stratified by veterinarian. The predicted probabilities represent the probability of having a median use of GPp of "sometimes, often or always" vs. "rarely or never". Veterinarians with only one producer response (n = 18) were excluded from this graph.

El diagrama de bloques de probabilidades predichas del modelo final de regresión ordinal multivariable estratificado por el veterinario. Las probabilidades predichas representan la probabilidad de tener un uso mediano de buenas prácticas de producción de "a veces, a menudo o siempre" versus "raramente o nunca". Los veterinarios con sólo una respuesta productora (n = 18) fueron excluidos de este gráfico.

farm entry and ensuring that protective clothing is worn by farm visitors and employees was another gap in respondents' use of GPP. These practices are important to prevent the introduction of infectious disease agents such as STEC and foot-and-mouth disease virus into the herd, particularly if visitors or employees have recently visited another farm (van Schaik *et al* 2002, Ellis-Iversen *et al* 2011). However, these practices might be less practical or feasible for smaller farms with limited visitor contact.

The ordinal regression model results indicated that respondents who often or always discussed food safety or GPp with their veterinarian had a higher median use of GPP. This result supports our hypothesis that veterinarian extension and knowledge exchange with cattle producers in this study is associated with producer use of GPP. In addition, respondents that had taken an educational course or seminar about food safety and GPp had a higher median use of GPP. Other studies have also reported that the completion of educational courses is associated with more positive attitudes towards food safety and more frequent use of GPp (Moore and Payne 2007, Young *et al* 2010[a], Young *et al* 2010[b]), underscoring the importance of providing training opportunities to cattle producers. Respondents' who were dairy producers had a higher median use of GPp compared to cow-calf producers. This difference is likely reflective of the nature of dairy production, which requires additional control measures to maintain herd health and achieve safe milk production. Future promotion of the use of GPp in Santa Fe should primarily target cow-calf producers and their veterinarians, who might be less familiar with GPp than those in the dairy industry. The veterinarian with the most producer responses (n = 26) had very high predicted probabilities, and it is possible that this veterinarian's responses were biased towards a high reported use of GPP. However, we kept this veterinarian in the model because a sensitivity analysis showed that the removal of his responses did not unduly affect the regression coefficients (i.e. changes of < 20%).

Veterinarians contributed to > 40% of the variation in the ordinal regression model outcome, which provides additional support that veterinarians in this study appear to serve an important role in producers' use of GPP. These results highlight the need for veterinarians in Santa Fe to expand upon their traditional role in animal health and

production and be key mediators and educators about food safety knowledge among producers. Part of the veterinarian's role should be to disseminate relevant information to producers and guide them to improve their knowledge of food safety and use of GPP. Additional training and resources, including financial incentives, will be required to engage veterinarians effectively in these activities (Gunn *et al* 2008). The remaining model variation was due to producer, farm and herd level factors, and future research is necessary to understand how these factors contribute to producers' use of GPP.

One of the limitations of this study is that the questionnaire was not pre-tested on the target population of cattle producers. However, we developed, revised and pre-tested the questionnaire with local veterinarians, and we believe that their input and feedback helped to ensure that the questionnaire was user-friendly and appropriately designed for producers. Another limitation is that producers could have over-reported their use of GPp to provide a more socially-desirable response (e.g. a higher frequency of using GPP). However, it is also possible that the veterinarians' presence could have deterred producers from over-stating their responses. Producers also might not have had any motive to exaggerate their responses given that the questionnaire was anonymous. Although some specificity might have been lost in using an index variable as the outcome in the ordinal regression model, we believe that the results provide a useful overall summary of factors associated with respondents' use of GPP. However, it should be noted that some important confounding factors might have been absent from the model, such as financial (e.g. income) and personnel (e.g. number of farm employees) variables, which were not measured in the current questionnaire due to logistical and sensitivity reasons, but should be considered in future surveys.

It can be concluded that this pilot study identified the knowledge and attitudes towards food safety and reported use of GPp among a sample of cattle producers in Santa Fe, Argentina. Future research about food safety and GPp among producers in Santa Fe should be prioritized based on these results. Veterinarians should be engaged as key educators and promoters of food safety and GPp among cattle producers in this region. Veterinarians and producers should work together to develop on-farm food safety programs for beef and dairy cattle production in Santa Fe to improve food safety for these commodities.

SUMMARY

On-farm implementation of good production practices (GPP) and effective translation of food safety knowledge to food-animal producers are recommended to achieve a safer food supply. A pilot study was conducted during 2009-2010 to assess the knowledge and attitudes towards food safety and reported use of GPp among a sample of 930 cattle producers in Santa Fe, Argentina. A response percentage of 31.8% (n = 296) was obtained. Several respondents indicated that they rarely or never isolate sick cattle (25.8%), keep records of diseases (32.5%) or antimicrobial use (43.3%), and ensure that farm visitors and employees, respectively, wash their hands (79.2% and 31.2%) and wear protective clothing (79.0% and 31.3%). Respondents' median use of 13 GPp was calculated and evaluated in a multivariable ordinal regression model. Previous training in food safety (OR = 2.59), often (OR= 5.89) or always (OR= 6.33) discussing food safety with the veterinarian, and being a dairy producer compared to cow-calf producer (OR= 3.86) were associated with a higher median use of GPP. Approximately 40% of the total variation in respondents' median use of GPp was attributable to veterinarians, indicating that they should have an important role in the education of cattle producers about food safety in Santa Fe. These preliminary results should be used to inform future research and decision-making about food safety and GPp in cattle production in Argentina.

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