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Associations between Farmer Demographics, Management Practices and Attitudes towards Bovine Viral Diarrhoea and its Control

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Abstract: Farmer participation is crucial to the successful mitigation of Bovine Viral Diarrhoea (BVD) associated losses. This study aimed to identify producer groups most likely to benefit from BVD education by assessing the relationships between demographic and management variables, biosecurity behaviours and BVD awareness. A postal survey of South Australian cattle farmers was conducted, with 631 responses received and analysed. The survey tested attitudes and interests towards and perceived and demonstrable knowledge of BVD. Increases in the respondents' perceived understanding, knowledge and interest scores were observed when Pestigard® was routinely used and when Pestivirus testing had been conducted in the herd. Perceived understanding and knowledge scores were also increased when quarantine procedures are in place, when the producer had attended a BVD seminar or educational session, or was aware of the Bovine Johnes Disease Market Assurance Program. Regular use of either 5in1 or 7in1 vaccinations was associated with increased knowledge of BVDV, while health and vaccination status checks prior to introduction of new cattle are associated with increased perceived understanding of BVDV. This study revealed that uptake of positive biosecurity and BVDV specific behaviours was associated with perceived understanding, knowledge and interest in BVDV and supports the need for excellent education and awareness-raising programs in association with systematic control or eradication schemes. Improvements in knowledge of BVD could be related to improvements in other areas of animal health and biosecurity.

Keywords: Survey, Awareness, South Australia, BVD, Bovine Viral Diarrhoea, Pestivirus

Introduction

Bovine Viral Diarrhoea (BVD), caused by a Pestivirus of the family Flaviviridae, has a significant financial impact in infected cattle populations. Structured control programs, generally based on a test and cull approach, have been shown to be highly effective and economically beneficial (Häsler *et al*., 2012; Valle *et al*., 2000). Stakeholder awareness is acknowledged as a primary factor crucial to the success of control and mitigation schemes (Barrett *et al*., 2011; Lindberg and Alenius, 1999). As such, control schemes, including those in Switzerland (Presi *et al*., 2011) and various American states (Ridpath, 2012), have often incorporated an educational component. An understanding of the relationships between demographic and management factors and farmer awareness of BVD may allow identification of producer groups that are most likely to benefit from educational programs, such as those that have the poorest awareness of BVD and implement the fewest biosecurity procedures. In turn, this may allow

education schemes to be effectively targeted to those producers ensuring the greatest positive impact and improving the likelihood of producer support of BVD control efforts. Therefore, this study aimed to assess the relationships between demographic and management factors, biosecurity behaviours and knowledge of, perceived understanding of and interest in BVD and its control.

Materials and Methods

Survey

As previously reported (Lanyon *et al*., 2015), a 4-page questionnaire was mailed to all (n = 4,165), South Australian cattle farmers registered in the Primary Industries Information Management System (PIIMS) database as managing a herd of 35 or more head of cattle. Farmers managing herds of fewer than 35 animals were excluded in an attempt to focus on commercial producers (and hence exclude part-time or hobby farmers). A total of 631 responses were received (response rate 15.2%). Response bias in this survey has been extensively discussed (Lanyon *et al*., 2015). Due to the relatively low response rate, the results presented in this manuscript are interpreted within the confines of the respondent population without extrapolation.

Statistical Analysis

A perceived understanding score and an interest score were calculated for each respondent as previously reported (Lanyon *et al*., 2015), with a high score (on a scale of 1 to 7) representative of high self-perceived understanding of BVD or high interest in BVD, respectively. Similarly, a knowledge score was calculated on a scale of -16 to 16 (Lanyon *et al*., 2015), with a high score indicative of high demonstrated knowledge of BVD.

Simple linear regressions were performed in statistical package R Version 3.1.2 using the lm() function to assess which of twenty-one explanatory variables (Table 1) were significantly associated with the dependent variables: Perceived understanding score, knowledge score and interest score variables. All explanatory variables included in the analysis had <10% missing responses. For each dependent variable, multiple linear regression was also performed in R Version 3.1.2 using the lm() function. The starting model consisted of the main effects of each explanatory variable that simple linear regression showed to be significantly ($p<0.05$) associated with that dependent variable. Backwards stepwise elimination was performed using Akaike Information Criteria (AIC) and t-values as elimination criteria, until only significant variables remained.

Table 1: Explanatory variables from a postal questionnaire survey of 631 South Australian cattle farmers. All variables have <10% missingness

Variable name	Question	Answer options
Adequate vaccination	How often do you administer [5in1 or 7in1 vaccine] to your cattle?	'Never' or 'single dose as calves' recorded as 'NO'. 'double dose as calves' or 'annually for life' recorded as 'Yes'.
Ag related occupation	Primary occupation	Free text. 'Agriculture related', as designated by authors, recorded 'YES'. 'Agriculture related' included farmer, grazier, livestock transport, fencing contractor and stock agent. 'Not agriculture related', including teacher, doctor or tradesman was recorded 'No'.
Age	Age	Recorded in years
Beef/Dairy	Are you involved in: Dairy/Beef? (Circle all that apply.)	Circled 'dairy' recorded as 'dairy'. Circled 'beef' recorded as 'beef'. Circled both 'beef' and 'dairy' recorded as 'both'.
Breeds	What breed(s) of cattle?	'ANGUS', Holstein/Friesian/Holstein Friesian recorded as 'FRIESIAN', '(Poll) Hereford', 'Murray grey', 'Santa GERTRUDIS', '(Poll) shorthorn', 'Other British Beef Breed', 'European beef breed', 'Other dairy breed', 'Mixed or cross beef breeds', 'Mixed or Cross Beef Breeds including angus blood', 'Mixed or cross dairy breeds'.
BVD seminar	Have you ever attended an educational session about or related to BVD?	'YES' or 'NO'
BVD testing	Do you test cattle for bovine viral diarrhoea (Pestivirus)?	'YES' or 'NO'

Table 1: Continue

Commercial breeder	What type of operation: Commercial breeder	'YES' or 'NO'.
Decision maker	Are you responsible for the majority of management decisions?	'YES', 'Part responsibility' or 'NO'
Disease report level	Would you report: Some/ 5/ 10% cattle lame/sick/aborted/dead	'Some', '5' or '10%'
Education	What is your highest level of education?	'Primary school', 'Year 10 or equivalent', 'Completed year 10, continued at school but did not complete year 12', 'Year 12 or equivalent', 'Post-school qualification-not ag related', 'Bachelor degree-not Ag related', 'Post-school qualification or bachelor degree-Ag related', 'Post-graduate degree'
Gender	Gender (of respondent)	'Male' or 'Female'
Herd size	How many head of cattle/breeding females?	Numeric
MN awareness and involvement	Are you aware of and currently involved in the Johnes cattle market assurance program?	'Unaware', 'Aware and involved', 'Aware and uninvolved', 'Aware and previously but not currently involved'
Pestigard	How often do you administer [Pestigard] to your cattle?	'Never' recorded as 'NO' 'Single dose as calves', 'double dose as calves', 'Annually for life' or 'before introduction' recorded as 'Yes'
Quarantine	Do you use quarantine procedures when introducing new cattle or to isolate sick cattle?	'Yes' or 'No'.
Report to	If you were to report unexplained cattle deaths, who would you report to?	'Vet', 'PIRSA', 'Vet and PIRSA' or 'other'
Role	Are you: Cattle owner/manager/farm worker/other?	'Cattle Owner', 'Manager', 'Farm worker' or 'other'
Stud	What type of operation: Stud cattle	'YES' or 'NO'
Vacc/health Status New stock	Do you ascertain the vaccination or health status of cattle entering your property?	'Yes' or 'No'
Year in industry	How long have you been involved in the cattle industry?	Recorded in years

Results

Overall, eight explanatory variables (of twenty-two included the analysis) were retained in the final multiple linear regression model for at least one dependent variable. Table 2-4 show the parameter estimates, standard errors and probabilities for each retained explanatory variable in the models for perceived understanding score, knowledge score and interest score, respectively.

The use of Pestigard® in the herd and any BVD testing of cattle was significantly associated ($p<0.004$) with increases in the respondents' perceived understanding, knowledge and interest scores. Attendance at a BVD seminar and (self-reported) implementation of quarantine procedures on farm were significantly associated with increases in perceived understanding and knowledge, but not interest scores. By contrast, respondents that were unaware of the Johne's Cattle Market Assurance Program that is active in South Australia, had significantly lower perceived understanding and knowledge scores than their counterparts that were aware of the program but not involved (the reference group). Interestingly, those respondents that were actively involved in the program had significantly lower perceived understanding (but not knowledge) scores than the reference group. Perceived understanding scores were also significantly associated with gender, with male respondents likely to score lower and with implementation of vaccination and health procedures when introducing stock associated with higher scores. In addition, knowledge scores were significantly positively associated with adequate routine vaccination against clostridial diseases, using either 5in1 or 7in1 vaccines.

Table 2: Parameter estimates, standard errors, and probabilities of significant explanatory variables in multiple regression analysis of farmer's perceived understanding of the disease Bovine viral diarrhoea as measured by composite 'perceived understanding score' (possible values ranging from 1 (low perceived understanding) to 7 (high perceived understanding). Parameter estimates indicate the change in perceived understanding score associated with the category, relative to the reference category

Variable	Category	Parameter estimate	Standard error	p-value
Intercept		4.34	0.17	<0.001
Gender	Female		Reference	
	Male	-0.59	0.14	<0.001
Undertakes vaccination and health check of New Stock	No		Reference	
	Yes	0.41	0.11	<0.001
Undertakes quarantine of New Stock	No		Reference	
	Yes	0.24	0.1	0.019
Has attended BVD seminar	No		Reference	
	Yes	0.64	0.13	<0.001
Has ever undertaken any BVD testing	No		Reference	
	Yes	0.57	0.16	<0.001
Ever uses pestigard	No		Reference	
	Yes	0.9	0.15	<0.001
Awareness of and involvement in Johnes disease cattle MAP	Aware of program but not involved		Reference	
	Aware of program and previously but not currently involved	-0.08	0.24	0.727
	Involved in program	-0.39	0.15	0.01
	Unaware of program	-0.67	0.11	<0.001

Model statistics: Adjusted R-squared: 0.3543, F-statistic: 29.77 on 9 and 463 DF, p-value: $< 2.2\times10^{-16}$

Table 3: Parameter estimates, standard errors, and probabilities of significant explanatory variables in multiple regression analysis of farmer's knowledge of the disease Bovine viral diarrhoea as measured by composite 'knowledge score' (possible values ranging from -16 (low knowledge) to +16 (high knowledge). Parameter estimates indicate the change in knowledge score associated with the category, relative to the reference category

Variable	Category	Parameter estimate	Standard error	p-value
Intercept		3.94	0.32	<0.001
Adequately vaccinates with 5in1 or 7in1	No		Reference	
	Yes	0.82	0.34	0.016
Undertakes quarantine of New Stock	No		Reference	
	Yes	0.68	0.31	0.03
Has attended BVD seminar	No		Reference	
	Yes	2.67	0.42	<0.001
Has ever undertaken Any BVD testing	No		Reference	
	Yes	2.2	0.51	<0.001
Ever uses pestigard	No		Reference	
	Yes	2.79	0.48	<0.001
Awareness of and involvement in Johnes disease cattle MAP	Aware of program but not involved		Reference	
	Aware of program and previously but not currently involved	-0.03	0.75	0.97
	Involved in program	-0.14	0.47	0.76
	Unaware of program	-1.54	0.35	<0.001

Model statistics: Adjusted R-squared: 0.3543, F-statistic: 29.77 on 9 and 463 DF, p-value: $< 2.2\times10^{-16}$

Table 4: Parameter estimates, standard errors, and probabilities of significant explanatory variables in multiple regression analysis of farmer's interest in the disease Bovine viral diarrhoea as measured by composite 'interest score' (possible values ranging from 1 (low interest) to 7 (high interest). Parameter estimates indicate the change in interest score associated with the category, relative to the reference category

Variable	Category	Parameter estimate	Standard error	p-value
Intercept		4.9	0.07	<0.001
Ever undertaken any BVD testing	No		Reference	
	Yes	0.51	0.17	0.003
Ever uses pestigard	No		Reference	
	Yes	0.77	0.17	<0.001

Model statistics: Adjusted R-squared: 0.06892, F-statistic: 20.54 on 2 and 526 DF, p-value: 2.573×10^{-16}

Discussion

There are many factors that may influence a farmer's attitudes and decision making process, including the physical and economic constraints of the farm, the farmer's demographics, education, experience and stage of life, the farm succession plan (Toma *et al*., 2013). The present study is the first of this nature undertaken in Australia, examining associations between knowledge, understanding and interest in BVD with farmer demographics and farm management practices. The results of this study revealed significant associations between the dependent variables of perceived understanding, knowledge and interest in BVD and on-farm disease management behaviours including vaccination practices and quarantine habits. While direct comparison between Australian respondents and those in Britain and the US is difficult, similarities are certainly evident. For example, Sanderson *et al*. (2000) reported that US beef breeders that quarantined introduced stock were more likely to vaccinate their herds and require cattle to be vaccinated prior to introduction, suggesting that these producers may be driven by an underlying characteristic, potentially their understanding of disease risk and biosecurity. Sanderson *et al*. (2000) point out that the evaluation of biosecurity must not only focus on effectiveness and cost, but must relate to producer-specific factors such perception of risk, risk aversion and potential disease losses.

In a survey of British livestock veterinarians, Gunn *et al*. (2008) revealed that veterinarians viewed farmers as unwilling, unable or lacking the interest or time to invest in biosecurity. These publications support the results of the present survey that suggest that knowledge and understanding of disease is positively associated with biosecurity and disease control behaviours. These results suggest that increasing knowledge of biosecurity (or, BVDV, specifically) could increase the implementation of positive biosecurity behaviours.

A study by Gunn *et al*. (2008) showed that British farmers have mixed perceptions of biosecurity, with farmers positively associating with increases in profitability gained through improved health a welfare and considering biosecurity to be a matter of personal pride and their own responsibility so as to secure a future in farming. However, these same farmers also associated biosecurity with decreased freedom, increased bureaucracy and rules, costly and as unlikely to achieve the desired outcome without the cooperation of all stakeholders.

In general, the farmers in that British study expressed positive views on biosecurity when self-referential and negative views when considering externally imposed biosecurity requirements. In the present study, high knowledge and perceived understanding of BVD was observed to be associated with positive biosecurity actions. This suggests that, when well informed, respondents to this survey generally viewed biosecurity in a positive manner, resulting in positive action. This is supported by a similar finding of a very strong relationship between the knowledge and perceived importance of biosecurity and action observed by Toma *et al*. (2013) in another UK-based study. In that study, positive action was also associated with high perceived effects of disease outbreaks on farm profitability and perceived usefulness of information sources.

Conclusion

Schemes for the control of BVD through implementation of biosecurity rely on the commitment and cooperation of farmer populations. This study revealed that uptake of positive biosecurity and BVDV specific behaviours was associated with perceived understanding, knowledge and interest in BVDV supports the need for excellent education and awareness-raising programs in association with such projects. Improvements in knowledge of BVD could be related to improvements in other areas of animal health and biosecurity.

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Author's Contributions

Sasha Renee Lanyon: Designed and coordinated the survey and questionnaire, completed data entry, management and analysis and drafted the manuscript.

Malcolm Anderson: Facilitated the survey mail-out and edited the manuscript.

Michael Phillip Reichel: Edited the questionnaire and edited the manuscript.

Ethics

This survey was approved by the University of Adelaide Human Research Ethics Committee (Project No: H-091-2011).

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