A survey of veterinarians and producers on Mycobacterium avium subspecies paratuberculosis infection in cattle in Iowa

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A survey of veterinarians and producers on *Mycobacterium avium subspecies paratuberculosis* infection in cattle in Iowa

by

Suelee Robbe

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Veterinary Clinical Sciences (Animal Production Medicine)

Major Professors: Nolan R. Hartwig and John U. Thomson

Iowa State University

Ames, Iowa

2000

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Graduate College
Iowa State University

This is to certify that the Master's thesis of

Suelee Robbe

has met the thesis requirements of Iowa State University

Signatures have been redacted for privacy
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John, your ethics and integrity have given me a standard to strive for.

Nolan, your patience with my continuous grammatical errors has been appreciated. I will never be able to use the word "on" without carefully considering the context of its usage!

A special thanks must be given to Pam Smith and her colleagues who volunteered to deliver surveys to veterinarians. Without them, the quality of this work would have suffered.

And finally, I would like to thank my husband, Tony Austerman, who is first and foremost a livestock caretaker. A man who will work to exhaustion to prepare his livestock for an impending blizzard or get up at 3:00 am to feed a ten dollar bottle lamb. You symbolize why I am in this great profession and you are who we, as livestock veterinarians, truly serve.

This project was funded by the Iowa Healthy Livestock Advisory Council.
Iowa veterinarians responsible for the health care of cattle were surveyed about Johne's disease to determine: 1) educational needs; 2) use and interpretation of Johne's disease by diagnostic tests; 3) control programs recommended; and 4) potential support for a federal control program. Iowa cattle producers owning Johne's positive herds were surveyed to determine: 1) knowledge of Johne's disease; 2) control strategies implemented; and 3) potential support for a federal Johne's control program. Two hundred and seventy-seven (277) of 450 (62%) veterinarians and 296 of 542 (55%) producers returned the survey. Eighty-two percent (82%) of veterinarians indicated they need more information about Johne's disease and only two percent (2%) do not want more continuing education about Johne's disease. Twenty-seven percent (27%) of veterinarians have had producers request they avoid obtaining a definitive diagnosis of Johne's disease and 16% of veterinarians have recommended that producers avoid getting a diagnosis confirmed by laboratory tests. Twenty-one percent (21%) of veterinarians and 27% of producers have used the Johne's disease vaccine. Of these, 81% of veterinarians and 75% of producers indicated it is effective. Seventy-one percent (71%) of veterinarians who use the vaccine are comfortable recommending it versus nine percent (9%) of veterinarians who do not use the vaccine. Forty-eight percent (48%) of veterinarians and 23% of producers want Johne's disease to be quarantinable. Veterinarians and producers were asked if they agreed with a proposed federally mandated Johne's disease control program that specified a four-year voluntary enrollment period followed by mandatory enrollment. Fifty-nine per cent (59%) of veterinarians and 19% of producers agreed with this approach. Six percent (6%) of
veterinarians and 39% of producers want the program to be voluntary. Seven percent (7%) of veterinarians and six percent (6%) of producers want the program to be mandatory, while fifteen percent (15%) of veterinarians and 16% of producers want the program to have a voluntary period longer than four years. Four percent (4%) of veterinarians and 12% of producers do not want a program.
INTRODUCTION

Paratuberculosis (Johne's Disease) is a chronic progressive wasting disease of ruminants. The causative agent, *Mycobacterium avium subspecies paratuberculosis*, invades macrophages in the intestinal submucosa, causing a granulomatous enteritis. Typically, animals are infected at a young age and remain subclinical for 2-5 years. The granulomatous enteritis slowly progresses until clinical signs develop. Clinical signs in cattle include profuse watery diarrhea and weight loss without a decrease in appetite.

Paratuberculosis occurs throughout the world. In the United States, an estimated 21.6% of dairy herds\(^1\) and 7.9% of beef herds\(^2\) are infected. The disease costs the U.S. dairy industry an estimated $200-$250 million annually.\(^1\) Currently, no cost estimates are available for the beef cattle industry. Control and prevention of Johne's disease benefits producers, but can be difficult. Subclinically infected cattle are often infectious long before clinical signs appear. Current diagnostic tests lack the sensitivity needed to detect subclinically infected animals.

The United States Animal Health Association (USAHA) and the American Association of Bovine Practitioners (AABP) have passed resolutions recommending increased Johne's disease educational programs for veterinarians and producers. Currently, there is no documentation about knowledge of Johne's disease by veterinarians or cattle producers, the effectiveness of educational programs, or how this knowledge is applied. The specific programs that veterinarians recommend and producers implement are unknown. Federal and state officials have proposed various control programs, but information is lacking about the types of programs producers and veterinarians need and
would support. The current knowledge and control strategies recommended by veterinarians and implemented by producers must be understood before effective national control programs can be developed.

This project benchmarks the educational needs and control strategies of Iowa veterinarians and producers. Veterinarians were surveyed to determine: 1) educational needs; 2) use and interpretation Johne's disease diagnostic tests; 3) control programs recommended; and 4) potential support for a federal control program. Iowa cattle producers were surveyed to determine: 1) knowledge of the disease; 2) control strategies implemented; and 3) potential support of a federal Johne's control program.
LITERATURE REVIEW

Description/ Etiology

Paratuberculosis (Johne's disease) is a chronic, infectious enteric disease, caused by *Mycobacterium avium subspecies paratuberculosis*, an acid-fast, mycobactin dependent *Mycobacterium*. Johne and Frothingham first diagnosed paratuberculosis in cattle in 1895, although they thought it was an unusual form of ruminant tuberculosis. In 1906 Bang determined that paratuberculosis was not a form of tuberculosis but was a different disease. He determined the disease was infectious and had a long incubation period. Paratuberculosis has been diagnosed in sheep, goats, llamas, and several other domestic and wild ruminants. Several animal species, including mice, hamsters, guinea pigs, rats, gerbils, and chickens have been experimentally infected with *M. avium ss. paratuberculosis*. Recently, *M. avium ss. paratuberculosis* has been isolated from wild rabbits, foxes (*Vulpes vulpes*) and stoats (*Mustela erminea*).

Clinical Signs

In cattle, Johne's disease typically causes profuse watery diarrhea accompanied by moderate to severe weight loss. Affected animals usually are afebrile with good appetite until the very terminal stages of disease. Clinical disease usually occurs in adult cattle between 2-5 years of age, although Johne's disease has been reported in calves as young as 4 months. Clinical disease is often precipitated by parturition, malnutrition, mineral deficiencies and other stresses.
Pathology

Histologic lesions are seen approximately 1-2 months post experimental infection. Typically these early lesions are located in the pharyngeal and mesenteric lymph nodes. The organism is thought to gain entry into the intestine via ileal dome M cells and then penetrate to the subepithelial macrophages where it multiplies and spreads to regional lymph nodes. Once established in the intestinal tract, *M. avium* *ss. paratuberculosis* organisms are shed intermittently in the feces for various time intervals. On necropsy, chronic enteritis, chronic lymphangitis and/or mesenteric lymphadenopathy are seen. Lesions have also been reported in the liver and associated lymph nodes. Calcification of the endocardium and aorta are also occasionally seen.

Transmission

The fecal-oral route is considered the most important means of disease transmission. Young calves are most susceptible to *M. avium ss paratuberculosis*, and as an animal ages, it becomes more difficult to establish an infection. However, Larson *et al.* demonstrated that it is possible for adult cattle to become experimentally infected although they were more resistant. Larson orally infected three groups of cattle, one-month-old calves, nine-month-old calves, and adults, 5-11 years old. Histologic lesions were evident, but less pronounced in the nine-month-old calves and adult cattle 150 days post inoculation. In 1962, Rankin exposed adult cattle to an environment heavily contaminated with *M. avium ss. paratuberculosis*. After four years, only one of seven cows developed clinical Johne's disease.
A study utilizing slaughterhouse materials for fetal tissue cultures estimated the relative risk of fetal infection by in utero transmission at 26.4%. The role played by nonruminants and rodents in the transmission of Johne's disease to wild and domestic ruminants is currently unknown.

The importance of soil type in the transmission and survival of *M. avium ss. paratuberculosis* has been investigated. Kopeckey examined the relationship of soil types in Wisconsin to the prevalence of Johne's disease. He found that Johne's disease persisted in regions with acidic soils but not in regions with alkaline and calcareous soils. Johnson-Ifearulundu *et al.* reported a 1.4% increase in the risk of a herd testing positive for every part per million (ppm) increase in soil iron content. An increase in soil pH of 0.1 was associated with a 5% decrease in the number of test-positive cattle and an increase in soil iron content of 10 ppm was associated with a 4% increase of test positive cattle. Application of lime to pasture areas was associated with a 72% reduction in number of test-positive cattle. Further experimental studies must be done to determine a causal relationship between soil type and survival of *M. avium ss. paratuberculosis*.

**Prevalence**

The NAHMS Dairy '96 survey estimated about 22% of U.S. dairies are infected with Johne's disease. Larger herds are more likely to be infected than small herds. Forty percent (40%) of herds with 300 or more cows were infected, compared to a prevalence of 18.6% of herds with fewer than 50 cows. Of the 4 regions studied in the NAHMS survey, West, Midwest, Northeast and Southeast, the Midwest has the highest percentage of dairy
operations (24.2%) infected. These estimates may be low as the researchers estimated the prevalence based on a test with a sensitivity of 45%. Their sampling technique was designed to identify herds with a prevalence of 10% or greater.\textsuperscript{1}

A recent study in Michigan found a 54% dairy herd prevalence and a 6.9% individual prevalence of Johne's disease.\textsuperscript{18} A study conducted in Wisconsin in 1994 calculated a 4.79% apparent prevalence of dairy cattle and a 34% herd prevalence.\textsuperscript{19}

In the NAHMS Beef '97 study, blood samples from 10,372 cows in 380 herds from 21 states were tested for Johne's disease. Of these samples, 40 (0.4 percent) were positive on the ELISA. These 40 positive animals were from 30 (7.9 percent) of the tested herds. Again, this estimate may be low, as the study design was to identify herds with greater than 10% prevalence.\textsuperscript{2}

**Economic Impact**

In 1997 Ott estimated the economic impact of Johne's disease as part of the NAHMS Dairy '96 study. He found Johne's-positive herds lost $100 per cow when compared to Johne's-negative herds. The majority of losses were due to reduced milk production and increased cow replacement costs. In herds that reported at least 10% of cull cows with clinical signs consistent with Johne's disease, economic losses were over $200 per cow. These high-prevalence herds experienced reduced milk production of over 700 kg per cow, culled more cows, had lower cull-cow revenues, and had higher mortality than Johne's-negative herds. Averaged across all herds, loss of productivity due to Johne's disease costs the US dairy industry $22 to $27 per cow or $200 to $250 million annually.\textsuperscript{20}
In a 1999 study, Johnson-Ife-arulundu et al. found that cow mortality rates among herds positive for paratuberculosis were 3% higher than among negative herds. For a Michigan herd of average size (136 cows) and cull rate, the reduction in mean weight of culled cows attributable to paratuberculosis represented a loss of approximately $1150 annually for each 10% increase in prevalence of paratuberculosis. The increased mortality rate attributable to paratuberculosis represented a loss of between $1607 and $4400 based on lost slaughter value and cost of replacement heifers for an average 136 cow herd.21

No economic estimates are available for losses due to Johne’s disease in beef cows. In NAHMS beef 97 study, but only 380 were herds tested. Thirty herds and 40 animals were test-positive. These findings, combined with sketchy production and financial data, makes accurate estimates of economic losses in beef cows difficult.2,20

Diagnostic Testing

ELISA

Historically, ELISAs developed for Johne's disease had poor sensitivity and specificity due to cross-reactions with various other mycobacteria and other organisms. However, Yokomizo and Milner reported that absorbing sera with Mycobacterium phlei increased the sensitivity and specificity of the test significantly.22,23 In June of 1992, IDEXX Laboratories was granted a license to market a kit using this technology and currently, it is the only commercially available absorbed ELISA in the U.S.

Various sensitivity and specificity results have been reported for this ELISA in the literature. In 1995 Sweeney published sensitivities based on clinical signs. The ELISA was highest for clinical cases of paratuberculosis (87%±8.4%), and lowest for subclinical,
light-shedding cattle (15%±6.6).\textsuperscript{24} Collins reported the sensitivity and specificity of the ELISA to be 50.9 and 94.9%, respectively using a serum repository with 47% of the serums from infected cows.\textsuperscript{25,26} Meylan \textit{et al.} reported a sensitivity and specificity of the ELISA to be 50% and 98% respectively.\textsuperscript{27} This is similar to a sensitivity of 57% and specificity of 98.9% reported by Milner.\textsuperscript{23} Lein \textit{et al.} found an ELISA sensitivity of 18.6% when compared to culture positive cows.\textsuperscript{28}

\textbf{Fecal Culture}

Fecal culture is considered by many to be the most sensitive diagnostic test available. Sensitivity can be significantly influenced by culture technique. No "standardized diagnostic kit" is available.

Centrifugation of fecal samples may increase the sensitivity of the test over the sedimentation method; however, centrifugation also increases contamination rates.\textsuperscript{29} Stabel \textit{et al.} described a new method for fecal culture which includes centrifugation of the total fecal sample supernatant and use of a 2-step decontamination protocol. This method was 10-fold more sensitive for detection of \textit{M. avium ss. paratuberculosis} colonies and contamination was significantly reduced when compared with traditional methods.\textsuperscript{30} Collins \textit{et al.} found that using radiometric culture of filter-concentrated specimens doubled the number of positive fecal specimens detected when compared to conventional methods.\textsuperscript{31}
The specificity of fecal culture is considered high but not 100%. Sweeney and others demonstrated that it is possible for non-infected cattle to ingest and passively shed *M. avium ss. paratuberculosis* in their feces.\textsuperscript{32}

Typically, infected dairy cattle are not fecal culture positive at 11 months of age or younger, and Kalis *et al.* found more heifers to be fecal culture positive at 13-14 months than any other time.\textsuperscript{33} No culture studies have been done in beef cattle to determine when beef cattle begin shedding, the most efficient time to begin testing cattle, and if there are times during production stages when cattle are more likely to be positive.

### Polymerase Chain Reaction (PCR)

The DNA probe was developed and licensed for sale in the United States (IDEXX, Westbrook, ME) but is currently not available. This test is based on a 218 bp segment of a DNA insertion sequence, IS900, that is specific for *Mycobacterium a. ss. paratuberculosis*. An advantage of using the DNA probe is that results can be obtained in 3 days compared to the six to sixteen weeks required for fecal culture.\textsuperscript{34}

Low sensitivity, cost, and the equipment required are major problems associated with the DNA probe. The DNA probe lacks sensitivity when cattle are shedding low numbers of the Johne’s disease organism.\textsuperscript{35}

A recent modification of the IS900/PCR assay to include two consecutive amplification reactions using nested primers markedly increased the sensitivity of this test.\textsuperscript{36}
Acid Fast Stain in Feces

Using an acid fast staining technique on fecal smears to detect *Mycobacterium avium ss. paratuberculosis* can be done quickly and easily. However, it lacks sensitivity. Egan demonstrated acid-fast bacteria were observed in smears from only 23.6% of samples that were culture positive.\(^3^7\) Because other organisms and particles can stain acid-fast in the feces, specificity may also be a problem.

Control Measures

Management Practices

Transmission routes of paratuberculosis are well documented. However, there are relatively few reports that actually document on-farm risk factors for the disease. Johnson-Ifeareulundu *et al.* found the use of an exercise lot for lactating cows was associated with a three-fold increase in odds of a herd being positive for infection. Cleaning of maternity pens after each use was associated with a three-fold reduction in odds of a herd being positive. Application of lime to pasture areas was associated with a ten-fold decrease in odds of a herd being positive for *M. avium ss. paratuberculosis* infection.\(^3^8\)

In 1977, Cetinkaya *et al.* evaluated risk factors for clinical Johne's disease. Calving place, group size of calves, length of time calves were kept in groups, type of concentrate feeds provided, Channel Island breeds (Jerseys and Guernseys), source of replacements, and the presence of farmed deer were identified as significant factors.\(^3^9\)-\(^4^1\)

Goodger *et al.* examined management variables that were significantly associated with apparent prevalence of Johne’s disease. The factors that were most associated with
prevalence were environmental conditions (hygiene), newborn calf care, grower calf care, mated heifer care and manure handling.\textsuperscript{42}

Vaccination

In the United States, a heat-killed whole cell vaccine for Johne's disease is currently available (Mycopar\textsuperscript{®}, Ft. Dodge Laboratories, Ft, Dodge, Iowa). This vaccine is prepared from strain 18, which is a \textit{M. avium} serotype 2 rather than a \textit{M. a. ss. paratuberculosis}.\textsuperscript{43}

Nonetheless, several investigators report that this vaccine is efficacious. Hurley \textit{et al.} reported a decrease of infection from 55\% for controls to 8.7\% for animals vaccinated with the Mycopar\textsuperscript{®} vaccine.\textsuperscript{44} Larson \textit{et al.} described a trial in which this vaccine significantly reduced the rate of animals showing evidence of clinical disease and the number of animals actually infected.\textsuperscript{45}

In a 1994 article in the Journal of the American Veterinary Medical Association (JAVMA) Collins states, "Although it (vaccination) may have served a purpose in the past, recent information indicates it is of limited value in controlling \textit{M. paratuberculosis} infections, causes a false sense of security in owners, is a serious health risk for veterinarians, and prevents use of serologic tests in a herd."\textsuperscript{46} No literature citation could be found that validates the statement, “…recent information indicates (the vaccine) is of limited value in controlling \textit{M. a. paratuberculosis} infections…”

Patterson \textit{et al.} investigated accidental self-inoculation with the Mycopar\textsuperscript{®} vaccine. Of 199 veterinarians who administered the vaccine to cattle, nineteen had experienced needle-stick exposure. Of these nineteen, five adverse reactions were reported.\textsuperscript{47}
Vaccinated animals may show a false positive reaction to the caudal fold tuberculin test. Animals vaccinated for Johne’s disease can be differentiated from tuberculous animals by using the comparative cervical skin test.\textsuperscript{48}

A live 316F-strain vaccine (Neoparasac, Rhone Merieux) is used in France, Denmark, and New Zealand.\textsuperscript{49} Several clinical trials have demonstrated the efficacy of this vaccine.\textsuperscript{50}

In the Netherlands, a killed vaccine has been shown to decrease infection rate by almost 50\%, from 6.8\% to 3.8\%.\textsuperscript{51} Another study failed to show a difference in infection rate, but did show a significant decrease in the number of cattle showing clinical signs of Johne’s disease.\textsuperscript{52}

**Current Regulatory Status of Johne's Disease in Iowa**

Currently Johne's disease is not an official “reportable” disease in Iowa. However, diagnostic laboratories provide a list of positively diagnosed cases to the office of the State Veterinarian. State district veterinarians are encouraged to visit herds diagnosed with Johne's disease to discuss control programs.

**National Voluntary Status Program**

The United States Animal Health Association (USAHA) formally adopted the Voluntary Johne's Disease Herd Status Program for Cattle (VJDHSP) in October of 1998. This program is designed to identify and protect herds at low risk for paratuberculosis. The
program consists of four levels, and requires at least three years to complete. If an animal is confirmed positive for Johne's disease, the herd is removed from the program.35

Survey Design and Response Rates

Asch et al. found that the mean response rate among mail surveys published in medical journals was approximately 60%. Published surveys of physicians had a mean response rate of 54%, while those of non-physicians had a mean response rate of 68%. In addition, he found that multivariable models suggest that written reminders provided with a copy of the instrument are associated with a 13% increase in response rate.53. Larroque et al. also found repeated mailings significantly increased survey response rates.54
MATERIALS AND METHODS

This project was a cross-sectional census about the knowledge of Johne’s disease of Iowa veterinarians and cattle producers, recommendations veterinarians make to producers, management practices producers implement and veterinarian’s and producer’s support for a control program. Two survey instruments were developed, one for veterinarians and one for beef and dairy producers. Both surveys were conducted during January and February, 1999.

Population and Sample

Survey of Veterinarians

The target population included actively practicing veterinarians in Iowa who serve dairy and/or beef cattle producers. No accurate information is available on how many veterinarians conduct bovine practice in Iowa. This problem was resolved when the State Veterinarians office volunteered to have their State District Veterinarians (SDVs) and Federal Veterinary Medical Officers (VMOs) hand deliver surveys to veterinarians who serve dairy and/or beef cattle producers in their respective districts.

The SDVs and VMOs are actively involved in regulatory medicine, have experience conducting epidemiological surveys in cooperation with the National Animal Health Monitoring Service (NAHMS), and know the type of practice conducted by private practicing veterinarians in their respective districts. They delivered the surveys to veterinarians in their districts who conduct bovine practice (see Appendix A.). Twelve
SDVs and VMOs participated in the project. Four hundred fifty (450) surveys were delivered.

Survey of Iowa Cattle Producers

The target population included dairy and/or beef producers whose herds have been diagnosed with Johne's disease in the last five years. Although Johne's disease is not reportable for regulatory activity in the state of Iowa, veterinary diagnostic laboratories in the region inform the state veterinarian's office of positive diagnoses. A positive diagnosis could include one or more of the following tests: serology, PCR, culture, or histopathology. The initial list of 612 producers with reported Johne's disease was obtained from the State Veterinarian's office. After removing duplicates and verifying addresses, 542 producers were identified. The producer survey was delivered by mail.

Survey Development and Design

Three faculty members in the Production Animal Medicine (PAM) section of The Department of Veterinary Diagnostic and Production Animal Medicine (VDPAM) at Iowa State University and Dr. Pam Smith, one of the State District Veterinarians, wrote questions. Drafts of the questionnaire were submitted to each survey author, then discussed jointly by the three PAM faculty members. The Survey Laboratory at Iowa State University then reviewed the questionnaire. After making recommended changes, the survey instrument was reviewed by several additional PAM faculty members.

The survey was tested on 3 cattle producers who are knowledgeable about Johne's disease and by several VDPAM faculty members. A final version of the questionnaire was
submitted to the Human Subjects Committee at Iowa State University for approval. Both surveys were approved on December 16, 1998. Response data were entered into OPIII®, a survey software program. This software is an object-oriented database that formats the survey and collects survey results.

Data Collection and Analysis

Veterinarian Survey

Twelve district VMOs or SVDs delivered four hundred and fifty (450) survey instruments to veterinarians in January, 1999. Surveys were returned in a business reply envelope or were picked up by the VMO within one to two weeks.

Producer Survey

The producer's survey was mailed to 542 herd owners on January 15, 1999. A reminder was mailed 14 days later. A duplicate survey was sent to non-respondents on February 18, 1999.

Analysis

The completed surveys were entered into OPIII survey software. OPIII is a medical, outcomes analysis, object-oriented database with the ability to modify surveys and track clients. The survey results were downloaded into a Microsoft Excel® spreadsheet. Statistical analysis was performed using Statistical Analysis Software (SAS) and Microsoft Excel. Statistical methodologies included averages, percentages, Chi-square, and standard

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a Velocity Healthcare Informatics, INC., 8441 Wayzata Blvd, Suite 105 Minneapolis, MN 55426
error of the mean (SEM). Each question that had answers rated on a scale was averaged over all respondents and compared using paired t-tests. The alpha critical value ($\alpha$) used for these tests was calculated by dividing .05 by the total number of possible pairwise comparisons.$^{55}$
RESULTS

Response rates

Two hundred and seventy-seven (277) of 450 (62%) veterinarians and 296 of 542 (55%) producers returned the survey.

Veterinarian Survey

Profile

Seventy-five percent (75%) of the veterinarians surveyed have diagnosed Johne's disease. Fifty-seven percent (57%) have diagnosed Johne's disease in dairy cattle and 54% in beef cattle. Of the 75% that have diagnosed Johne's disease, 28% have used Johne's vaccine.

Table 1 displays distribution information of responding veterinarians. Iowa is divided into 5 regulatory regions with state and federal VMO's assigned within these regions (See Appendix A). Twenty-nine percent (29%) of responding veterinarians were from Northeast Iowa where dairy production predominates. This is the only region where a majority of veterinarians have used the vaccine for Johne's disease. In the Southern half of the state (SE, SW), only four veterinarians of 112 (3.5%) have used the vaccine.

Educational Needs

Eighty-two percent (82%) of veterinarians responding to the survey want more information about Johne's disease (Table 2). Veterinarians who have diagnosed Johne's disease are more likely to want information than those who have not diagnosed the
Table 1. Responses of veterinarians by regulatory districts (Appendix A)

<table>
<thead>
<tr>
<th></th>
<th>Region 1 (North West)</th>
<th>Region 2 (North Central)</th>
<th>Region 3 (South East)</th>
<th>Region 4 (South East)</th>
<th>Region 5 (South West)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Veterinarians</td>
<td>44 (16%)</td>
<td>35 (13%)</td>
<td>80 (29%)</td>
<td>46 (17%)</td>
<td>66 (24%)</td>
</tr>
<tr>
<td>(n=277)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veterinarians who</td>
<td>2 (3%)</td>
<td>13 (22%)</td>
<td>40 (68%)</td>
<td>3 (5%)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>vaccinate (n=59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veterinarians who</td>
<td>27 (18%)</td>
<td>17 (11%)</td>
<td>33 (22%)</td>
<td>29 (19%)</td>
<td>38 (25%)</td>
</tr>
<tr>
<td>do not vaccinate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=150)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veterinarians who</td>
<td>15 (23%)</td>
<td>4 (6%)</td>
<td>7 (11%)</td>
<td>13 (20%)</td>
<td>25 (39%)</td>
</tr>
<tr>
<td>have not Diagnosed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(n=64)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* Number (%)

*a* Four veterinarians did not confirm if they have or have not diagnosed Johne's disease.

*b* Six veterinarians did not identify their region.

Table 2. Requests by veterinarians for information on Johne's disease

<table>
<thead>
<tr>
<th></th>
<th>Need more information Number (%)</th>
<th>Attended Johne's CE in the last 2 years Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (n=277)</td>
<td>228 (82%)</td>
<td>140 (51%)</td>
</tr>
<tr>
<td>Have Diagnosed (n=208)</td>
<td>180 (87%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>120 (58%)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Have not diagnosed (n=64)</td>
<td>43 (67%)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20 (31%)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup><sup>b</sup> p value = <.0005

disease (p value = <.0005). Fifty-one percent (51%) have attended continuing education (CE) about Johne's disease in the last two years. Fifty-eight percent (58%) of veterinarians who have diagnosed Johne's disease and 38% who have not diagnosed have attended CE in the last two years (p value = <.0005). Significantly more veterinarians (87%) who have
diagnosed Johne's disease want more information than those (31%) who have not diagnosed.

In a "choose all that apply" question, veterinarians overwhelmingly preferred written material (65%) and meetings (64%) to other educational venues for Johne's disease education (Table 3). The Iowa Cable Network, a real-time, interactive fiber optic, statewide communication service, was preferred by 29%, while workshops were preferred by 20%. Only 2% said they preferred no Johne's disease continuing education.

### Table 3. Veterinarian's educational format preference

<table>
<thead>
<tr>
<th>Format</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written Material</td>
<td>180 (65%)</td>
</tr>
<tr>
<td>Meetings</td>
<td>178 (64%)</td>
</tr>
<tr>
<td>Iowa Cable Network</td>
<td>80 (29%)</td>
</tr>
<tr>
<td>Workshops</td>
<td>56 (20%)</td>
</tr>
<tr>
<td>None</td>
<td>6 (2%)</td>
</tr>
</tbody>
</table>

### Diagnostic Test Utilization

Veterinarians were asked how often they used specific tests as a method of diagnosis (Table 4). The ELISA test and clinical observation were used most frequently, followed by fecal culture. PCR and fecal acid-fast stain were the least used tests. Performing individual animal versus herd diagnostic tests did not significantly affect test preference by veterinarians with the exception that veterinarians were less likely to use clinical observation when diagnosing populations rather than individuals.
Table 4. Utilization of diagnostic tests

<table>
<thead>
<tr>
<th></th>
<th>Individual animal basis*</th>
<th>Herd basis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELISA</td>
<td>3.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.9&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Clinical observation</td>
<td>3.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.5&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fecal culture</td>
<td>3.0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.7</td>
</tr>
<tr>
<td>PCR</td>
<td>2.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.0&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fecal acid fast stain</td>
<td>1.6</td>
<td>1.8&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*Scale: 1=Least often, 5=Most often

<sup>a, b</sup> Column numbers with the same letters are not significantly different. (α value = .0033)

<sup>l</sup> Row numbers that are significantly different. (α value = .05)

Veterinarians were asked to indicate reasons they requested diagnostic testing for Johne's disease (Table 5). Observing clinical signs was the leading reason, followed by evidence of a severe herd problem and by owner's requests for diagnostic tests. Purchasing or selling cattle were the least likely reasons for requesting diagnostic tests.

Table 5. Reasons veterinarians request diagnostic testing

<table>
<thead>
<tr>
<th>Reason</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical signs</td>
<td>4.6</td>
</tr>
<tr>
<td>Severe herd problem</td>
<td>3.9</td>
</tr>
<tr>
<td>Owners request</td>
<td>3.3</td>
</tr>
<tr>
<td>Purchasing cattle</td>
<td>2.5</td>
</tr>
<tr>
<td>Selling cattle</td>
<td>1.9</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least often, 5 = Most often

All column numbers are significantly different. (α value = .005)
Twenty-seven percent (27%) of veterinarians have had producers request they avoid obtaining a definitive diagnosis of Johne's disease (Table 6). Thirty-four percent (34%) of veterinarians previously diagnosing Johne's disease have had owners want to avoid testing, versus 8% of the veterinarians who had never diagnosed Johne's disease.

### Table 6. Avoiding a laboratory diagnosis of Johne's disease

<table>
<thead>
<tr>
<th>Producer wants veterinarian to avoid testing</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians Total (n=277)</td>
<td>76 (27%)</td>
</tr>
<tr>
<td>Have Diagnosed (n=208)</td>
<td>71 (34%)</td>
</tr>
<tr>
<td>Have Not Diagnosed (n=64)</td>
<td>5 (8%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Veterinarian suggests not to test</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians Total (n=277)</td>
<td>53 (16%)</td>
</tr>
<tr>
<td>Have Diagnosed (n=208)</td>
<td>46 (22%)</td>
</tr>
<tr>
<td>Have Not Diagnosed (n=64)</td>
<td>7 (11%)</td>
</tr>
</tbody>
</table>

\(^a\) p value = <.0005  
\(^b\) p value = .049

Sixteen percent (16%) of veterinarians have recommended that producers avoid getting a diagnosis confirmed by laboratory tests. Eleven percent (11%) of the veterinarians who have never diagnosed Johne's disease and twenty-two percent (22%) of the veterinarians who have diagnosed Johne's disease have recommended that producers avoid getting a laboratory confirmed diagnosis.
Knowledge

Forty-three percent (43%) of veterinarians responding to the survey indicated there is a breed pre-disposition to developing clinical Johne's disease. Veterinarians were asked how they advised producers about milk production from test-positive cows (Table 7). Two percent (2%) of veterinarians said there was no effect on milk production from test-positive cows; 13% said that milk production was slightly decreased; and 62% said milk production was decreased by over 500 pounds per year. Twenty-two percent (22%) of veterinarians did not answer. More veterinarians (34%) who have never diagnosed Johne's disease did not answer this question that those who have diagnosed (17%) (p value = .004).

Table 7. Veterinarians' advise to producers about Johne's test positive status

effect on milk production

<table>
<thead>
<tr>
<th></th>
<th>No effect</th>
<th>Slight decrease</th>
<th>Decreased at least 500lbs</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians Total (n=277)</td>
<td>6 (2%)</td>
<td>37 (13%)</td>
<td>172 (62%)</td>
<td>62 (22%)</td>
</tr>
<tr>
<td>Have Diagnosed (n=208)</td>
<td>5 (2%)</td>
<td>28 (13%)</td>
<td>139 (67%) b</td>
<td>36 (17%) b</td>
</tr>
<tr>
<td>Have Not Diagnosed (n=64)</td>
<td>1 (2%)</td>
<td>8 (13%)</td>
<td>33 (52%) a</td>
<td>22 (34%) b</td>
</tr>
</tbody>
</table>

a p value = .028  
b p value = .004

Veterinarians were asked to estimate the positive predictive value of a Johne's ELISA test that had a sensitivity of 50% and a specificity of 98% in a herd with a prevalence of 10% (Table 8). Twenty-seven percent (27%) of veterinarians underestimated the positive predictive value. Twelve percent (12%) of veterinarians estimated positive predictive value correctly, while 42% of veterinarians overestimated positive predictive
Table 8. Estimation of the positive predictive value of a Johne's ELISA, with 10% prevalence, 50% sensitivity, and 98% specificity

<table>
<thead>
<tr>
<th></th>
<th>Under estimate</th>
<th>Correct</th>
<th>Over estimate</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total (n=277)</td>
<td>73 (27%)</td>
<td>32 (12%)</td>
<td>117 (42%)</td>
<td>55 (19%)</td>
</tr>
<tr>
<td>Have Diagnosed</td>
<td>57 (28%)</td>
<td>21 (10%)</td>
<td>94 (45%)</td>
<td>36 (17%)</td>
</tr>
<tr>
<td>Have Not Diagnosed</td>
<td>15 (23%)</td>
<td>11 (17%)</td>
<td>22 (34%)</td>
<td>16 (25%)</td>
</tr>
</tbody>
</table>

a Data does not conform to a random distribution. (p value = <.0005)

-value. Veterinarians preferentially choose the answer 92% (p value = .005). Nineteen percent (19%) of veterinarians did not respond.

Recommendations Made

Sixty-six percent (66%) of veterinarians routinely discussed the economic impact of Johne's disease with their clients. Forty-eight percent (48%) of veterinarians said Johne's disease could be controlled through management practices alone.

Veterinarians were asked to rate the management recommendations they felt were most important in the control of Johne's disease (Table 9). Culling clinical animals was rated as most important. Closely following were a group of management recommendations including proper colostrum and/or raw milk management, culling test positive animals, reducing the fecal contamination of the environment, calf removal at birth, purchasing animals from herds with a known Johne's status and providing designated clean calving pens. The management practices veterinarians said were least important were pre-purchase testing, acquiring test negative semen, and purchasing only adult animals.
Veterinarians were asked to rate the importance of various transmission routes (Table 10). They rated fecal/oral and milk transmission as most important, followed by vertical transmission, then adult to adult transmission. Transmission through semen was considered the least important.

Table 9. Veterinarian’s ranking of the importance of management practices to control Johne’s disease

<table>
<thead>
<tr>
<th>Management Practice</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culling clinical animals</td>
<td>4.7</td>
</tr>
<tr>
<td>Culling test positive animals</td>
<td>4.4</td>
</tr>
<tr>
<td>Reducing fecal contamination of water feed and environment</td>
<td>4.4</td>
</tr>
<tr>
<td>Colostral and raw milk management</td>
<td>4.4</td>
</tr>
<tr>
<td>Calf removal at birth</td>
<td>4.3</td>
</tr>
<tr>
<td>Purchasing animals from herds with a Johne’s known status</td>
<td>4.3</td>
</tr>
<tr>
<td>Designated clean calving pens</td>
<td>4.2</td>
</tr>
<tr>
<td>Pre-purchase testing</td>
<td>3.8</td>
</tr>
<tr>
<td>Acquiring negative semen</td>
<td>3.0</td>
</tr>
<tr>
<td>Pre-purchasing only adult replacement animals</td>
<td>2.8</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least effective, 5 = Most effective

a, b... Column numbers with the same letters are not significantly different. (α value = .0011)

Table 10. Veterinarian’s ranking of the importance of Johne’s disease transmission routes

<table>
<thead>
<tr>
<th>Transmission Route</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal/oral</td>
<td>4.3</td>
</tr>
<tr>
<td>Milk</td>
<td>4.1</td>
</tr>
<tr>
<td>Vertical</td>
<td>3.5</td>
</tr>
<tr>
<td>Adult to adult</td>
<td>3.0</td>
</tr>
<tr>
<td>Semen</td>
<td>2.6</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least important, 5 = Most important

All column numbers are significantly different. (α value = .005)
Johne's Disease Vaccination

Eighty-one percent (81%) of veterinarians who have vaccinated for Johne's disease indicated the vaccination was effective (Table 11). Seventy-one percent (71%) of veterinarians who have vaccinated for Johne's disease and 9% of veterinarians who have not vaccinated are comfortable recommending the vaccine.

Table 11. Veterinarians' opinions on vaccine use

<table>
<thead>
<tr>
<th>Johne's vaccine was beneficial</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarians (have vaccinated, n= 59)</td>
<td>48 (81%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comfortable recommending the vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have vaccinated (n= 59)</td>
</tr>
<tr>
<td>Have not vaccinated (n= 150)</td>
</tr>
</tbody>
</table>

a p value = <.0005

Veterinarians indicated reducing clinical disease was the most important possible benefits of Johne's vaccination (Table 12). Decreased transmission and increased production were next, followed by an increase in the value of animals. Reducing the need for management changes was regarded as the least important possible benefit of vaccination. Veterinarians who vaccinate believe there is a greater benefit from reducing clinical signs than veterinarians who do not vaccinate. There were no other major differences between veterinarians about the possible benefits of using the vaccine.

Veterinarians regarded the confounding of serology results as the greatest disadvantage of vaccination (Table 13). Reduced marketing options and restrictions on the movement of animals were next, followed by human health risks and decreased value of
vaccinated animals. Veterinarians who do not vaccinate consider "not effective", "cost of vaccination" and "vaccine causes disease" as more important limitations than veterinarians who vaccinate.

Table 12. Possible benefits to vaccination

<table>
<thead>
<tr>
<th></th>
<th>Vets who vaccinate* (SEM)</th>
<th>Vets that do not vaccinate* (SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced clinical signs</td>
<td>4.4 (0.11)</td>
<td>3.8 b, l (0.10)</td>
</tr>
<tr>
<td>Decreased transmission</td>
<td>3.8 a (0.18)</td>
<td>3.8 b,c (0.11)</td>
</tr>
<tr>
<td>Increased production</td>
<td>3.5 a (0.13)</td>
<td>3.5 c (0.10)</td>
</tr>
<tr>
<td>Increased value</td>
<td>2.9 (0.17)</td>
<td>2.6 (0.10)</td>
</tr>
<tr>
<td>Reduced management changes</td>
<td>1.7 (0.14)</td>
<td>1.9 (0.10)</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least important, 5 = Most important

a, b... Column numbers with the same letters are not significantly different. (α value = .005)

l Row numbers that are significantly different. (α value = .05)

Table 13. Possible factors limiting the use of vaccination

<table>
<thead>
<tr>
<th></th>
<th>Vets who vaccinate* (SEM)</th>
<th>Vets that do not vaccinate* (SEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confounds serology</td>
<td>4.2 (0.14)</td>
<td>4.4 (0.07)</td>
</tr>
<tr>
<td>Restricts market options</td>
<td>3.2 a (0.16)</td>
<td>3.5 d (0.10)</td>
</tr>
<tr>
<td>Restricts movement of animals</td>
<td>3.1 a,b (0.15)</td>
<td>3.4 d (0.10)</td>
</tr>
<tr>
<td>Human health risks</td>
<td>2.8 a,b,c (0.17)</td>
<td>3.2 d (0.12)</td>
</tr>
<tr>
<td>Decreased value</td>
<td>2.6 b,c (0.16)</td>
<td>2.8 d (0.10)</td>
</tr>
<tr>
<td>Not effective</td>
<td>2.4 c, l (0.16)</td>
<td>3.4 d,e (0.09)</td>
</tr>
<tr>
<td>Cost of vaccination</td>
<td>2.4 c, l (0.16)</td>
<td>2.8 e,f (0.10)</td>
</tr>
<tr>
<td>Vaccine causes disease</td>
<td>1.6 l (0.15)</td>
<td>2.6 r (0.12)</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least important, 5 = Most important

a, b... Column numbers with the same letters are not significantly different. (α value = .0018)

l Row numbers that are significantly different. (α value = .05)
Regulatory Issues

Forty-seven percent (47%) of veterinarians said they would sign health papers on animals coming from known infected herds (Table 14). Of these, 84% said they would write a statement on a health paper about the status of Johne's disease in the herd. Only 18% of the veterinarians responding to the survey are aware of the Iowa uniform commercial warranty code.

Because of the similarity of questions on the surveys of veterinarians and producers, responses to other regulatory issues from veterinarians are addressed in the producer survey section.

Table 14. Regulatory questions

<table>
<thead>
<tr>
<th>TABLE 14. REGULATORY QUESTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (%)</td>
</tr>
<tr>
<td>Veterinarians who would sign health papers on animals from known infected herds (n=277)</td>
</tr>
<tr>
<td>Veterinarians who would put a statement on the health paper regarding the Johne's status of the herd (n=130)</td>
</tr>
<tr>
<td>Aware of the Iowa uniform commercial warranty code (n=277)</td>
</tr>
</tbody>
</table>

Producers Survey

Profile

The target population included producers who owned herds with a positive diagnostic test for Johne's disease that were reported to the state veterinarian's office. Eighty percent (80%) of producers responding said they knew their herd was diagnosed
with Johne's disease and 19% said they did not know. Eighty-two (82%) said they still own the same herd that was diagnosed with Johne's disease.

Sixty-eight percent (68%) of producers responding to the survey owned dairy cattle, 9% owned commercial beef cattle, 3% owned beef breeding-stock, and 10% owned both dairy and beef cattle (Table 15). Nine percent (9%) of producers did not own cattle at the time of the survey. These producers did not complete the survey.

<table>
<thead>
<tr>
<th>Table 15. Type of cattle herd producers own</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n=297</strong></td>
</tr>
<tr>
<td><strong>Number (%)</strong></td>
</tr>
<tr>
<td>Dairy</td>
</tr>
<tr>
<td>Beef-commercial</td>
</tr>
<tr>
<td>Beef-breeding stock</td>
</tr>
<tr>
<td>Both dairy and beef</td>
</tr>
<tr>
<td>No longer owned a cattle herd</td>
</tr>
</tbody>
</table>

Thirty-nine percent (39%) of producers responding to the survey have owned their cattle herd longer than 20 years, 31% for 10-20 years, 17% for 5-10 years and 12% for 1-5 years (Table 16). Ninety-six percent (96%) of producers have no plans to sell their herd in the near future.

Thirty-one percent (31%) of responding producers have not had a suspect Johne's animal within the last year (Table 17). Twenty-two percent (22%) have had one suspect, 31% have had 2-4 suspects and 13% have had five or more suspects in the last year.
Table 16. Number of years producers have owned their herd

<table>
<thead>
<tr>
<th>n=269</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20+ years</td>
<td>104 (39%)</td>
</tr>
<tr>
<td>10-20 years</td>
<td>84 (31%)</td>
</tr>
<tr>
<td>5-10 years</td>
<td>47 (17%)</td>
</tr>
<tr>
<td>1-5 years</td>
<td>32 (12%)</td>
</tr>
<tr>
<td>&lt;1 years</td>
<td>1 (0.3%)</td>
</tr>
<tr>
<td>No response</td>
<td>3 (1%)</td>
</tr>
</tbody>
</table>

Table 17. Number of suspect Johne's disease cases in the last 12 months

<table>
<thead>
<tr>
<th>n=269</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 suspects</td>
<td>83 (31%)</td>
</tr>
<tr>
<td>1 suspects</td>
<td>60 (22%)</td>
</tr>
<tr>
<td>2-4 suspects</td>
<td>85 (31%)</td>
</tr>
<tr>
<td>5+ suspects</td>
<td>36 (13%)</td>
</tr>
<tr>
<td>No Response</td>
<td>5 (2%)</td>
</tr>
</tbody>
</table>

Educational Needs

Producers receive most of their information about Johne's diseases from publications and from their local veterinarians (Table 18). The third most common source of information was from other producers, followed by extension and university personnel. State or federal regulatory veterinarians were the least common source of information about Johne's disease.
Table 18. Sources of information for producers

<table>
<thead>
<tr>
<th>Source</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publications</td>
<td>3.2^a</td>
</tr>
<tr>
<td>Local veterinarians</td>
<td>3.0^a</td>
</tr>
<tr>
<td>Other producers</td>
<td>1.9</td>
</tr>
<tr>
<td>Extension</td>
<td>1.7^b</td>
</tr>
<tr>
<td>University</td>
<td>1.7^b</td>
</tr>
<tr>
<td>State veterinarian</td>
<td>1.4</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least important, 5 = Most important
^a, ^b: Column numbers with the same letters are not significantly different. (\( \alpha \) value = .0033)

Diagnostic Test Utilization

Eight percent (8%) of producers would discourage other producers from confirming an animal suspected of having Johne's disease (Table 19). Fifteen percent (15%) of producers have had a veterinarian suggest it would be better for them not to obtain a laboratory confirmation of Johne's disease.

Table 19. Producers' views about confirming suspect Johne's disease herds

<table>
<thead>
<tr>
<th>Category</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would discourage others from confirming Johne's disease</td>
<td>21 (8%)</td>
</tr>
<tr>
<td>A veterinarian has discouraged them from confirming Johne's disease</td>
<td>40 (15%)</td>
</tr>
</tbody>
</table>
Knowledge

When producers were asked what would happen if nothing was done to control Johne's disease in their herd, 67% said that the disease would gradually worsen (Table 20). Twelve percent (12%) said that the disease prevalence would stay the same and 4% thought that the prevalence would decrease.

Table 20. Producers' thoughts if no attempt was made to control Johne's disease

<table>
<thead>
<tr>
<th></th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradually worsen</td>
<td>179 (67%)</td>
</tr>
<tr>
<td>Stay about the same</td>
<td>33 (12%)</td>
</tr>
<tr>
<td>Eventually be seen less</td>
<td>11 (4%)</td>
</tr>
<tr>
<td>Do not know</td>
<td>46 (4%)</td>
</tr>
</tbody>
</table>

Producers were asked about the economic impact of Johne's disease in their herd (Table 21). Reduced salvage value had the largest perceived impact, followed by premature slaughter/mortality, lost production, and increased cost of management changes and/or vaccination. Producers said slower genetic improvement and loss of markets had the least economic impact.
Table 21. Producers’ ranking of areas with the most economic impact from Johne’s disease

<table>
<thead>
<tr>
<th>Area</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced salvage value</td>
<td>3.2</td>
</tr>
<tr>
<td>Premature slaughter/mortality</td>
<td>2.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lost production</td>
<td>2.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Increased cost of management changes and/or vaccination</td>
<td>2.7&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Slows genetic improvement</td>
<td>2.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lost markets</td>
<td>2.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least important, 5 = Most important

<sup>a, b</sup>: Column numbers with the same letters are not significantly different. (α value = .0033)

Recommendations/Control Measures

In a "choose all that apply" question, 77% of producers responding to the survey have sold their Johne's disease suspects to slaughter (Table 22). Twenty-four percent (24%) have sold them at an auction market, 6% have retained them in the herd, 5% have destroyed the animals, 2% have changed the ration and 1% have treated them with antibiotics.

Fifty percent (50%) of producers have sold feeder steers or heifers in the last 12 months (Table 23). Forty-two percent (42%) have sold baby calves, 14% have sold replacement heifers, 13% have sold breeding bulls, 12% have sold bred cows, 6% have sold colostrum, and 3% have sold semen in the last 12 months. Producers who vaccinate are less likely to sell replacement heifers than those who do not (p value = .007).
Table 22. How producers handle Johne's disease suspects

<table>
<thead>
<tr>
<th>Action</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sell to slaughter</td>
<td>206 (77%)</td>
</tr>
<tr>
<td>Sell to auction market</td>
<td>65 (24%)</td>
</tr>
<tr>
<td>Retain in the herd</td>
<td>15 (6%)</td>
</tr>
<tr>
<td>Destroy</td>
<td>14 (5%)</td>
</tr>
<tr>
<td>Change diet</td>
<td>5 (2%)</td>
</tr>
<tr>
<td>Treat with antibiotics</td>
<td>3 (1%)</td>
</tr>
<tr>
<td>No response</td>
<td>12 (4%)</td>
</tr>
</tbody>
</table>

Table 23. Producers who have sold animals/animal products in the last 12 months

<table>
<thead>
<tr>
<th>Product</th>
<th>Total (n=269)</th>
<th>Vaccinate (n=72)</th>
<th>Do not vaccinate (n=194)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeder steers or heifers</td>
<td>135 (50%)</td>
<td>37 (51%)</td>
<td>97 (50%)</td>
</tr>
<tr>
<td>Baby calves</td>
<td>114 (42%)</td>
<td>32 (44%)</td>
<td>82 (42%)</td>
</tr>
<tr>
<td>Replacement heifers</td>
<td>38 (14%)</td>
<td>3 (4%)</td>
<td>34 (18%)</td>
</tr>
<tr>
<td>Breeding bulls</td>
<td>35 (13%)</td>
<td>6 (8%)</td>
<td>29 (15%)</td>
</tr>
<tr>
<td>Bred cows</td>
<td>32 (12%)</td>
<td>6 (8%)</td>
<td>26 (13%)</td>
</tr>
<tr>
<td>Semen</td>
<td>9 (3%)</td>
<td>2 (3%)</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>Colostrum</td>
<td>8 (3%)</td>
<td>2 (3%)</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>No response</td>
<td>41 (15%)</td>
<td>13 (18%)</td>
<td>26 (13%)</td>
</tr>
</tbody>
</table>

* Number (%)

a p value = .007

b p value = .17

Sixty-nine percent (69%) of producers purchase breeding cattle, 26% maintain a closed herd. The most common source for purchasing breeding stock is from single source farms of unknown Johne's disease status (Table 24). Test negative herds are the second
Table 24. Where producers purchase their breeding animals

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single source with Unknown Johne's status.</td>
<td>2.2</td>
</tr>
<tr>
<td>Single source from test negative herds</td>
<td>1.8</td>
</tr>
<tr>
<td>Auction markets</td>
<td>1.5^a</td>
</tr>
<tr>
<td>Cattle dealers</td>
<td>1.5^a</td>
</tr>
</tbody>
</table>

* Scale: 1 = Least often, 5 = Most often

^a, b: Column numbers with the same letters are not significantly different. (α value = .0083)

most common, followed by auction markets and cattle dealers. In the survey, the term "sale barn" was used rather than "auction market."

Ninety-four percent (94%) of dairy producers separate calves from adults until the calves are at least six months of age (Table 25). Eighty percent (80%) of all producers keep sick cows isolated from calves. Fifty-seven percent (57%) of dairy producers use free stall barns. Thirty-seven percent (37%) of all producers use the same equipment to handle manure and feed. Thirty-three percent (33%) of all producers keep cows in areas with access to surface water such as ponds. Twenty-five percent (25%) of all producers only provide colostrum or raw milk to calves if it is from cows that have tested negative for Johne's disease. Twenty-three percent (23%) of all producers require a negative Johne's test on all cattle added to the herd. There was no significant difference in any of the above management practices between producers who vaccinate and producers who do not vaccinate.
Johne's Disease Vaccination

Twenty-seven percent (27%) of producers have used Johne's vaccine. Of these, 75% indicated that the vaccine was effective and 8% do not know as they have just started the vaccination program.

Table 25. Management practices used in Johne's disease positive herds

<table>
<thead>
<tr>
<th>Practice</th>
<th>Total Number (%)</th>
<th>Vaccinate&lt;sup&gt;ab&lt;/sup&gt;</th>
<th>Do not vaccinate&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate cows from calves (Dairy producers)</td>
<td>217 (94%)</td>
<td>67 (96%)</td>
<td>150 (93%)</td>
</tr>
<tr>
<td>Sick cows are isolated from calves (All producers)</td>
<td>216 (80%)</td>
<td>60 (83%)</td>
<td>155 (80%)</td>
</tr>
<tr>
<td>Use free stall barns (Dairy producers)</td>
<td>133 (57%)</td>
<td>35 (51%)</td>
<td>97 (60%)</td>
</tr>
<tr>
<td>Same equipment for manure and feed (All producers)</td>
<td>100 (37%)</td>
<td>26 (38%)</td>
<td>63 (39%)</td>
</tr>
<tr>
<td>Cows have access to surface water (All producers)</td>
<td>88 (33%)</td>
<td>17 (24%)</td>
<td>69 (36%)</td>
</tr>
<tr>
<td>Use only colostrum/raw milk from test negative cows (All producers)</td>
<td>66 (25%)</td>
<td>17 (24%)</td>
<td>45 (23%)</td>
</tr>
<tr>
<td>Test new additions to the herd (All producers)</td>
<td>63 (23%)</td>
<td>17 (24%)</td>
<td>45 (23%)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Three producers did not indicate vaccine use.
<sup>b</sup> No significant differences between columns.

Seventy-two percent (72%) of producers responding to the survey do not use Johne's vaccine. When asked why in a "choose all that apply question", 58% said their veterinarian did not recommend the vaccine and 57% were not aware of the program (Table 26). Thirty-six percent (36%) were in the process of a test and removal program,
and 23% said the vaccine was not effective. Eighteen percent (18%) of the producers said the vaccine was too expensive; 8% said the vaccine was too much work; and 4% did not want to do the whole herd tuberculosis test required for the vaccination program.

**Table 26. Reasons why producers are not in the vaccination program**

<table>
<thead>
<tr>
<th>Reason</th>
<th>n=194</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not recommended by veterinarian</td>
<td>112</td>
<td>(58%)</td>
</tr>
<tr>
<td>Not aware</td>
<td>110</td>
<td>(57%)</td>
</tr>
<tr>
<td>Too expensive</td>
<td>35</td>
<td>(18%)</td>
</tr>
<tr>
<td>Too much work</td>
<td>16</td>
<td>(8%)</td>
</tr>
<tr>
<td>Vaccine not effective</td>
<td>45</td>
<td>(23%)</td>
</tr>
<tr>
<td>We are Testing and removing</td>
<td>67</td>
<td>(36%)</td>
</tr>
<tr>
<td>Do not want to TB test</td>
<td>7</td>
<td>(4%)</td>
</tr>
<tr>
<td>No response</td>
<td>2</td>
<td>(1%)</td>
</tr>
</tbody>
</table>

**Regulatory Issues**

Fifty-one percent (51%) of producers surveyed knew laboratories reported positive Johne's diagnoses to the state veterinarian's office. Thirty-two percent (32%) of producers have received notification from the state veterinarian's office regarding the Johne's status of their herd.

**Veterinarian and Producer Regulatory Issues**

Eight-six percent (86%) of producers want the cattle industry to address the Johne's disease problem in this country (Table 27). There was no significant difference between beef or dairy producers regarding cattle industry involvement with Johne's disease. Sixty-
eight percent (68%) of veterinarians want Johne's disease to be a reportable disease while
48% of veterinarians and 23% of producers want Johne's disease to be quarantinable. Beef
producers (43%) were more likely to want Johne's disease to be quarantinable than dairy
producers (19%) (p value <.0005). Producers owning both beef and dairy were not
significantly different than either dairy or beef producers.

Veterinarians and producers were asked if they agreed with a proposed federally
mandated Johne's disease control program that specified a four-year voluntary enrollment
period followed by mandatory enrollment. Fifty-nine per cent (59%) of veterinarians and
21% of producers agreed with this approach (Table 26). Six percent (6%) of veterinarians
and 39% of producers want the program to be voluntary. Seven percent (7%) of
veterinarians and 6% of producers want the program to be totally mandatory, while 15% of
veterinarians and 16% of producers want the program to have a voluntary period longer
than four years. Four percent (4%) of veterinarians and 12% of producers do not want a
program. Six percent (6%) of veterinarians and 7% of producers did not to respond to this
question. Significantly more producers (p< .0005) would rather have a voluntary program
or no program than would veterinarians.
Table 27. Veterinarian and producer response to regulatory questions

<table>
<thead>
<tr>
<th></th>
<th>Cattle industry should address Johne's</th>
<th>Johne's should be reportable</th>
<th>Johne's should be quarantinable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Veterinarians</strong></td>
<td>Not asked</td>
<td>188 (68%)</td>
<td>134 (48%)</td>
</tr>
<tr>
<td>(n=277)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Producers</td>
<td>231 (86%)</td>
<td>Not asked</td>
<td>62 (23%)</td>
</tr>
<tr>
<td>(n=269)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beef Producers</td>
<td>30 (81%)</td>
<td>Not asked</td>
<td>16 (43%)</td>
</tr>
<tr>
<td>(n=37)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy Producers</td>
<td>172 (86%)</td>
<td>Not asked</td>
<td>39 (19%)</td>
</tr>
<tr>
<td>(n=201)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both Dairy and Beef</td>
<td>28 (93%)</td>
<td>Not asked</td>
<td>8 (27%)</td>
</tr>
<tr>
<td>(n=30)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**What kind of federally mandated program?**

<table>
<thead>
<tr>
<th></th>
<th>4 year voluntary then mandatory</th>
<th>Totally voluntary</th>
<th>Totally mandatory</th>
<th>Longer voluntary then mandatory</th>
<th>No program</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Veterinarians</strong></td>
<td>164 (59%)</td>
<td>16 (6%)</td>
<td>20 (7%)</td>
<td>40 (15%)</td>
<td>10 (4%)</td>
<td>17 (6%)</td>
</tr>
<tr>
<td>(n=277)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Producers</strong></td>
<td>55 (21%)</td>
<td>105 (39%)</td>
<td>15 (6%)</td>
<td>42 (16%)</td>
<td>33 (12%)</td>
<td>18 (7%)</td>
</tr>
<tr>
<td>(n=269)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(a,c,d,e\) (p value < .0005)  
\(b\) (p value =.0028)
DISCUSSION

Materials and Methods

The selection of veterinarians for this survey was challenging as it was difficult to determine which of the 1400 veterinarians in Iowa were actively engaged in bovine practice. Options included using the directory of the American Veterinary Medical Association, the list of Iowa veterinarians who precondition cattle, or hand delivery by state and federal veterinary medical officers. The American Veterinary Medical Association (AVMA) directory was rejected because of inaccurate information about location and lack of information about whether veterinarians conduct bovine practice. Using the list of veterinarians who precondition cattle would have led to a significant under-representation of veterinarians who conduct dairy practice. The use of state and federal VMOs offers several advantages. VMOs have an intimate knowledge of the type of practice conducted by veterinarians in their districts. They also have been extensively trained in survey administration because of participation in the National Animal Health Monitoring Service (NAHMS) surveys. It was also felt that hand-delivering the surveys would increase the response rate over a mailed survey.

The producer population was chosen based on positive diagnostic test results reported to the state veterinarian's office during the past five years. Veterinarians provide the name and address of producers to the diagnostic laboratory. The laboratories, in turn, provide this information to the office of the State Veterinarians. Producer names and addresses were not always complete or accurate. Forty-six (46) producers who had been
reported to have Johne's disease infected herds did not have verifiable addresses and were not included in the survey population.

Response Rates

Response rates of veterinarians (62%) and producers (55%) to the survey were consistent with mailed cross-sectional surveys as reported in the medical literature.53 Professionals such as doctors and lawyers typically have a lower response rate than the general public. Hand-delivery of the surveys to veterinarians by state or federal regulatory veterinarians was probably a major reason for a better response rate from veterinarians than from producers.

Profile

A substantial number of veterinarians (75%) surveyed have diagnosed Johne's disease. Information was not obtained about the length of time veterinarians were in private practice or the percent of time devoted to bovine practice. Thus a comparison of the years and/or the amount of bovine practice to the likelihood of diagnosing Johne's disease was not possible.

There are significant regional differences in cattle populations and veterinarians in Iowa. Appendix A displays a map of Iowa divided into regulatory districts. The Northeast region has over 55% of the dairy herds and 12% of the beef herds in the state. In this region, almost 92% of veterinarians have diagnosed Johne's disease. In the Southeast region, which has 5% of the dairy herds and 23% of the beef herds, 72% of veterinarians have diagnosed Johne's disease. In the Southwest region, which has 3% of the dairy herds
and 25% of the beef herds, 62% of veterinarians have diagnosed Johne's disease. The Northeast is the only region where a majority of veterinarians vaccinate for the disease. This most likely reflects the concentration of dairy in that part of the state. Regional variation may also be a factor, as Wisconsin borders the Northeast region and over 300 herds vaccinate in that state.

Nearly 20% of producers responding to the survey were unaware their herd had been diagnosed with Johne's disease. This is surprisingly high. Possible explanations include: submitting veterinarians did not provide producers with diagnostic laboratory results, producers simply forgot the results, producers never understood what disease had been diagnosed, or the State Veterinarian's Office failed to notify the producers. Some veterinarians may have interpreted a positive test such as the Johne's ELISA as a false positive and did not report it to the producer.

Over 85% of producers responding to the survey owned dairy cattle. The State Veterinarian's Office does not have accurate information about which herds were beef or dairy to determine response rates of these two production classes. Only one of the 113 herds currently participating in the vaccination program is a beef operation. Three of the 72 producers responding as having vaccinated for Johne's disease are beef operations.

It should be noted that the majority (70%) of beef and dairy producers have owned their cattle operations for longer than ten years and 96 % of them have no plans to sell their herd in the near future.
Education

An overwhelming majority of veterinarians (82%) feel they need more information about Johne's disease, although 52% have attended Johne's disease continuing education programs in the last two years. It is difficult to determine from the questions asked if veterinarians feel continuing education has been adequate or if there is a more general lack of information known about Johne's disease. Only two percent (2%) of veterinarians did not want continuing education about Johne's disease.

Producers believe they receive as much information about Johne's disease from publications as they do from veterinarians. Several producers commented on the frustration of getting adequate information. Producers were not asked if they felt information they had received about Johne's disease was adequate or accurate.

Diagnostic Test Utilization

Veterinarians prefer to use the ELISA and "clinical observation" to diagnose Johne's disease. "Clinical observation" may be popular because current tests lack sensitivity and clinical signs are fairly diagnostic. Many experts believe that fecal culture is the most sensitive test available, but a six to sixteen week turnaround time from diagnostic laboratories and the expense of conducting the test are probable reasons why fecal culture ranks third as the preferred diagnostic test. The fecal acid-fast stain is the least used test, although it is inexpensive, quick, and can easily be done in a veterinary clinic. This test lacks sensitivity and may be difficult to interpret. Veterinarians use the same approaches to diagnosis whether attempting to make a diagnosis in a herd or in an individual animal.
Several questions were asked about veterinarians and producers avoiding obtaining a definitive diagnosis of Johne's disease. The extent to which avoiding a diagnosis occurs has never been documented. Even though Johne's disease is not reportable for regulatory action in Iowa, veterinary diagnostic laboratories notify state regulatory authorities of a positive diagnosis. Producers may be concerned they will be subject to regulatory action if a Johne’s disease control program is ever instituted. A significant number of veterinarians (27%) have had producers not want to confirm a Johne's diagnosis, and some veterinarians (16%) have recommended producers avoid confirming a Johne's diagnosis.

Producers were also asked questions about avoiding laboratory confirmation of Johne's disease. Seven per cent (7%) of producers would recommend to their neighbors that they not seek a laboratory diagnosis and some producers (14%) have had veterinarians suggest they avoid obtaining a laboratory confirmation. It is important to remember that producers responding to the survey have previously consented to Johne's disease diagnostic testing.

Knowledge

The ELISA is commonly used; therefore, it is important to document and understand how veterinarians interpret ELISA results for Johne’s disease. Sensitivity, specificity, and prevalence have a major impact on diagnostic test interpretation. Appendix B describes how sensitivity, specificity, and positive predictive value are calculated. Positive predictive value is a measure of the reliability of a diagnostic test result. For example, if a test result had a positive predictive value of 90%, the veterinarian would be 90% sure that the positive result was truly positive.
In the survey, twelve percent (12%) of veterinarians correctly determined the positive predictive value of an ELISA with a sensitivity of 50% and a specificity of 98% in a herd with a prevalence of 10%. More veterinarians (42%) overestimated the positive predictive value than underestimated (27%) the positive predictive value. There were five possible answers to this question, 17%, 27%, 33, 71% (correct answer), and 92%. A random guess would result in 20% of veterinarians choosing each answer. Veterinarians selected the answer, 92%, forty-two percent of the time; therefore, there was a statistically significant tendency for veterinarians to over-estimate the positive predictive value of the ELISA.

The most frequently cited reason veterinarians request laboratory diagnostic testing for Johne's disease is to confirm clinical findings. This is a highly defensible use of the currently available diagnostic tests as they are most sensitive when animals are clinically affected with Johne’s disease. Veterinarians request testing least often when producers purchase or sell cattle. This may be a reflection of the poor sensitivity of Johne's diagnostic tests for subclinical animals. Producers are also unlikely (23%) to request pre-purchase testing for Johne's disease.

Nearly half (43%) of veterinarians responding to the survey indicated there is a breed predisposition to developing clinical Johne's disease. Most veterinarians said dairy breeds were more susceptible than beef breeds, with Jerseys and Guernseys commonly mentioned as most susceptible. The beef breed most often mentioned was Shorthorn. Current literature does not support a breed predisposition for susceptibility to Johne's disease, although there are several reports in the literature of a higher prevalence, especially in the Channel Islands breeds (Jerseys and Guernseys).41
Recommendations/Management Practices

Veterinarians indicated management is critical to controlling Johne's disease. Forty-eight percent (48%) said Johne's disease could be controlled through management practices alone. When asked to rank management practices on a scale of one to five according to their importance, veterinarians ranked all management practices high, but there was some differences.

The management practices veterinarians indicated were most important included: culling clinical and test positive animals, reducing fecal contamination of the environment, and colostrum/raw milk management, as they are directly related to transmission. Veterinarians indicated the fecal/oral route of transmission is most important, followed by milk transmission, and then vertical transmission. The literature agrees with the veterinarians.8

Twenty-five percent (25%) of producers use only colostrum/raw milk from test negative cows. One possibility for this low percentage is producers do not test cows on a regular basis. Only thirty-six percent (36%) of producers are involved in a test and removal control program.

Producers were asked to rank the sources where replacement animals are purchased on a scale of one (least likely) to five (most likely). Purchasing replacement animals from farms with unknown Johne's status was the most common, scoring a 2.1. Response scores to this question were low over all, probably because 26% of producers maintain a closed herd.

Producers indicated the greatest economic impact of Johne's disease is "reduced salvage value," closely followed by "premature slaughter or mortality" and "lost
production". This is not consistent with reports in the literature, as lost milk production accounts for 64-84% of dollars lost due to Johne's disease. Reduced salvage value and premature slaughter or mortality account for approximately 16-34% of lost revenue.¹

Producers perceive "loss of markets" as having the lowest economic impact. This is most likely because producers do not change how they market cattle once their herd has been diagnosed with Johne’s disease. Fourteen percent (14%) of producers continue to sell replacement heifers, 13% sell breeding bulls, 12% sell cows, and 6% sell colostrum. In the NAHMS Dairy '96 survey, Johne's positive dairy herds were as likely to sell replacements as Johne's negative herds ¹.

The producers responding to the survey who vaccinate were less likely to sell replacement heifers than producers who do not vaccinate. This is most likely because of limited marketing options for vaccinated heifer. Producers were not specifically asked if they had changed marketing practices or had lost markets once their herd was diagnosed with Johne's disease.

The majority of producers sell Johne's disease suspects to slaughter, but nearly one quarter (24%) have sold them at an auction market. The significance of this is unknown as nearly all Johne's disease suspects sold at auction are sent to slaughter.

Twenty-one percent (21%) of veterinarians use the vaccine for Johne's disease. A high percentage (81%) of these indicated the vaccine is effective. Most veterinarians vaccinating (71%) do not have reservations about recommending its use; this is contrasted by only 9% of veterinarians who do not use the vaccine.

When veterinarians were asked about the possible benefits of Johne's vaccination, there was little difference between those who vaccinate and those who do not vaccinate,
with the exception that veterinarians who vaccinate indicated that "reduced clinical signs" offer a bigger benefit than those who do not vaccinate. Both said the vaccine could not take the place of management changes.

Veterinarians who vaccinate for Johne’s disease view the disadvantages of vaccination differently from those who do not use the vaccine. The largest differences between scores were the factors "the vaccine is not effective", "the vaccine causes disease" and "cost of vaccination" with veterinarians who do not vaccinate viewing these as larger disadvantages.

Seventy-two percent (72%) of producers indicated the vaccine for Johne's disease is effective and 8% do not know, as they have just started to vaccinate. This mirrors the reports in the literature which demonstrate the vaccine decreases clinical Johne's disease.44,45

A concern cited about vaccination is giving producers a "false sense of security".46 In this survey, producers who vaccinate did not differ in management practices from those who vaccinate for Johne's disease. There is also no difference in how animals are marketed with the exception that producers who vaccinate market fewer replacement heifers.

Approximately half of producers (51%) are not aware Iowa has a Johne's disease vaccination program. The most likely reason for this lack of awareness is that local veterinarians do not recommend the vaccine for Johne's disease. This is supported by 58% of producers stating their veterinarians did not recommend Johne's disease vaccination. Furthermore, Iowa State District Veterinarians are encouraged to contact producers in their districts about Iowa's Johne's disease control program when a producer is first diagnosed
with Johne's disease. Only 32% of producers recall being contacted by the State Veterinarian's Office.

Regulatory Issues

A large majority of producers (86%) want the cattle industry to address the Johne's disease problem in the United States. However, they are far more cautious about wanting a federally mandated Johne's disease control program. Approximately half (51%) of producers want a "totally voluntary program" or "no program". This is in contrast to 72% of veterinarians who prefer a "voluntary program, followed by a mandatory program" or a "totally mandatory program".

Sixty-eight percent (68%) of veterinarians want Johne's disease to be reportable, and 48% want Johne's disease to be quarantinable. Again, this is in contrast to producers where only 23% want Johne's disease to be quarantinable. More veterinarians who have never diagnosed Johne's disease (55%) want Johne's disease to be quarantinable than veterinarians who have diagnosed Johne's disease (46%). This may be because veterinarians who have not diagnosed the disease have less understanding and experience with the difficulties of testing for Johne's disease. Similarly, more beef producers (39%) than dairy producers (16%) want Johne's disease to be quarantinable. This may be due to the lower prevalence of Johne's disease in beef than dairy cattle.

Almost half of veterinarians (47%) would sign health papers on animals from known infected herds. Most of these veterinarians (84%) who would sign health papers, however, would put a statement on the health paper regarding the Johne's status of the herd.
Only 18% of veterinarians are aware of the Iowa uniform commercial warranty code, which makes sellers of livestock liable for knowingly misrepresenting the health status of livestock.
CONCLUSION

Summary

Veterinarians requested more information about Johne's disease. Continuing education formats they prefer include written material and meetings. They lack knowledge about diagnostic test interpretation. As an example, the majority over-estimate positive predictive value. Nearly half (43%) of veterinarians said there is a breed predisposition for clinical Johne's disease. A significant number of veterinarians (16%) have suggested that producers avoid obtaining a laboratory confirmation of Johne's disease. Nearly one-third (27%) of veterinarians have had requests from producers to avoid a laboratory confirmation of Johne's disease.

An overwhelming majority of veterinarians and producers who vaccinate indicate the vaccine is effective. Veterinarians indicated they are reluctant to sign health papers on animals originating from *Mycobacterium avium ss paratuberculosis* infected herds, and if they do sign health papers, they are likely to write a statement on the health paper as to the status of the herd.

Johne's disease does not significantly impact marketing options for producers. Within the last 12 months, 10% of owners of infected herds have sold replacement heifers, breeding bulls, and/or bred cows to other producers.

An overwhelming majority of producers want the cattle industry to address the Johne's disease problem in this country, but they are cautious about wanting a mandatory control program. The majority of veterinarians want Johne's disease to be reportable and nearly half want Johne's disease to be quarantinable. Only one-quarter of producers want
Johne's to be quarantinable. Seventy-two percent (72%) of veterinarians versus 38% of producers eventually want a mandatory control program.

**Recommendations**

The cattle industry must assume a leadership role in addressing the Johne's disease problem in this country and Johne's disease control programs must take into account the limitations of current diagnostic tests and producer's reluctance for a mandatory program. Continuing education about Johne's disease for veterinarians needs to be a high priority with an emphasis on informing veterinarians about interpretation of diagnostic tests.

**Future Research**

Veterinarians and producers have a high opinion about the effectiveness of the vaccine for Johne’s disease; therefore, further research about the efficacy of vaccination is needed to confirm clinical observations.

Veterinarians and producers indicated that development of diagnostic tests with improved sensitivity for Johne's disease would be important in control of the disease.

This survey provides information about the knowledge and opinions of veterinarians and producers about Johne's disease. Future studies can measure progress of knowledge and needs of Iowa veterinarians and producers about Johne's disease.
APPENDIX A

IOWA REGULATORY DISTRICTS
Figure 1. Map of Iowa regulatory districts
APPENDIX B

DECISION MAKING WITH DIAGNOSTIC TEST RESULTS
Decision making with diagnostic test results

<table>
<thead>
<tr>
<th>Prevalence</th>
<th>10.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test sensitivity</td>
<td>50.000%</td>
</tr>
<tr>
<td>Test specificity</td>
<td>98.000%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>True</th>
<th>True</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positives</td>
<td>Negatives</td>
<td>Totals</td>
</tr>
<tr>
<td>Prevalence</td>
<td>100</td>
<td>900</td>
<td>1000</td>
</tr>
<tr>
<td>Test sensitivity</td>
<td>50</td>
<td>18</td>
<td>68</td>
</tr>
<tr>
<td>Test specificity</td>
<td>c/d</td>
<td>c+d</td>
<td></td>
</tr>
<tr>
<td>Prevalence:</td>
<td>the proportion of animals in the population that have the disease.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity:</td>
<td>the proportion of animals with the disease who have positive or abnormal test results.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity:</td>
<td>the proportion of animals without the disease who have negative or normal test results.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Positive predictive value  
\[
a/(a+b) = 73.53%
\]

Negative predictive value  
\[
d/(c+d) = 94.64%
\]

Likelihood ratio for a positive test result  
\[
(LR+) = \frac{sens}{1-spec} = 25
\]

Likelihood ratio for a negative test result  
\[
(LR-) = \frac{1-spec}{sens} = 0.04
\]

Pre-test-odds  
\[
\frac{prevalence}{1-prevalence} = 0.1111111 (0.11:1)
\]

Post-test-odds  
\[
(pre-test odds) \times (LR+) = 2.7777778 (2.77:1)
\]

Post-test-probability  
\[
\frac{post-test odds}{(post-test odds+1)} = 73.53%
\]

APPENDIX C
VETERINARY SURVEY

Survey of Iowa Veterinarians about Johne's Disease in Cattle

1. Do you feel the need for more information about Johne's in cattle?
   - Yes
   - No

2. Have you attended any educational presentations on Johne's during the past two years?
   - Yes
   - No

3. What type of educational offering for Johne's would you like to see? Check all that apply.
   - Meetings
   - Iowa Cable Network
   - Written material
   - None

4. Have you ever diagnosed Johne's in a dairy herd?
   - Yes
   - No

5. Have you ever diagnosed Johne's in a beef herd?
   - Yes
   - No

6. When attempting to diagnose Johne's in an INDIVIDUAL animal, which test(s) do you commonly use? (Score on a scale of 1 to 5, with 1 being the least commonly used and 5 the most commonly used.)
   - ELISA
   - PCR (DNA probe)
   - Fecal culture
   - Acid fast stain
   - PPD (skin test)
   - Clinical observation
   - Other (Specify)

7. When attempting to diagnose Johne's in a GROUP of animals, which test(s) do you commonly use? (Score on a scale of 1 to 5, with 1 being the least commonly used and 5 the most commonly used.)
   - ELISA
   - PCR (DNA probe)
   - Fecal culture
   - Acid fast stain
   - PPD (skin test)
   - Clinical observation
   - Other (Specify)
8. Assume that the sensitivity and specificity of the Johne's ELISA test are 50% and 98% respectively. If you test a herd of 100 cows with an estimated 10% prevalence and have 1 ELISA test positive animal, what percent of the time would you estimate that the test has correctly identified the animal?
- Yes
- No

9. The PPD skin test for Johne's has not been commonly used because of its questionable sensitivity and specificity. If these areas are improved, do you feel the PPD skin test could be effectively utilized in your practice?
- Yes
- No

10. Do you feel there are certain breeds of cattle that are predisposed to developing Johne's disease? If yes, what are the clinical signs of Johne's?
- Yes
- No

10. a) Which breed(s)?

11. When do you request laboratory testing for Johne's? Using a scale of 1 to 5, with 1 being the least common reason and 5 the most common reason.

11. a) When clinical signs suggest
- 1
- 2
- 3
- 4
- 5

11. b) When purchasing animals
- 1
- 2
- 3
- 4
- 5

11. c) When selling animals
- 1
- 2
- 3
- 4
- 5

11. d) At owner's request
- 1
- 2
- 3
- 4
- 5

11. e) When problem becomes severe
- 1
- 2
- 3
- 4
- 5

11. f) Other (Specify)

12. Have you ever had an owner request that you avoid making a definitive laboratory diagnosis for Johne's?
- Yes
- No

13. Have you ever avoided acquiring a definitive laboratory diagnosis for Johne's to minimize client complications?
- Yes
- No

14. How often do you see the following clinical signs associated with Johne's? (Score on a scale of 1 to 5, with 1 never, 2 rarely, 3 commonly, 4 frequently, 5 almost always.)

14. a) Diarrhea
- 1
- 2
- 3
- 4
- 5

14. b) Pneumonia
- 1
- 2
- 3
- 4
- 5

14. c) Bloody diarrhea
- 1
- 2
- 3
- 4
- 5

14. d) Chronic wasting
- 1
- 2
- 3
- 4
- 5

14. e) Loss of appetite
- 1
- 2
- 3
- 4
- 5

14. f) Fever
- 1
- 2
- 3
- 4
- 5

14. g) Other (Specify)
15. In general, do you advise that the milk productivity of a cow that tests positive for Johne's will...?
- [ ] 1. not be affected significantly.
- [ ] 2. be slightly decreased.
- [ ] 3. be reduced by less than 500 lbs. per lactation.
- [ ] 4. be reduced by 1400 lbs. per lactation.

16. Do you routinely discuss the economic impact of Johne's with your clients who have Johne's infected herds?
- [ ] Yes
- [ ] No

17. Indicate how significantly the following items are affected by Johne's, when 1 means least significantly affected and 5 means most significantly affected.

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. a) Reduced milk production</td>
<td></td>
<td></td>
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<tr>
<td>17. b) Increased culling rate</td>
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<td>17. c) Lost genetics</td>
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<tr>
<td>17. d) Reduced marketing opportunities</td>
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</tr>
<tr>
<td>17. e) Reduced feed efficiency</td>
<td></td>
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<td></td>
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<tr>
<td>17. f) Reduced reproduction</td>
<td></td>
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<tr>
<td>17. g) Other (Specify)</td>
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</tbody>
</table>

18. How important is each of the following management practices in controlling Johne's. Use a scale of 1 to 5, with 1 the least important and 5 most important.

<table>
<thead>
<tr>
<th>Practice</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. a) Colostral and raw milk management</td>
<td></td>
<td></td>
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<tr>
<td>18. b) Calf removal at birth</td>
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<td>18. c) Culling test positive animals</td>
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<tr>
<td>18. d) Culling clinical animals</td>
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<tr>
<td>18. e) Pre-purchase testing</td>
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<tr>
<td>18. f) Acquiring negative semen</td>
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<tr>
<td>18. g) Reducing fecal contamination of water, feed and environment</td>
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<tr>
<td>18. h) Maintaining designated, clean calving pens</td>
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<tr>
<td>18. i) Purchasing only adult replacement animals</td>
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<tr>
<td>18. j) Purchasing animals from herds with a Johne's known status</td>
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<td></td>
</tr>
</tbody>
</table>

19. Do you feel Johne's can be controlled within a herd through management practices alone?
- [ ] Yes
- [ ] No
20. How important is it to discuss each of the following types of TRANSMISSION with your client? Use a scale of 1 to 5, with 1 being the least important and 5 the most important.

<table>
<thead>
<tr>
<th>Type of Transmission</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Horizontal (adult to adult)</td>
<td></td>
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<tr>
<td>b) Vertical (in-utero or mother to calf)</td>
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<tr>
<td>c) Colostral/raw milk</td>
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<td></td>
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<tr>
<td>d) Fecal/oral</td>
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<td></td>
</tr>
<tr>
<td>e) Semen</td>
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</tr>
<tr>
<td>f) Other (Specify)</td>
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</tr>
</tbody>
</table>

21. Have you participated in a Johne's vaccination program?  
- Yes  
- No

22. Do you feel comfortable in recommending a Johne's vaccination program?  
- Yes  
- No

23. In your professional opinion rate the possible benefits obtained through a Johne's vaccination program? Use a scale of 1 to 5, with 1 being the least beneficial and 5 most beneficial.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Reduce clinical signs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Increase production</td>
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<tr>
<td>c) Decreased transmission of disease with the herd</td>
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<tr>
<td>d) Reduce need for management changes</td>
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<tr>
<td>e) Increase animal's value</td>
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<td></td>
</tr>
<tr>
<td>f) Other (Specify)</td>
<td></td>
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</tr>
</tbody>
</table>

24. Rate the possible limiting factors of a Johne's vaccination program, with 1 being the least limiting and 5 the most limiting.

<table>
<thead>
<tr>
<th>Limiting Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Serologically distinguishing between infected and vaccinated animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Vaccine is not effective</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Vaccine may cause disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>d) Human health risks from the vaccine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Decreases the value of vaccinated animals</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>f) Restricts the movement of cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
24. g) Restricts market options for vaccinated animals
   □ 1 □ 2 □ 3 □ 4 □ 5

24. h) Cost of a vaccination program
   □ 1 □ 2 □ 3 □ 4 □ 5

24. i) Other (Specify)

25. Do you feel Johne's should be a reportable disease?
   □ Yes □ No

26. Do you feel cowherds that contain Johne's culture positive cows should be quarantined?
   □ Yes □ No

27. A National Johne's control program has been proposed to include a 4 year voluntary time period, followed by a mandatory federally regulated program. Do you agree with this approach?
   □ Yes □ No

27. a) If no, would you prefer a...?
   □ Total voluntary program
   □ Total mandatory program
   □ Mandatory program after a longer voluntary program
   □ No program

28. If you have made a definitive diagnosis of Johne's in a cattle herd, would you provide health papers for animals originating from that herd?
   □ Yes □ No

28. a) If yes, would you provide a disease statement on the Johne's status of the herd?
   □ Yes □ No

29. Are you aware of the Iowa uniform commercial warranty code?
   □ Yes □ No

THANK YOU FOR YOUR COOPERATION.
# APPENDIX D
## PRODUCER SURVEY

**Survey of Iowa Cattle Producers about Johne's Disease**

**Iowa State Veterinarian’s Office**
**Animal Health Information Network**

This survey is coded for tracking purposes only. Individual results will remain strictly confidential and cannot be traced back to any producer.

### Mark your answers in the appropriate boxes as demonstrated below.

1. Are you aware that all herds diagnosed positive for Johne's (pronounced Yoh-knees) Disease by laboratory confirmation are reported to the state veterinarian's office?
   - Yes
   - No

2. Are you aware that you previously had a cow herd diagnosed with Johne's?
   - Yes
   - No

3. Did you ever receive any notification from a state veterinarian regarding the Johne's diagnosis in your herd?
   - Yes
   - No

4. Do you own any cattle at this time?
   - Yes
   - No

If you DO NOT own cattle you have completed the necessary questions for this survey. Thank you for your cooperation.

If you OWN a cow herd please continue......

5. What type of herd do you own?
   - Dairy
   - Beef-commercial
   - Beef- sell breeding stock
   - Both Dairy and Beef

6. Do you still own the same herd diagnosed with Johne's?
   - Yes
   - No

7. What is the AVERAGE age of the cows in your current herd?
   - 2-4 yr.
   - 4-6 yr.
   - 7+ yr.
   - Do not know

8. How many years have you owned this herd?
   - Less than 1 year
   - 1-5 years
   - 5-10 years
   - 10-20 years
   - Greater than 20 years

9. Do you plan to continue ownership of this herd?
   - Yes
   - No

10. How many animals have shown symptoms of Johne's in your herd during the past 12 months?
    - 1 suspected animal
    - 2-4 suspected animals
    - 5 or more suspected animals
    - no suspected animals
11. When you suspect an animal of having Johne's disease, what do you do? (Choose all those that apply)
   - Sell to slaughter
   - Treat with antibiotics
   - Destroy
   - Change diet
   - Sell to sale barn
   - Retain in the herd

12. How frequently do you get information on Johne's Disease from the following sources? (Score these on a scale of 1 to 5: 1 never, 2 rarely, 3 sometimes, 4 often, 5 always)

<table>
<thead>
<tr>
<th>Source</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>12a. State Veterinarian</td>
<td></td>
</tr>
<tr>
<td>12b. A practicing veterinarian</td>
<td></td>
</tr>
<tr>
<td>12c. Extension</td>
<td></td>
</tr>
<tr>
<td>12d. Publications/Magazines</td>
<td></td>
</tr>
<tr>
<td>12e. University</td>
<td></td>
</tr>
<tr>
<td>12f. Other producers</td>
<td></td>
</tr>
<tr>
<td>12g. Other (Specify)</td>
<td></td>
</tr>
</tbody>
</table>

13. If you do not attempt to control Johne's disease in your herd, with time, do you believe the disease would:
   - Eventually be seen less?
   - Stay about the same?
   - Gradually worsen?
   - Don't know.

14. Are you aware that there is a state Johne's vaccination program available for infected herds?
   - Yes
   - No

15. Have you ever used Johne's vaccination in your herd?
   - Yes, please go to question 15 a.
   - No, please go to question 17.

16. If you are CURRENTLY participating in the Iowa Johne's vaccination program, how is the vaccine being used? (Choose one response)
   - Vaccinating ALL calves between 1-35 days of age
   - Vaccinating ONLY heifer calves between 1-35 days of age.
   - Vaccinating ONLY REPLACEMENT heifer calves between 1-35 days of age.
   - None of the above

17. If you are NOT participating in the Iowa Johne's vaccination program, mark all reasons that reflect your reasons for not vaccinating.
   - Not aware of the program
   - Not recommended by veterinarian
   - Too expensive
   - Too much work
   - Vaccine is not effective
   - Are testing and removing positive animals
   - Do not want to test herd for tuberculosis
   - None of the above

18. Do you buy bulls, cows, springing heifers, or calves?
   - Yes
   - No
19. How frequently do you usually get replacement animals from the following sources? (Score these on a scale of 1 to 5: 1 never, 2 rarely, 3 sometimes, 4 often, 5 always.)

19 a. Single source farm tested negative for Johne's Disease
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19 b. Single source farm sales of unknown Johne's status
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19 c. Cattle dealers
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19 d. Sale barns
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

19 e. Other (Specify)

20. During the past 12 months, have you sold any of the following? (Choose ALL that apply)

☐ feeder steers or heifers ☐ colostrum
☐ baby calves ☐ replacement heifers
☐ breeding bulls ☐ bred cows
☐ semen

21. Do you separate calves from adults until the calves are at least 6 months of age?
☐ Yes ☐ No

22. Do you use the same equipment to handle manure and feed?
☐ Yes ☐ No

23. Do you use free stall barns?
☐ Yes ☐ No

24. Do your cows have access to surface water, such as ponds?
☐ Yes ☐ No

25. Are sick cows isolated in a pen where calves do not have access?
☐ Yes ☐ No

26. If you provide colostrum or raw milk for your calves, is it from cows that have tested negative for Johne's Disease?
☐ Yes ☐ No ☐ Do not know

27. If you ARE testing for Johne's in your herd are you...(Choose ALL that apply)

☐ testing all adult animals annually
☐ testing only suspect animals
☐ removing all positive animals
☐ removing offspring of positive cows
☐ testing a certain percent of the adults

28. Do you require a negative Johne's test on all cattle added to your cowherd?
☐ Yes ☐ No

29. To control Johne's, would it be possible for you to split and manage your cowherd in a young (<7 years old) and an old (>7 years old) herd?
☐ Yes ☐ No

30. Mark the level at which you feel Johne's impacts the economics of your herd. (Score on a scale of 1 to 5, with 1 being very little impact and 5 extremely high impact)

30 a. Lost markets (sale of replacement animals)
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

30 b. Lost production (milk production, reproduction efficiency, calf weight)
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

30 c. Cow/bull death loss or premature slaughter
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

30 d. Slows genetic improvement
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
30 e. Reduced salvage value

☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

30 f. Increased cost of management changes and/or vaccination

☐ 1  ☐ 2  ☐ 3  ☐ 4  ☐ 5

31. Would you discourage other producers from confirming a suspected Johne's problem in their herd?

☐ Yes  ☐ No

32. Has a veterinarian ever suggested that it would be better for you not to obtain laboratory confirmation of a suspected Johne's problem?

☐ Yes  ☐ No

33. Do you feel Johne's positive herds should be quarantined?

☐ Yes  ☐ No

34. Do you feel the cattle industry should address the Johne's disease problem in this country?

☐ Yes  ☐ No

35. A National Johne's control program has been proposed to include a 4 year voluntary time period, followed by a mandatory federally regulated program. (Choose one response)

☐ I agree with the proposed program

☐ I would prefer a totally voluntary program

☐ I would prefer a totally mandatory program

☐ I would prefer a mandatory program after a longer voluntary period

☐ I prefer no program

THANK YOU FOR YOUR COOPERATION.
REFERENCES


