PEER REVIEWED

# A description of infectious bovine keratoconjunctivitis outbreaks in West Virginia beef herds

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**Abstract**

Infectious bovine keratoconjunctivitis (IBK) is the most important ocular disease of cattle. Prevention and control of the disease can prove challenging, and the list of potential etiologic agents has expanded in recent years. Little has been recently published characterizing IBK outbreaks at the herd level. This case series investigation was conducted to describe the disease characteristics and management practices in herds affected by IBK outbreaks in 1 practice area in West Virginia in 2019. Seven producers were interviewed: 6 cow-calf producers and 1 stocker producer. Producers were asked questions pertaining to disease severity and management, such as herd health protocols and husbandry. In addition, organisms from each of the herds were identified by culture and/or PCR. Results revealed a range of disease incidence as well as similarities and differences in management practices among herds. The interpretability of results is limited due to small sample size and data collection method; however, results suggest that some herds in the area where producers were interviewed experienced severe IBK outbreaks, and that some management practices relevant to IBK were similar between herds. Results also suggest that further study to identify poorly characterized IBK risk factors is warranted.

**Key words:** IBK, infectious bovine keratoconjunctivitis, pinkeye

## Introduction

Infectious bovine keratoconjunctivitis (IBK) is a worldwide ocular disease of cattle,[3] often occuring in seasonal and geographic outbreaks. Large differences in incidence have been reported between outbreaks, with some reaching 90%.[3,5,20,22,27] The highest incidence of disease occurs in summer months.[5,15,27] IBK is often described as being associated with corneal ulceration, eyelid and conjunctival edema, and signs of pain, including excessive lacrimation and photophobia.[1,4,7] Mild cases of IBK may resolve spontaneously; however, acute infections can lead to permanent ocular damage and blindness.[5] Several risk factors for IBK, such as exposure to tall vegetation and dust, have been suspected, but little controlled research has confirmed the importance of specific risk factors.[19] The rationale for these suspicions is founded in the idea that these factors lead to corneal damage in the same manner as confirmed risk factors, such as flies and UV radiation.[5,12,13] Flies, such as the house fly (*Musca domestica*), the barn fly (*Stomoxys calcitrans*), and the face fly (*Musca autumnalis*) may be involved in transmission of the pathogens that cause IBK.[5] The face fly, *Musca autumnalis*, in particular, has many traits that lend evidence to its role as a vector for IBK.[14,23] IBK has also been associated with vaccination for infectious bovine rhinotracheitis (IBR).[27] Calves treated with a modified-live IBR vaccine can have enhanced IBK when infected with *Moraxella bovis*.[10]

Infectious bovine keratoconjunctivitis is considered the most important ocular disease in cattle due to its negative impact on production. Affected calves often have lighter weaning weights and yearling weights, and decreased rib backfat and rib eye area compared to healthy cattle, even at finishing.[9,22] Calf prices are often discounted when sold with corneal scarring from past episodes of IBK (IJS, personal observations). Management and control of IBK often relies on antimicrobials, due perhaps in part to demonstrated ineffectiveness of both commercial and farm-of-origin autogenous vaccines.[6,8,17] In 2007, the National Animal Health Monitoring System (NAHMS) found IBK to be the second most common reason for preweaned calves or heifers to be treated with antimicrobials.[25] The importance of antimicrobials in the management of IBK means that the disease is likely a significant contributor to generation of antimicrobial resistance on beef operations.

In the past, *Moraxella bovis* was considered the sole causative agent of IBK.[5] However, there is now evidence suggesting the etiology of IBK could be more complicated, with other apparently contributing agents including *Moraxella bovoculi*, *Mycoplasma bovis*, and *Mycoplasma bovoculi*.[16] However, the exact role that each of these agents plays has been difficult to determine.[2,18]

The capacity of IBK to reduce productivity of beef cattle, new questions about its pathogenesis, and the impactful and costly antimicrobial treatments used to manage IBK warrant updated disease characterization. One of the co-authors of this paper (IJS) has anecdotally noted increases in incidence and severity of IBK in his practice area in recent years, sometimes in the absence of previously described and theorized risk factors. Therefore, the objective of this investigation was to characterize the clinical signs of IBK and management practices of herds that have experienced IBK outbreaks within a single region in West Virginia in 2019.

## Materials and Methods

*Herd Selection Criteria*

Herds selected for study inclusion were clients of a single veterinary practice in West Virginia. Names of participating producers and their farms were kept confidential, and thus Institutional Review Board approval was not required for this investigation. These herds were managed by producers who felt that the IBK in their herd was severe enough to warrant ocular diagnostic testing. Therefore, with the help of the supervising veterinarian (IJS), all herds surveyed in this case series submitted eye swab samples for culture when they experienced an outbreak of IBK. These herds had laboratory-confirmed identification of *Moraxella bovis*, *Moraxella bovoculi*, *Mycoplasma bovis*, and/or *Mycoplasma bovoculi* in 1 or more eye swab samples collected in 2019. Diagnostic testing was completed at either the Nebraska Veterinary Diagnostic Center (Lincoln, NE), the California Animal Health and Food Safety Laboratory (Davis, CA), or Cambridge Technologies (Worthington, MN).

*Phone Questionnaire and Interviews*

A questionnaire was designed to gather data by phone interviews with producers from enrolled herds. The questionnaire was pretested by interviewing 3 individuals who own cattle or are familiar with cattle management. The questionnaire included categories of questions concerning herd demographics, number and age of animals observed with IBK, number and age of animals treated for IBK, vaccination protocol, treatment protocol, use of fly control, animal environment, and general herd management. Once the questionnaire was completed, producers were interviewed in the summer of 2020 using the questionnaire to collect information about their herds. In the interview, IBK was referred to as "pinkeye" and was defined as "…a watery or tearing eye, a white spot on the eye, or an entirely white, pink or red eye. This does not include any cases that you know had injury to the eye, had an object stuck in the eye, or had cancer eye." A "heifer" was defined as "…an approximately 10- to 24-month-old female that has not calved." All interviews were conducted by the same investigator (CHG). If producers indicated that they had multiple groups of cattle on their operation, they were asked to answer questions only about the group most affected by pinkeye. The questionnaire is included in this manuscript as Appendix A.

*Organism Identification*

Culture and PCR data taken from eye swabs of cattle from each herd were used to compile a qualitative description of organisms identified in cattle with IBK lesions within each herd. The microbiological data described here were collected to characterize disease in the herds and to support creation of autogenous vaccines, not for research purposes. Thus, not all herds were tested for all agents possibly related to IBK by all possible methods. Samples were submitted to 1 of 3 different laboratories for identification of *Moraxella bovis*, *Moraxella bovoculi*, *Mycoplasma bovis*, and/or *Mycoplasma bovoculi*.

## Results

*Herd Characteristics*

Information was obtained from 7 herds, including 6 cow-calf herds and 1 stocker herd. Results from cow-calf herds will be presented separately from the stocker herd due to the differences in these types of operations. Information regarding herd sizes and IBK incidence is summarized for the cow-calf herds in Table 1. Of the 6 cow-calf operations, only herd D calved in the spring and fall while the other 5 herds calved primarily in the spring. The total number of cattle in each herd ranged from 36 to 1,030, with a median of 165.

**Table 1.** Number of cattle diagnosed with IBK out of the total number at risk (%) in 6 West Virginia cow-calf herds in 2019.

| Herd | Calves (%) | Mature cattle* (%) | Total herd (%) |
|---|---|---|---|
| A | 18/18 (100) | 17/18 (94) | 35/36 (97) |
| B | 40/108 (37) | 60/114 (53) | 100/222 (45) |
| C | 60/130 (46) | 40/146 (27) | 100/276 (36) |
| D | 75/375 (20) | 75/505 (15) | 150/880 (17) |
| E | 29/180 (16) | 6/245 (2) | 35/425 (8) |
| F | 30/500 (6) | 10/530 (2) | 40/1030 (4) |
| Median (%) | 28.5 | 21.1 | 26.6 |
| Mean (%) | 30.9 | 32.3 | 34.6 |
| SD | 30.9 | 32.7 | 31.6 |

*Bulls, cows, and heifers combined

The affected group of cattle that was the focus of data collection for Herds D and E included heifers; the affected group included bulls in all but herd A.

*Disease Characteristics in Cow-Calf Herds*

The cumulative incidence of IBK by herd is shown in Table 1, ranging from 4% to 97%. The incidence in mature cattle was higher than in calves in 1 out of the 6 herds. Herd size and IBK incidence were inversely related (Spearman's ρ= -0.94; $P = 0.017$). The percent of cases per herd with bilateral IBK ranged from 0% to 22%, with a median of 10%. The incidence of cases per herd with prolapsed eyes ranged from 0% to 20%, with a median of 4%. The percent of IBK cases per herd that occurred in first-calf cows ranged from 5% to 49%, with a median of 11%; all but herd F had cases of IBK that required more than 1 treatment. The temporal distribution of IBK in the herds is shown in Figure 1. The earliest case observed by any of the herds was in February and the latest case observed was in December, while 4 of 6 herds observed the most cases of IBK in June. The organisms identified from each herd are shown in Table 2.

*Cow-calf Herd Health Management*

Prophylactic medication for IBK was not administered to cattle in any of the study herds. Cattle in 3 of the 6 herds received a commercial IBK vaccine, which was given in April and May, and cattle in 2 of these herds were administered booster vaccinations. Cattle in all herds except herd B received an autogenous IBK vaccine, which was given in April and May, and 3 of these herds revaccinated cattle with the same vaccine. All herds utilized modified-live virus respiratory vaccines as part of their health program. All producers treated at least some of the IBK cases they observed; some treatments were extralabel. The percent of IBK cases in calves and mature animals that were treated is shown in Table 3. Cattle in all herds received antimicrobials as treatment for IBK cases (Table 4): tulathromycin (herds A, C, D, E, F); florfenicol (herds D, F); tetracycline (herds B, C, D); and penicillin (herd B). Except for those cattle in herd A, cattle were administered antimicrobials via the subcutaneous route. Cattle in herd B received antimicrobials via both subcutaneous and intramuscular routes, cattle in herd A received antimicrobials via the intramuscular route, cattle in

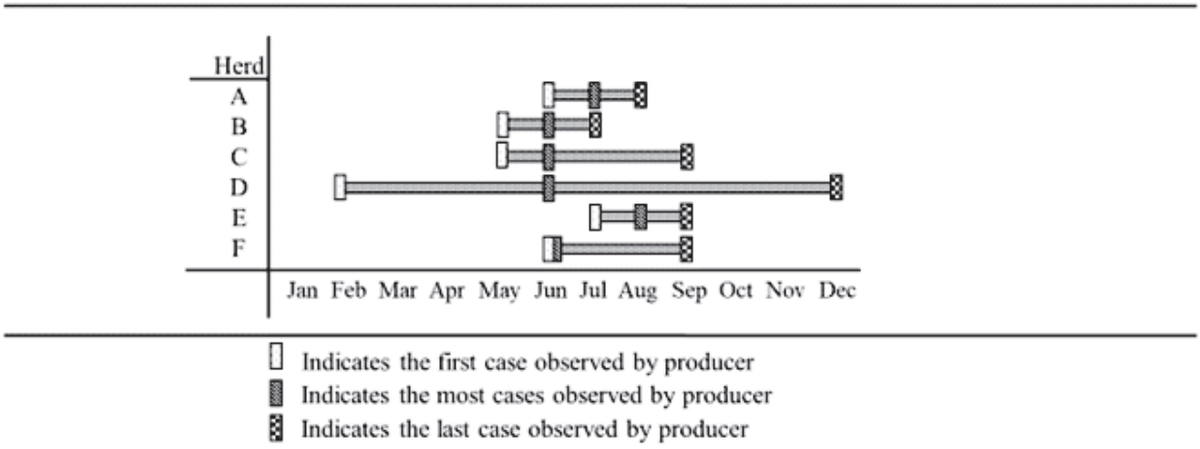


**Figure 1.** The temporal distribution of IBK cases in 6 West Virginia cow-calf herds during 2019.

**Table 2.** Organisms identified in eye swab samples from at least 1 animal in 6 West Virginia cow-calf herds that experienced an outbreak of infectious bovine keratoconjunctivitis during 2019.*

| | ***Moraxella bovis*** | | ***Moraxella bovoculi*** | | ***Mycoplasma* spp** | ***Mycoplasma bovis*** | ***Mycoplasma bovoculi*** |
|---|---|---|---|---|---|---|---|
| **Herd** | **Culture** | **PCR** | **Culture** | **PCR** | **Culture** | **PCR** | **PCR** |
| A | YES | NO | YES | YES | NO | NO | YES |
| B | YES | - | YES | - | - | - | - |
| C | NO | YES | YES | NO | NO | NO | YES |
| D | YES | YES | YES | YES | YES | NO | YES |
| E | YES | YES | YES | YES | - | NO | YES |
| F | NO | - | YES | - | - | - | - |

* blank cells indicate that the test was not done

**Table 3.** Percent of IBK cases treated in calves, mature cows, and all cattle, and vaccine use, in 6 West Virginia cow-calf herds that experienced an outbreak of infectious bovine keratoconjunctivitis (IBK) during 2019. All but herd B used an autogenous IBK vaccine.

| Herd | Percent of calf cases treated | Percent of mature cases treated | Percent of all cases treated | Use of commercial vaccine | Commercial vac booster | Autogenous vac booster |
|---|---|---|---|---|---|---|
| A | 18/18 (100) | 17/17 (100) | 35/35 (100) | NO | N/A | YES* |
| B | 40/40 (100) | 60/60 (100) | 100/100 (100) | YES | NO | N/A |
| C | 60/60 (100) | 20/40 (50) | 80/100 (80) | NO | N/A | NO |
| D | 10/75 (13) | 5/75 (7) | 15/150 (10) | NO | N/A | NO |
| E | 20/29 (69) | 0/6 (0) | 20/35 (57) | YES | YES | YES |
| F | 20/30 (66) | 0/10 (0) | 20/40 (50) | YES | YES | YES |
| Median (%) | 84.5 | 28.3 | 68.6 | | | |
| Mean (%) | 74.8 | 43.8 | 66.2 | | | |
| SD | 31.0 | 45.2 | 31.6 | | | |

*Herd A only revaccinated calves.

**Table 4.** Medications reportedly administered to at least some cattle affected with infectious bovine keratoconjunctivitis in 6 West Virginia cow-calf herds that experienced outbreaks during 2019.

| Herd | Non-antibiotic medications | Antibiotic medications |
|---|---|---|
| A | none | tulathromycin* |
| B | flunixin meglumine, dexamethasone | tetracycline, penicillin |
| C | none | tulathromycin, tetracycline |
| D | none | tulathromycin, tetracycline, florfenicol† |
| E | dexamethasone | tulathromycin |
| F | dilute hypochlorous acid (0.015%)‡ | tulathromycin, florfenicol |

*DRAXXIN®, Zoetis Inc., Kalamazoo, MI
†Nuflor®, Merck Animal Health, Madison, NJ
‡Vetricyn Plus® Antimicrobial Pinkeye Spray, Innovacyn, Inc., Rialto, CA

herds B and C received antimicrobials via spray application directly in the eye, and cattle in herd D received antimicrobials via a subconjunctival route (routes were not mutually exclusive among herds). Cattle in half of the herds received medications other than antimicrobials that included dexamethasone, flunixin meglumine, and a commercial pinkeye spray containing dilute hypochlorous acid (Table 4). Cattle in all herds were treated while restrained in a cattle chute; herd A also administered medication to cattle via a dart gun. Some treatments administered were extralabel.

*Use of Fly Control in Cow-calf Herds*

All but herd B used a form of fly control. Four of the 6 herds received pour-on fly control; all cattle in herds A, E, and F received pour-on fly control, and 25% of animals in herd D received pour-on fly control. Only cattle in herd F received fly tags for fly control. Other forms of fly control used by producers included rubs (herds A and C) and a feed-through insect growth regulator in the mineral (herds A and F).

*Cow-calf Herd Husbandry and Environment*

Year-round mineral supplementation was provided in all cow-calf herds, with 5 herds receiving a free-choice complete mineral and 4 herds receiving salt in the mineral. All herds had access to shade and a water trough, and herds B-F also had access to both a stream and pond. Cattle in herd A were fed in a bunk; herd B used a creep feeder; herd C used a trough, creep feeder and a bunk; herd D used both a trough and a bunk; and herd E only used a trough. Herd F did not feed cattle in any kind of feeder. Cattle in all herds were fed hay, and all cattle except those in herd C were fed hay using a hay ring. All herds grazed grass and all herds rotated through pastures; however, only herd B rotated pastures at least twice a week. Four of the 6 herds utilized stockpile grazing. Cattle in 4 of the 6 herds grazed grass that had been fertilized with chicken litter within the previous 2 years. Half the producers mowed pastures on their farms, and herds C, E, and F grazed in a pasture that shared a fence with a different farm. The grazing area herds had access to ranged from 100 to 4000 acres (median, 1300 acres). None of the cow-calf herds spent more than a day in a barn during 2019, and only half of the herds spent any time in a dirt lot. Selected management practices among herds are summarized in Table 5.

*Stocker Herd*

Herd G was a stocker herd with a capacity of 275 animals at the time of the interview, but had 830 animals on the farm over the course of 2019. Cattle in this herd were between

**Table 5.** Management practices reported by 6 West Virginia cow-calf herds that experienced an outbreak of infectious bovine keratoconjunctivitis during 2019.

| Herd | Stockpile grazing | Fertilized with chicken litter | Mowed grass | Spent time in dirt lot | Shared a fence with a neighbor |
|---|---|---|---|---|---|
| A | YES | NO | YES | YES | NO |
| B | YES | YES | NO | NO | NO |
| C | NO | YES | NO | NO | YES |
| D | NO | NO | YES | NO | NO |
| E | YES | YES | NO | YES | YES |
| F | YES | YES | YES | YES | YES |

weaning age and 2 years of age. A total of 222 (27%) animals were observed with IBK in 2019. Nine IBK cases were bilateral, and no cases were observed with a prolapsed cornea. The operation experienced its first case of IBK in January and its last case in October. The number of cases peaked in June. Culture of ocular swabs collected from affected cattle in the stocker herd yielded *Moraxella bovoculi.* Ocular swabs tested by PCR were positive for *Moraxella bovis*, *Moraxella bovoculi*, and *Mycoplasma bovoculi*; PCR testing for *Mycoplasma bovis* was negative. Cattle on this operation did not receive prophylactic medication for IBK, but were vaccinated with a commercial and also an autogenous IBK vaccine without administration of a booster vaccination. They also were vaccinated with a modified-live virus respiratory vaccine. Calves diagnosed with IBK were treated with tulathromycin subcutaneously while restrained in a cattle chute. This operation did not use any form of fly control. Cattle received a free-choice complete mineral mix year-round. They were housed in an 18,000 $ft^2$ (1672 $m^2$) barn for the entire time they were present on the farm. Water was supplied via a water trough, and baleage was provided in a bunk. These animals did not graze grass at any time while on the farm.

## Discussion

Although this study included only a small number of herds, it provides a relatively detailed description of IBK as currently experienced by beef cattle producers in 1 US state. Many of the disease characteristics described here are consistent with previous characterizations of IBK; however, some were not. For example, 1 cow-calf herd and the stocker herd experienced IBK in winter months, even though the disease is commonly described as a summer disease.[5,15,27] Cattle in the stocker herd were housed in a barn, so neither tall grass or flies would have contributed to the winter IBK cases on that operation. While the findings of this study come from herds in only 1 practice area of 1 state, and thus may not represent herds in other parts of the country, they emphasize the concept that factors contributing to IBK risk on some farms are not clearly defined.

There was a wide range of cumulative IBK incidence in the herds in this study, with the highest cumulative incidence reaching 97%. This wide range of incidence is similar to herds described historically, where IBK incidence has been reported to range from 1% to 90%.[3,22,27] Contrary to past descriptions of IBK,[5,21,27] 1 herd experienced a higher incidence in mature animals than in calves. The strong and statistically significant (P=0.017) inverse relationship between herd size and IBK incidence found here was noteworthy. This finding may relate to easier identification of IBK in small herds; alternatively, it may be that other risk factors related to small herd size contribute to IBK incidence.

Although fly control was practiced in all cow-calf herds except herd B, 3 herds (A, C, and D) nonetheless had a relatively high (> 10%) incidence of IBK, with herds A and C experiencing IBK in summer months when fly activity is expected to be greatest. It is possible that the efficacy of fly control was not equivalent on all farms. In a previous report, herds treated with fly control that reduced fly populations by 54% had an overall proportion of affected animals of 1.5%, compared to 33.3% in herds with no fly control.[11] Lack of efficacy for face fly control could impact IBK incidence because of the correlation between face flies and IBK.[11]

Many management practices such as vaccination, treatment with antimicrobials, use of fly control, grazing and rotating through pastures, access to shade and water, and mineral supplementation were similar among the cow-calf herds. The fact that an IBK vaccination program was used in all cow-calf herds is not surprising, as all herds had utilized diagnostic testing to support the development of an autogenous vaccine. No conclusion can be drawn regarding the efficacy of vaccination to control IBK in the herds described here since no unvaccinated herds were enrolled to serve as unvaccinated controls.

The frequent use of costly antimicrobials for treatment of IBK by producers in this study provides a glimpse at the economic impact of IBK due to drug cost, without consideration of reduced performance. For example, 5 of the 6 cow-calf herds surveyed used tulathromycin for treatment of IBK. At a published retail price of $1167 for a 250-mL bottle,[26] a label dose of tulathromycin (5.5 mg/lb [2.5 mg/kg], provided as 1.1 mL/100 lb [45 kg]) costs $15.41 for a 300 lb (136 kg) calf. Given that producers in this study that used tulathromycin for treatment treated between 10 and 60 calves, the

drug alone in this example would be $154 to $925, assuming the treated calf weighed 300 lb (136 kg). While the actual price of medication may vary from this estimate, it is clear that treatment costs represent a significant financial impact in herds with a high pinkeye incidence. The NAHMS report found IBK is the second most common reason for preweaned calves or heifers to be treated with antimicrobials,[25] which supports the concept that this disease drives substantial antimicrobial use on US cow-calf operations.

## Conclusion

These findings demonstrate that, even among a small number of herds managed by producers concerned enough about IBK incidence to utilize ocular diagnostic testing, and using similar management practices, the cumulative incidence of disease can vary widely. On some farms, IBK occurs in multiple cattle in winter months, even when not exposed to risk factors such as flies or tall grass. Further research is needed to identify factors that may be amenable to control or mitigate IBK. The use of antimicrobials on farms with a high incidence of IBK likely represents an important financial burden, and may also contribute to dissemination of antimicrobial resistance, thus better methods of IBK prevention are needed.

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## Appendix A
## West Virginia Bovine Pinkeye Case Series Phone Survey

Date: _____

Script:

"Hi, This is Caleb Glover, and I am a student working with Dr. Isaiah Smith's practice and the College of Veterinary Medicine at Mississippi State University on a study on bovine pinkeye. Is this a good time to talk? This shouldn't take more than about 20 minutes."

**[pending a yes…]**

"Thank you, For this study, I will need to ask you some questions about your herd in 2019. In case you are wondering, your individual answers will be kept confidential. The information you provide will be summarized and added to information from other producers which will be shared in a report, but not your individual information. **When I ask about pinkeye, what I mean is any of the following: a watery or tearing eye, a white spot on the eye, or an entirely white, pink or red eye. This does not include any cases that you know had injury to the eye, had an object stuck in the eye, or had cancer eye.**

This first set will be general questions about your herd and the pinkeye outbreak.

1. What is your first and last name?
   _____ _____
2. What is your unique farm name?
   _____
3a. Is the herd we are describing cow-calf or stocker? (if multiple groups, ask them just to focus on the one that was most affected. If they have time, they can answer the questions on a second questionnaire about the less-affected group.)
   Cow-calf Stocker
   [if stocker, skip to 4.]
3b. Are these mature cows or heifers?
   Mature cows Heifers Both
3c. Do they calve in the spring or the fall?
   Spring Fall
4. [Stocker only] How many animals were in this herd in 2019?
   [Cow-calf only] How many cows, calves, heifers, and bulls were in this herd 2019? Here, a heifer means an approximately 10 to 24 month old female that has not calved.
   Animals_____
   Cows_____
   Heifers _____
   Calves_____
   Bulls _____
5. How many animals were brought into this herd in 2019? _____
6a. How many animals in this herd were observed to have pinkeye in 2019? _____
6b. How many of the animals observed to have pinkeye were treated? _____
   [only if Cow-calf]
7. In 2019, how many of the pinkeye infected animals in this herd were calves still nursing their mothers? _____
8. In 2019, how many of the pinkeye infected animals in this herd were between weaning age and 2 years? _____
9a. In 2019, how many of the pinkeye infected animals in this herd were older than two years of age? _____
   [if none, skip to 10]
9b. How many of these were first calf cows? _____
10. How many of the animals that had pinkeye in this herd in 2019 had:
   pinkeye in one eye? _____
   pinkeye in both eyes? _____
   a popped or protruding eye (popeye)? _____
11. With respect to pinkeye cases observed in this herd during 2019:
   What was the month of the first pinkeye case observed? _____
   What was the month when there were the most cases of pinkeye observed? _____
   What was the month of the last pinkeye case observed? _____

The next set of questions will be about your herd health management.

12a. In 2019, was this herd vaccinated for pinkeye at least once with a commercial or autogenous vaccine?
Yes No
[if no, skip to 13a.]
Commercial Autogenous

12b. What month were they given the vaccine? _____

12c. Were they given a second vaccination within two months of the first vaccine?
Yes No
[if yes, skip to 12e.]

12d. Were they given a second vaccination at all in 2019?
Yes No
[if no, skip to 13a.]

12e. What month were they given the second vaccine? _____

13a. Did these animals receive a modified live respiratory vaccine in 2019?
Yes No
[if no skip to 14a.]

13b. Did you give the modified live respiratory vaccine intranasally (in the nose)
Yes No

13c. Did you give the modified live respiratory vaccine by injection ? (under the skin or in the muscle)
Yes No

14a. In 2019, other than a vaccine, were these animals given any type of preventive medication or treatment for pinkeye before they developed signs of pinkeye?
Yes No
[if no, skip to 15a.]

14b. What medication were they given to prevent pinkeye? _____

15a. In 2019, When animals had pinkeye, did you treat them with any medication?
Yes No
[If no, skip to 17a.]

15b. How many nursing calves did you treat? _____

15c. How many animals between weaning and 2 did you treat? _____

15d. How many animals older than 2 did you treat? _____

15e. Were any of the animals treated for pinkeye treated more than once?
Yes No

15f. At any time, did you put cattle in a chute to give the medication?
Yes No

15g. At any time, was the medication given using a dart?
Yes No

16a. In 2019, was the medication you gave an antibiotic?
Yes No
[If no, skip to 16d.]

16b. What antibiotic did you treat with? _____

16c. Did you give the antibiotic any of the following routes? (select all that apply)
Intramuscular (in the muscle)
Subcutaneous (under the skin)
Intravenous (in a vein)
Subconjunctival (injected underneath the membrane covering the eyeball)
Spray directly in the eye (without a needle)

16d. Did you give any medications that were not antibiotics? If so, what did you give?
Yes No _____

17a. Was fly control used in this herd in 2019?
Yes No
[if no, skip to 18]

17b. Were fly tags used in this herd?
Yes No
[if no, skip to 17d.]

17c. How many fly tags per animal were used? _____
17d. Was pour on fly control used in this herd?
Yes No
[if no, skip to 17f.]
17e. How many animals in this herd had pour on fly control? _____
17f. Was any other type of fly control used in 2019? If so, please specify.
Yes No _____
18. Was this herd checked for pregnancy by a vet?
Yes No

The following questions will be about what kind of environment your herd was in.

19. How many acres were these animals on in 2019? _____
20a. Was this herd housed in a barn at any time in 2019?
Yes No
[if no, skip to 21a.]
20b. How long was this herd housed in a barn? _____
21a. Was this herd kept in a dirt lot at any time in 2019?
Yes No
[if no, skip to 22]
21b. While on a dirt lot, were the animals fenced in using anything other than wire? (For example, wood, guard rails or pipe?)
Yes No
22. Were these animals in a pasture that shared a fence with a neighbor's herd in 2019?
Yes No
23. Did this herd have access to any of the following in 2019?
Stream
Pond
Water trough
24. Did the animals have access to shade in 2019?
Yes No

The next few questions will be about how your herd was fed.

25. Were these animals fed in any of the following In 2019? (select all that apply)
Trough
Creep Feeder
Bunk
26a. Was this herd fed hay in 2019?
Yes No
[if no, skip to 27a.]
26b. Were they fed hay with a ring or feeder?
Yes No
27a. Was this herd fed baleage in 2019?
Yes No
[if no, skip to 28a.]
27b. Were they fed baleage with a ring or feeder?
Yes No
28a. Did this herd graze grass in 2019?
Yes No
[if no, skip to 29a.]
28b. Did the animals rotate through pastures at all?
Yes No
[if no, skip to 28c.]
28b1. Did the animals rotate through pastures at least twice a week?
Yes No
28c. Was stockpiling used? (growing pasture for later use, usually fescue: "standing hay")
Yes No
28d. Did this herd graze on any land that was fertilized with chicken litter within the last 2 years?
Yes No

28e. Do you bush hog or mow on your farm?
Yes No
29a. Did this herd receive any minerals in 2019?
Yes No
[if no, the interview is finished]
29b. How many months did they receive minerals? _____
29c. Did this herd receive any of the following?
Free choice complete mineral mix
Free choice mineral mixed with salt
Mineral in a TMR

That was the last question. Do you have any questions or any thoughts about pinkeye you would like us to know? Thank you very much for your time and have a good rest of the day."