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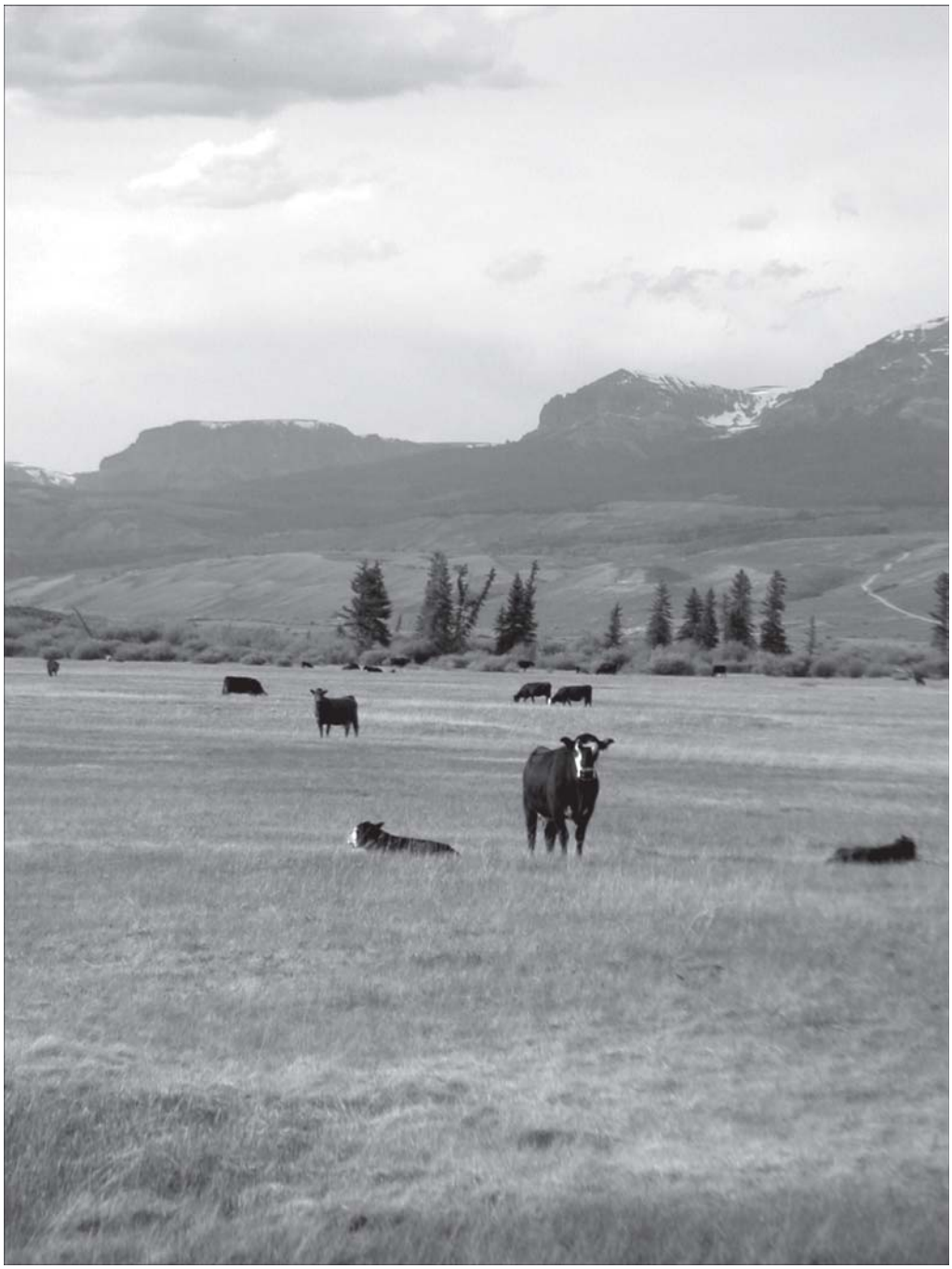
Beef 2007–08

Prevalence and Control of Bovine Viral Diarrhea Virus on U.S. Cow-calf Operations, 2007–08



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Cover photo courtesy of Dr. Dave Dargatz

Items of Note

The cattle industry has made significant efforts in recent years to control Bovine Viral Diarrhea Virus (BVDV) in cattle. These efforts have been facilitated by a more complete understanding of the epidemiology of BVDV in cattle and wildlife populations, enhanced availability of diagnostics for detecting animals persistently infected with BVDV, and a better idea of the economic impact BVDV has on cattle herds. These advancements have made it clear that in some groups of cattle the impacts of BVDV can be substantial. Furthermore, the knowledge gained in the epidemiology of BVDV and the improvement in diagnostics tools have made the control of BVDV feasible.

Based on the NAHMS 2007-08 Beef Cow-calf study, only 12.3 percent of cow-calf operations had not heard of BVDV, and 64.0 percent of operations knew some basics or were fairly knowledgeable about the virus. These results are likely a reflection of the substantial coverage the agriculture media has devoted to BVDV in the past few years. While producers are generally aware of BVDV, relatively few (4.2 percent) had done any testing of calves for persistent infection with the virus in the past 3 years. Larger operations (200 or more beef cows) were much more likely than smaller operations to have tested calves for persistent infection with BVDV in the past 3 years (15.6 percent of operations). The low overall rate of testing might indicate that most producers do not believe their herd is at risk. Producers might also believe that the cost-benefit ratio for controlling the disease is prohibitive. Information on the economic impacts BVDV has on a herd is relatively new; therefore, it is possible that the majority of producers had not yet received the information by the time of the interview or that they had not had time to fully assimilate it. This premise might be supported by the finding that 46.6 percent of cow-calf operations did not know if removing calves that tested positive for persistent infection with BVDV would affect the value of the remaining calves in the herd. Larger operations were more inclined than smaller operations to believe that removing persistently infected calves would increase the value of the remaining calves.

Among operations that vaccinated any cattle for any diseases, 80.7 percent vaccinated at least some calves at 22 days of age through weaning and 61.2 percent vaccinated weaned replacement heifers before breeding. While some of these herd owners might believe that by vaccinating these animals they are effectively controlling the development of animals persistently infected with BVDV, the high-level use of vaccines could also be a reflection of the widespread belief by producers that BVDV can have significant animal health impacts; overall, 66.7 percent of producers believed that BVDV was a significant problem for the U.S. beef industry.

The ear-notch testing done during the Beef 2007-08 study confirmed, as have other studies, that animals persistently infected with BVDV are relatively infrequent within a herd and that most operations might not even have any persistently infected calves in any particular calf crop. Of the 205 cow-calf operations that submitted ear-notch samples for BVDV testing, only 8.8 percent had one or more persistently infected animals identified. Among the 44,150

ear-notch samples collected and tested, only 53 (0.12 percent) were positive for the BVDV antigen. While it is tempting to ignore such a small fraction of the total calf crop, these animals have a tremendous capacity to transmit the infection to other animals in the herd or to other groups of cattle in which they come in contact. Although such transmission rarely results in the creation of another animal persistently infected with BVDV, it can and does result in disease related to acute infection with BVDV, such as respiratory disease or reproductive disease. A number of feedlots have noted the substantial impact of animals persistently infected with BVDV on in-contact cattle and have instituted screening programs to remove them at arrival. In some cases it appears that groups of calves that test negative for persistent infection with BVDV sell at a higher price than comparable groups that have not been tested.

Selected Highlights

Only 12.3 percent of producers had not heard of BVDV.

Only 4.2 percent of operations had tested any calves for persistent infection with BVDV in the previous 3 years.

Overall, 46.6 percent of producers were unsure if removing calves that tested positive for persistent infection with BVDV would affect the value of the remaining calves in the herd.

Overall, 33.1 percent of operations vaccinated calves against BVDV at 22 days through weaning; 25.1 percent vaccinated weaned replacements heifers through breeding; and 28.1 percent vaccinated cows.

Of operations that vaccinated at least some cattle against BVDV in 2007, more than 8 of 10 used a vaccine that included both type 1 and type 2 BVDV on all cattle groups vaccinated.

A higher percentage of operations used a killed virus vaccine than a modified live virus vaccine on bred replacement heifers precalving, on cows precalving, and on bulls.

Overall, 8.8 percent of operations had a calf persistently infected with BVDV.

Only 0.12 percent of calves tested were positive for persistent infection with BVDV.

Acknowledgments

This report was a cooperative effort between two U.S. Department of Agriculture (USDA) Agencies: the National Agricultural Statistics Service (NASS) and the Animal and Plant Health Inspection Service (APHIS).

We want to thank the NASS enumerators who contacted beef producers and collected the data. Their hard work and dedication were invaluable. The roles of the producers, area veterinarians in charge, NAHMS coordinators, veterinary medical officers, and animal health technicians were critical in providing quality data for the Beef 2007–08 reports. Recognition also goes to the personnel at the USDA-APHIS-Veterinary Services' Centers for Epidemiology and Animal Health for their efforts in generating and distributing this report.

Additional biological sampling and testing for the Beef 2007–08 study were afforded by the generous contributions of collaborators, including:

- USDA Agricultural Research Service (ARS)
  - –Bovine Functional Genomics Laboratory, Beltsville, MD
  - –Bacterial Epidemiology and Antimicrobial Resistance Research Unit, Athens, GA
  - –Environmental Microbial Safety Laboratory, Beltsville, MD
  - –Virus and Prion Research Unit, Ames, IA
- USDA:APHIS:VS National Veterinary Services Laboratories, Ames, IA
- IDEXX Laboratories, Inc., Westbrook, ME

All participants are to be commended, particularly the producers whose voluntary efforts made the Beef 2007–08 study possible.

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Director
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Feedback
Feedback, comments, and suggestions regarding Beef 2007–08 study reports are welcomed. Please forward correspondence via email at: NAHMS@aphis.usda.gov

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Introduction

The National Animal Health Monitoring System (NAHMS) is a nonregulatory program of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service. NAHMS is designed to help meet the Nation's animal health information needs and has collected data on cattle health and management practices on cow-calf operations through two previous studies, the 1992–93 Cow-calf Health and Productivity Audit and Beef '97.

The Beef 2007–08 study was conducted in the 24 States (see map next page) with the largest beef-cow populations and provides participants, stakeholders, and the industry as a whole with valuable information representing 79.6 percent of U.S. cow-calf operations and 87.8 percent of U.S. beef cows. Parts I and II of the study contain information from the 2,159 cow-calf operations that participated in Phase I of the Beef 2007–08 study. Part III provides comparisons among population estimates from all three NAHMS beef studies: Beef 2007–08, Beef '97, and the 1992–93 Cow-calf Health and Productivity Audit.

Of the 2,159 operations participating in Phase I of the Beef 2007–08 study, 1,033 consented to be contacted by a veterinary medical officer regarding participation in Phase II of the study. Of these 1,033 operations, 567 completed the Phase II Initial Visit Questionnaire. Data from the Initial Visit Questionnaire are reported in Part IV of the Beef 2007–08 study. Of the 567 operations that completed the Initial Visit Questionnaire, 470 agreed to continue in Phase II of the study and completed the Second Visit Questionnaire, data from which are reported in Part V of the study.

Producers participating in Phase II that met inclusion criteria were given the option to submit ear-notch samples from their calf crops to be tested for bovine viral diarrhea virus (BVDV) persistent infection. Participation was limited to spring calving herds in which 70 percent or more of the calves were born from November 1, 2007, through June 30, 2008. Of the 567 operations participating in Phase II, 472 were eligible based on meeting the criterion of being a spring calving herd, and 306 ordered kits to collect and submit ear-notch samples. (Based on 2007 calving information, 272 of these operations were eligible for BVDV persistent infection testing and 34 operations were not.) A total of 205 operations actually submitted samples, of which 190 were eligible based on 2007 calving data, and 15 were eligible based on 2008 calving data or other available information.

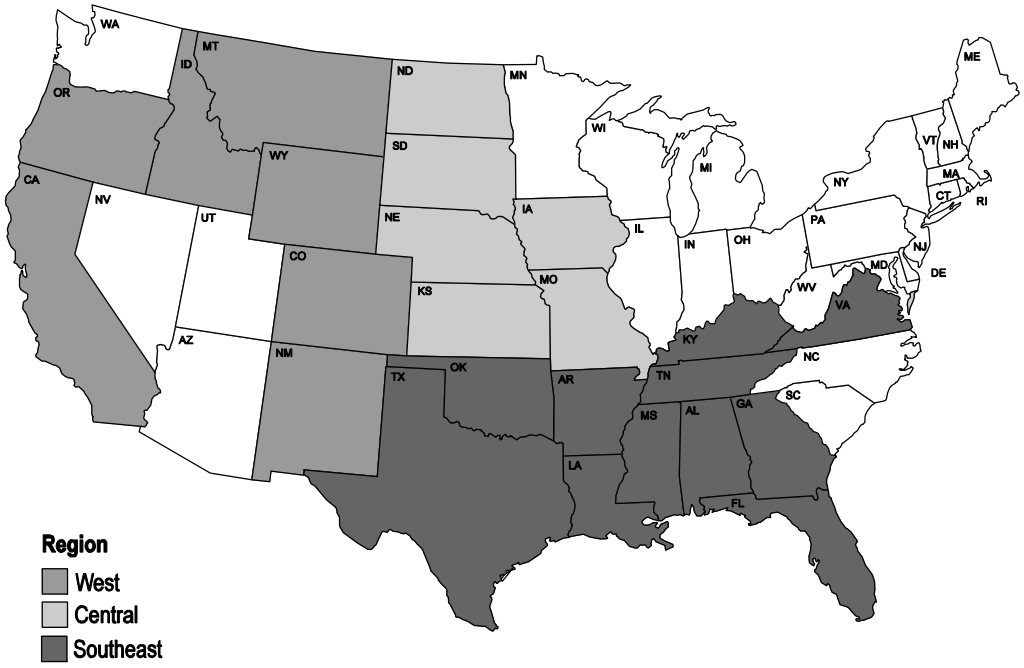
Section I of this report provides an overview of BVDV and control of BVDV, including testing and surveillance strategies.

Section II contains population estimates from management data collected during Phase I and Phase II of the Beef 2007–08 study and provides population inferences on general BVDV management practices.

Section III of this report provides test results from the 205 operations that submitted ear-notch samples for BVDV persistent infection testing.

Data in items 3 and 4 of Section III are not weighted to represent the U.S. beef population. Rather, they describe the management and production practices of the 205 operations that participated in the voluntary BVDV sampling study.

NAHMS Beef 2007-08 Participating States



Terms Used in This Report

Antigen capture: An enzyme-linked immunosorbent assay **(**ELISA) that binds (captures) BVDV antigen for detection.

Beef cow: Female bovine that has calved at least once.

Beef heifer: Female bovine that has not yet calved.

Congenital defects: Abnormalities present at birth, including defects of the brain, eyes, hair, skeleton, and lungs. Defects may result from BVDV infections at 100 to 150 days of gestation.

Cytopathic biotype: A strain of the BVDV that kills epithelial cells when cultured in vitro.

Enzyme-linked immunosorbent assay (ELISA): A laboratory method that can detect either BVDV antigen or antibody.

Herd size: Herd size is based on October 1, 2007, cow inventory. If there were no cows on October 1, 2007, then July 1, 2007, cow inventory was used.

Immunocompetence: The ability of a calf to produce an immunologic response to an infection.

Immunohistochemistry (IHC): A method to detect BVDV antigen in formalin-fixed skin samples.

Immunotolerance: Failure of a calf to immunologically respond to an infection, which results in the calf never eliminating the infection.

Noncytopathic biotype: A strain of the BVDV that does not kill epithelial cells when cultured in vitro.

Operation: Premises with at least one beef cow on October 1, 2007, or July 1, 2007.

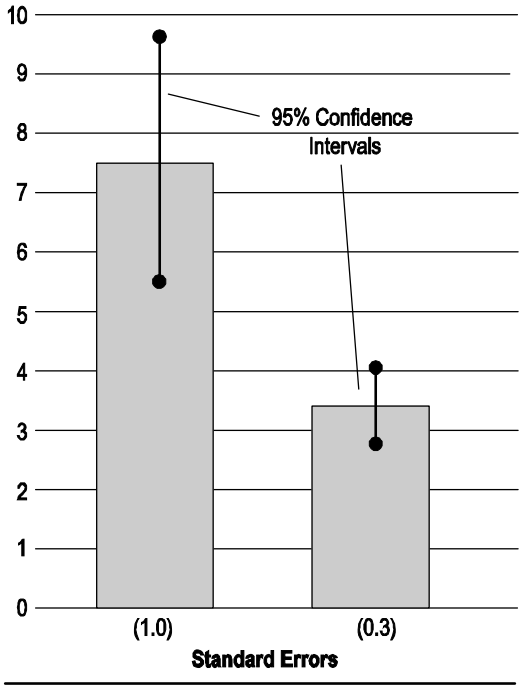
Operation average: The average value for all operations. A single value for each operation is summed over all operations reporting divided by the number of operations reporting. For example, operation average dollars per head (p 29) is calculated by summing reported dollars per head over all operations divided by the number of operations.

Persistent infection: A calf infected with noncytopathic BVDV from about 40 to 125 days of gestation. Calf is immunotolerant and persistently sheds large quantities of BVDV for the rest of its life.

Population estimates: The estimates in this report make inference to all of the operations in the target population (see Section V: Methodology, p 75). Data from the operations responding to the survey are weighted to reflect their probability of selection during sampling and to account for any survey nonresponse.

Precision of population estimates: Estimates in this report are provided with a measure of precision called the standard error. A 95-percent confidence interval can be created with bounds equal to the estimate plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. In the example to the right, an estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). The second estimate of 3.4 shows a standard error of 0.3 and results in limits of 2.8 and 4.0. Alternatively, a 90-percent confidence interval would be created by multiplying the standard error by 1.65 instead of 2. Most estimates in this report are rounded to the nearest tenth. If rounded to 0, the standard error was reported (0.0). If there were no reports of the event, no standard error was reported (—).

Examples of a 95% Confidence Interval



Polymerase chain reaction (PCR):
A laboratory method used to generate numerous copies of specific genetic segments to allow detection. In the context of BVDV testing, the PCR method can be used to create copies of the genetic material (RNA) of BVDV. This allows detection of the virus in a sample even if it is present in very small quantities.

Regions:
West: California, Colorado, Idaho, Montana, New Mexico, Oregon, Wyoming
Central: Iowa, Kansas, Missouri, Nebraska, North Dakota, South Dakota
Southeast: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Oklahoma, Tennessee, Texas, Virginia

Sample profile: Information that describes characteristics of the operations from which Beef 2007–08 data were collected.

Transient infection: An animal infected with either biotype of BVDV (cytopathic or noncytopathic) following birth, sheds low

quantities of BVDV for a limited period, and is immunocompetent with a normal immune response to clear the virus.

Type 1 genotype: A grouping of BVDV based on gene sequences of the virus. Type 1 BVDV may be of the cytopathic or noncytopathic biotype.

Type 2 genotype: A grouping of BVDV based on sequences of the virus. Type 2 BVDV may be of the cytopathic or noncytopathic biotype.

Virus isolation: A laboratory method used to grow BVDV on cell cultures, which provides virus to perform genotype and biotype tests.

Section I: Bovine Viral Diarrhea Virus

A. Disease Agent/Disease

1. Overview

Bovine viral diarrhea virus (BVDV) was first recognized in 1946 as a cause of diarrhea and ulcers on mucus membranes in cattle and abortion in cows. Today, it is known that BVDV is associated with a variety of cattle diseases. The majority of disease from BVDV in a cow-calf herd is associated with reproduction (Grooms, 2004). The presence of BVDV in a herd may cause decreased fertility in breeding cows, abortions, congenital malformations in calves, and the birth of calves persistently infected with BVDV. Signs of disease may also include increased rates of diarrhea and pneumonia in suckling or weaned calves (Baker, 1995). Persistently infected individual calves may show signs of severe, bloody diarrhea and ulcerations on mucus membranes.

There are two biotypes of BVDV—cytopathic (CP) and noncytopathic (NCP) (see Terms Used in This Report, p 3). Both biotypes can cause disease (Donis, 1995).

There are also two genotypes of BVDV—type 1 and type 2. Both types have been associated with clinical disease, including respiratory, digestive, and reproductive diseases. Type 2 BVDV has sometimes been associated with more severe clinical disease in adult cattle, including thrombocytopenia (low number of blood platelets) [Donis, 1995].

While infection with BVDV can manifest in a variety of ways, the most significant effects of BVDV occur following infection of a cow during pregnancy. A cow infected with BVDV rarely shows any signs of disease, but the effects on its fetus can be devastating.

The effects of BVDV during pregnancy vary depending on the stage of pregnancy at infection and the BVDV biotype (Grooms, 2004). Note that the time categories below overlap because there is biological variation and lack of clarity in the effects of BVDV infection in the progression of gestation.

- Days 0 to 45 of gestation: Embryo or fetal death due to either CP or NCP biotype.
- Days 40 to 125:
  - CP biotype rarely results in fetal death and abortion, or mummification.
  - NCP biotype results in infection of calves and immunotolerance to BVDV. Calves infected during this period become persistently infected and shed large quantities of the virus throughout their lives. Brain and/or eye defects may be present in some cases.
- Days 100 to 150: Beginning of immunocompetence. Either CP or NCP virus can cause congenital defects (brain or eye) in calves, but not persistent infection. Abortions can also result from infection at this time.
- Day 125 to term: Birth of normal calves with evidence of an immune response, but may also have abortions and weak calves.

Persistent infection occurs when a cow infected with the NCP biotype of BVDV during approximately 40 to 125 days of gestation passes the virus to her calf. Persistently infected calves may or may not have congenital defects, but do shed large quantities of BVDV in nasal and oral secretions, and in feces. Typically, calves persistently infected with BVDV are poor performers; however, some will gain and grow relatively well, sometimes well enough to be retained as replacement heifers. Persistently infected calves are the major source of continued infection for the herd (Baker, 1995; Houe, 1995; Larson et al., 2004b). Persistently infected cows always produce persistently infected calves. However, more than 90 percent of persistently infected calves are the result of transient BVDV infections of their dams (Wittum et al., 2001).

Persistently infected calves

- Shed large quantities of virus which can be transmitted to other members of the herd;
- Usually perform poorly, but not always;
- Usually have increased sickness and death loss; and
- Occasionally perform well enough to be incorporated into the breeding herd.

Normal calves born with serum antibody to BVDV are the result of infection after 125 days of gestation. These calves are not a problem. They have been exposed to BVDV and have eliminated it by an active immune response.

Normal calves can be infected with BVDV following birth. Known as transiently infected, these calves shed relatively low quantities of virus for a limited time (up to 7 to 14 days), but then clear the infection and cease shedding the virus. Calves transiently infected with BVDV may show few signs of disease but may also be immunosuppressed and more susceptible to other infections. Symptoms of transient infection in calves may include either diarrhea or pneumonia (Baker, 1995).

2. Surveillance strategies

Optimal surveillance strategies for BVDV and persistent infection with BVDV should incorporate the epidemiology of the disease agent, the attributes of the herd, and current knowledge of diagnostic tests and testing methods. While basic information about each of these areas has been incorporated in this report, producers and their veterinarians are advised to seek out the most current information before tailoring a specific plan for an individual herd.

Signs of BVDV presence within a herd include increased sickness and death in calves from birth to weaning, decreased pregnancy rates, increased abortion rates, and the birth of calves with congenital malformations. Available data suggest that most herds do not have persistently infected animals within the herd (Wittum et al., 2001). If an operation does have one or more persistently infected animals, testing to identify and remove these animals may be necessary to stop transmission. Since cows or heifers persistently infected with BVDV will always produce persistently infected calves, testing all calves in the herd is an efficient way to identify positive calves and potentially positive cows or heifers. Additionally, all cattle in the herd not represented by a calf (replacement heifers not yet calved, bulls, etc.) should be tested.

BVDV would not be suspected in a cow-calf herd in which a high percentage of cows exposed to a bull wean a calf and in which no laboratory evidence exists of transiently infected or persistently infected animals.

Four possible surveillance strategies to detect BVDV are outlined in Larson et al. (2004a).

1. Surveillance Strategy I—monitor production and health

- Low-cost/low-sensitivity strategy.
- Slow introduction to persistent infection through diagnostic testing (production must be negatively influenced before presence of persistent infection is detected).
- Monitor overall pregnancy proportion and percentage of pregnant animals in first 21 days.
- Monitor stillbirths, neonatal morbidity, neonatal mortality, and weaning percentage.
- Necropsy and submit tissues (thymus, Peyer's patches, spleen, skin, blood) for laboratory analysis on high percentage of abortions, stillbirths, and mortalities.
- If unexplained suckling calf losses occur (pneumonia, scours, etc.) send appropriate samples to diagnostic laboratories to identify transiently infected and persistently infected calves.
- Positive test results should be confirmed with other supporting evidence.

2. Surveillance Strategy II—serology (type I and type II) of herd subset

- Low-cost/low-sensitivity strategy.
- Serology of nonvaccinated, sentinel animals has been used to identify persistently infected animals in dairies.

- Differentiation of titers due to vaccination or field virus exposure (height of serologic titers) is difficult, subjective, and must include consultation with laboratory diagnosticians for interpretation.

3. Surveillance Strategy III—pooled PCR of blood (entire calf crop)

- High-cost/high-sensitivity strategy.
- Identifies persistent infections prior to breeding season if done before bull turn-out.
- Delayed response to persistent infection introduction if done after breeding season.
- Pool samples of 20 to 30, with repooling and rerunning of positive pools.
- Positive PCR does not differentiate between transient infection and persistent infection; therefore, additional confirmatory testing is needed.

4. Surveillance Strategy IV—IHC or ELISA on skin samples (entire calf crop)

- High-cost/high-sensitivity strategy.
- Identifies persistent infections prior to breeding season if done before bull turn-out.
- Must confirm positive tests if BVDV is not suspected because of poor positive predictive value in herds with no prior evidence of persistent infection.

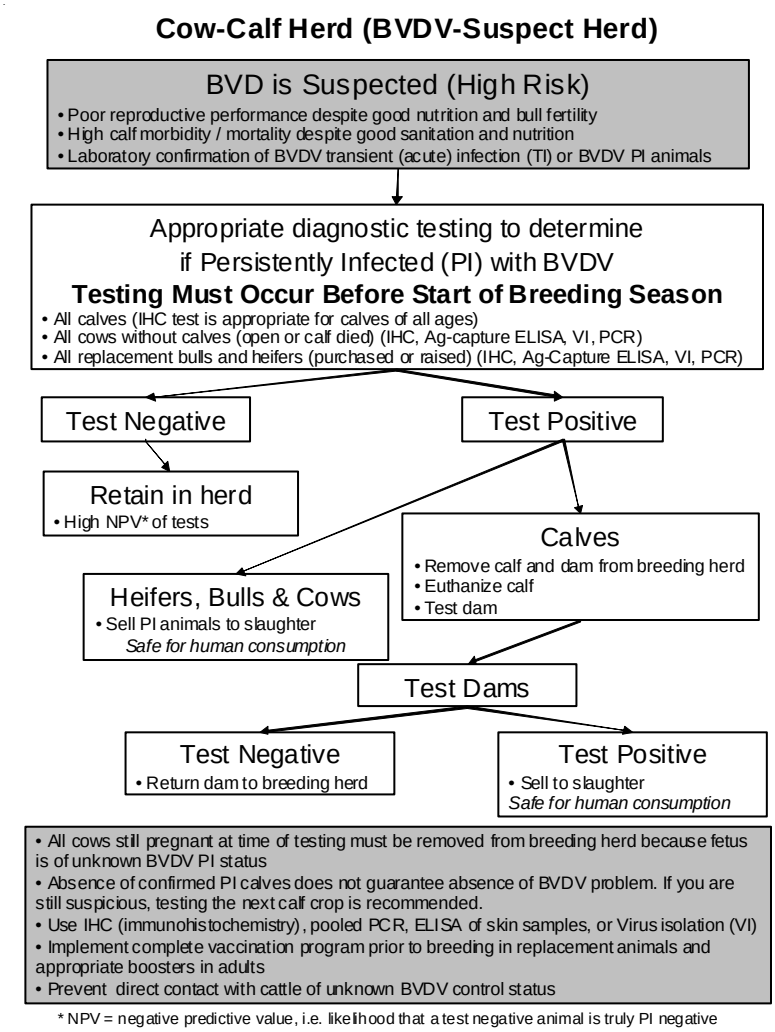
In cow-calf herds in which BVDV infection is suspected because of poor reproductive performance, high calf morbidity or mortality, or laboratory confirmation of animals transiently infected with BVDV, an appropriate diagnostic plan will help determine if persistently infected animals are present in the herd (see figure, next page). To optimize its value, the diagnostic effort should be done before the start of the breeding season to ensure the timely removal of persistently infected animals before the next crop of persistently infected calves would be created— i.e., days 40 to 125 of gestation. A structured or planned approach to testing will minimize the number of tests necessary to obtain the most information about the herd. All animals in the herd do not have to be tested to know the herd's persistent infection status.

Three groups of animals should be selected for testing:

- Group 1: All calves—since a persistently infected cow will always produce a persistently infected calf, neither the cow nor the calf are persistently infected if the calf tests negative. However, a persistently infected calf does not necessarily mean that the cow is persistently infected, since a transient infection in the cow can lead to a persistently infected calf.
- Group 2: All cows without calves.
- Group 3: All bulls and replacement heifers (purchased or raised) because these animals are not represented by testing of the other two groups.

Test results from these three groups of animals will determine if other testing is indicated. For example, if a persistently infected calf is identified, its dam should be tested to determine if she is also persistently infected. Test results can then be used to determine the appropriate course of action for control/elimination of BVDV from the herd.

Eliminating Animals Persistently Infected with BVD



Source: Larsen et al., 2004a.

B. Control of BVDV

As with the design of surveillance strategies, control strategies should be tailored to the individual herd situation and should make use of the most current vaccines, tests, and biosecurity protocols. For herds affected with BVDV, control revolves around identifying and eliminating persistently infected animals, preventing entry of new persistently infected animals, and vaccinating to minimize the effects of disease. (Larson et al., 2004a).

1. Identifying and eliminating persistently infected animals

Because persistently infected animals are central to the continuation of BVDV in a herd, identifying and eliminating these animals is the first and most important step in controlling BVDV. Removal of any persistently infected animals before the breeding season, coupled with biosecurity practices, can effectively prevent production of new persistently infected animals. Numerous tests are available for detecting animals persistently infected with BVDV (Larson et al., 2005a). Test selection should be based on test performance, samples required, and the BVDV control goals of the operation. Persistently infected animals are most likely to be the youngest animals in the herd, so testing programs should focus first on calves. If BVDV is suspected in the herd because of diagnostic test results on ill or dead cattle, lowered reproductive efficiency, the birth of calves with congenital anomalies, or excess morbidity, it is important to test all calves before the start of the breeding season to interrupt transmission. Since animals persistently infected with BVDV will always produce persistently infected calves, the dams of any positive calves should be tested to determine if they are also persistently infected. However, few adult animals are persistently infected; more than 90 percent of persistently infected calves are born to dams that were transiently infected during gestation (Wittum et al., 2001).

2. Preventing entry of persistently infected animals to the herd

Preventing the entry of persistently infected cattle is accomplished by recognizing the risks associated with importing different classes of cattle and by applying appropriate quarantine and testing procedures to identify and exclude persistently infected animals. A common factor in herds with persistently infected cattle is the recent importation of pregnant females or cow-calf pairs. Although it is possible that any cattle introduced to the herd are persistently infected, young cattle are the most likely candidates for persistent infection with BVDV. Prevention is achieved by not importing calves or pregnant females into the herd, or by testing calves in the herd to identify persistently infected animals and removing them before the next breeding season

begins. Fenceline contact with neighboring herds that have persistently infected animals may also expose pregnant females to BVDV. Preventing contact with neighboring herds from breeding to weaning is crucial, since this is the time that most pregnancies will pass through the high risk period (40 to 125 days of gestation) for producing persistently infected calves.

a. Possible testing strategies for controlling BVDV infection in cow-calf herds

Testing Strategy	Test	Rationale
Testing sick suckling calves (scours, pneumonia, septicemia, etc.) for possible BVDV involvement	♦ IHC or AC-ELISA from skin sample will identify persistently infected calves and sometimes transiently infected calves ♦ PCR of blood or serum to identify both persistently and transiently infected calves (Use of PCR will increase testing cost)	Maternal antibody may interfere with microtiter VI and AC-ELISA using serum or plasma, therefore these tests are not recommended for young calves. If a live calf is IHC or AC-ELISA negative from a skin sample but BVDV positive from a blood or serum sample, transient infection is likely. Retest to confirm. False positive indication of persistent infection with IHC or AC-ELISA of skin samples from transiently infected cattle can occur in situations with high viral exposure due to the presence of multiple persistently infected cattle.
Testing dead suckling calves (scours, pneumonia, septicemia, etc.) for possible BVDV involvement	♦ IHC or AC-ELISA from skin sample will identify persistently infected calves and sometimes transiently infected calves – IHC will work if skin is not desiccated ♦ IHC, FA, or VI from tissues (thymus, Peyer's patches, mesenteric lymph nodes,) to identify infected calves (will not differentiate between persistent and transient infection)	Maternal antibody may interfere with microtiter VI and AC-ELISA using serum or plasma, therefore these tests are not recommended for young calves. If a dead calf is IHC or AC-ELISA negative from a skin sample but positive from a tissue sample, transient infection is likely.

a. Possible testing strategies for controlling BVDV infection in cow-calf herds (continued)

Testing Strategy	Test	Rationale
Screening a herd (suckling calves, cows that lost calves, replacement animals) because of laboratory evidence of BVDV in the herd.	♦ IHC or AC-ELISA from skin sample will identify persistently infected cattle and sometimes transiently infected cattle.	Maternal antibody may interfere with microtiter VI and AC-ELISA using serum or plasma, therefore these tests are not recommended for young calves. Any animal positive by IHC and AC-ELISA test is usually considered persistently infected. However, false positive IHC or AC-ELISA of skin samples from transiently infected cattle can occur in situations with high viral exposure due to the presence of multiple persistently infected cattle. Retest valuable animals to confirm status.
Screening open replacement heifers (raised or purchased), purchased open cows, or bulls (raised or purchased)	♦ IHC or AC-ELISA from skin sample will identify persistently infected cattle and sometimes transiently infected cattle. ♦ PCR – pool serum or whole blood into groups of 30-40 or less.* Test individual blood or skin samples of animals in positive pools to identify PIs. Animals in negative pools are not considered persistently infected.	Any positive test in valuable animals could be confirmed by segregating the animals and using IHC, AC-ELISA, VI, or PCR of serum or blood samples taken not less than 21 days later, which will eliminate the possibility that transiently infected animals and false-positive animals are incorrectly identified as persistently infected.
Screening purchased pregnant replacement heifers or cows prior to entry into the herd	♦ IHC or AC-ELISA from skin sample will identify persistently infected cattle and sometimes transiently infected cattle. ♦ PCR – pool serum or whole blood into groups of 30-40 or less.* Test individual blood or skin samples of animals in positive pools to identify persistent infection. Animals in negative pools are not considered persistently infected. ♦ Isolate pregnant cattle away from resident herd until calves are born and tested for persistent infection status via IHC or AC-ELISA from a skin sample.	Any positive test in valuable animals could be confirmed by segregating the animal and using IHC, AC-ELISA, VI, or PCR of serum or blood samples taken not less than 21 days later, which will eliminate the possibility that transiently infected animals and false-positive animals are incorrectly identified as persistently infected. A test-negative pregnant dam can have a persistently infected fetus. Cattle that conceived off the premises should be isolated from the resident herd until the calf is born and determined to be test-negative for persistent infection.

a. Possible testing strategies for controlling BVDV infection in cow-calf herds (continued)

Testing Strategy	Test	Rationale
Screening raised replacement heifers and bulls prior to sale by a seedstock supplier	♦ IHC or AC-ELISA from skin sample will identify persistently infected cattle and sometimes transiently infected cattle. ♦ PCR – pool serum or whole blood into groups of 30-40 or less.* Test individual blood or skin samples of animals in positive pools to identify persistent infection. Animals in negative pools are considered persistently infected.	Any positive test in valuable animals could be confirmed by segregating the animal and using IHC, AC-ELISA, VI, or PCR of serum or blood samples taken not less than 21 days later, which will eliminate the possibility that transiently infected animals and false-positive animals are incorrectly identified as persistently infected.
Testing ill or dead stocker or feedlot animals for possible BVDV involvement	♦ IHC or AC-ELISA from skin sample will identify persistently infected cattle and sometimes transiently infected cattle – IHC will work if skin is not desiccated.	Any animal positive by IHC and AC-ELISA test is usually considered persistently infected. To rule-out possible transient BVDV infection interfering with identification of persistently infected animals, confirm any positive test on live cattle in three weeks.

Modified from: Larson et al., 2005a.
*Further information about using pooled samples is available at Munoz-Zanzi et al., 2000 and Larson et al., 2005.

b. Tests currently available for identifying persistent BVDV infection

Test	Cost	Advantages	Disadvantages	Specimens / Shipping
Virus Isolation ♦ 1-3 week turnaround	Moderate to high	♦ Gold Standard for BVDV diagnosis ♦ High specificity ♦ Virus available for study at a later date	♦ Specimens shipped on ice to keep virus viable ♦ Potential false negative due to interference by maternal antibodies in serum. Microplate VI may be less sensitive than full plate isolation ♦ To distinguish between persistent and transient infections, retest positive cattle in 3-4 weeks	♦ Whole blood (10 mL) or serum (2-3 mL) ♦ Send in insulated container with cold packs ♦ Do not freeze samples
Immunohisto-chemistry (IHC) of skin ♦ 2-5 day turnaround	Low	♦ High sensitivity ♦ Usually identifies persistent infections only – transiently infected animals usually test negative	♦ Formalin usage ♦ Will generally not identify transiently infected animals	♦ Determine laboratory preferred sample and shipping ♦ Skin samples, usually ear notch ♦ Send fresh on wet ice or stored in 1:10 volume of 10 percent neutral buffered formalin
Antigen-capture ELISA of serum ♦ 1-5 day turnaround	Low	♦ High sensitivity	♦ Potential false negative due to interference by maternal antibodies ♦ To distinguish between persistent and transient infection, must retest animal in 3 weeks	♦ Serum (2 mL) ♦ Send in insulated container with cold packs
Antigen-capture ELISA of skin ♦ 1-3 day turnaround	Low	♦ High sensitivity ♦ Usually identifies persistent infections (PI) only – transiently infected animals usually test negative	♦ Will generally not identify transiently infected animals	♦ Skin samples ♦ Send in insulated container with cold packs – can hold samples by freezing ♦ Determine laboratory's preferred method of packaging and shipping
Polymerase chain reaction (PCR) ♦ 1-3 day turnaround	Moderate to high (can be reduced by pooling 30 or more samples).	♦ High sensitivity	♦ Potential for laboratory contamination (false positive) ♦ To distinguish between persistent and transient infection, must retest positive cattle in 3 weeks	♦ Whole blood (10 mL) or serum (2-3 mL) ♦ Send in insulted container with cold packs

Modified from: Larson et al. 2005a.

3. Vaccination

Vaccinating calves against BVDV may help to protect them from respiratory disease, as BVDV is a common etiologic agent of the bovine respiratory disease complex. Vaccinating replacement heifers and cows may help protect them from reproductive disease and may provide some degree of fetal protection from persistent infection with BVDV if the cow is exposed during pregnancy.

Vaccination is a useful adjunct to other strategies for BVDV control. Vaccination can help mitigate the effects of BVDV in a herd should animals in the herd be exposed through introduction of new animals or contact with neighboring herds. Vaccination can reduce the severity of disease (reproductive, respiratory, digestive) and the number of animals affected. In addition, vaccination can provide some additional protection for the herd if the testing program fails. While vaccinating will not prevent all transient or persistent infections, it will decrease the cost of an outbreak.

Available evidence suggests that modified live virus vaccines may provide more protection from production of persistently infected calves than vaccination with killed virus products (Kelling, 2004). Modified live virus vaccines may provide sufficient immunity with a single dose, although a multiple-dose primary series is generally recommended for replacement heifers. Killed virus vaccines require at least a two-dose primary series. Modified live virus vaccines have limitations in the timing of administration and generally must be avoided during pregnancy and for 3 to 4 weeks before breeding. Killed vaccines are safe for administration at any time. Vaccinating dams provides some protection against fetal infection during pregnancy, thereby decreasing the risks of persistent infection in the calf, abortion, and congenital defects.

Vaccinating dams also increases passive immunity to calves and may provide protection against respiratory and digestive infections in calves. Vaccinating calves with modified live virus vaccines may also increase respiratory and digestive disease protection. Cross protection for BVDV type 2 infections when using vaccines that contain only BVDV type 1 may be incomplete and depends on the specific strains of BVDV involved (Ficken et al., 2006b). Some evidence suggests that vaccinating dams with a vaccine containing both type 1 and type 2 genotypes may provide the most protection from fetal infection and subsequent persistent infections (Kovacs et al., 2003; Fairbanks et al., 2004; Ficken et al., 2006a , 2006b). In all cases, BVDV vaccine administration should be timed to provide maximal immunity during the first 120 days of pregnancy.

4. Industry concern

The cattle industry has clearly established BVDV control as a priority concern. The National Cattlemen's Beef Association has established a BVDV working group within the Animal Health and Well-being Committee to address research, education, technical issues, and to liaison with other industry and allied groups. The Academy of Veterinary Consultants has issued a position statement on BVDV, recognizing the "enormous losses due to the effects of BVDV infection" and calling for "the beef and dairy industries to adopt measures to control and target eventual eradication of BVDV from North America". This position statement has been endorsed by the American Association of Bovine Practitioners Board of Directors and by the National Cattlemen's Beef Association Animal Health and Well-being Committee. Numerous articles have targeted both producers and cattle veterinarians to increase knowledge and effective management of BVDV.

Section II: Population Estimates

A. BVDV on U.S. Cow-calf Operations

1. Producer familiarity with BVDV

For any BVDV control program to be successful, producers must be knowledgeable about the effects of BVDV and the production and economic value of eradicating the disease. In addition, producers must have access to the appropriate tools/guidelines for achieving control or elimination of BVDV.

The majority of producers surveyed in the Beef 2007–08 study had at least some knowledge of BVDV. Approximately two of three operations (64.0 percent) knew some basics or were fairly knowledgeable about BVDV. A higher percentage of operations with 200 or more beef cows were fairly knowledgeable about BVDV compared with operations with fewer than 100 cows.

Producers on large operations may have greater general knowledge about issues affecting cow-calf operations than producers on smaller operations, since large operations are more likely to be primary or secondary sources of income than small operations. The cow-calf operation was the primary source of income for only 5.3 percent of operations with 1 to 49 beef cows but was the primary source of income for 65.0 percent of operations with 200 or more beef cows (USDA, 2008a). Producers on almost 9 of 10 operations with 200 or more beef cows (89.3 percent) knew some basics or were fairly knowledgeable about BVDV. Despite numerous articles in industry publications about BVDV, over 4 of 10 producers (42.2 percent) with fewer than 50 cows recognized the name only or had not heard of BVDV.

An effective program as outlined by the Academy of Veterinary Consultants to “adopt measures to control and target eventual eradication of BVDV from North America” will likely require additional efforts to educate producers on BVDV disease and the options for control. These efforts may need to focus on the large number of smaller operations. According to the 2007 Census of Agriculture (USDA:NASS, 2009), 79.0 percent of cow-calf operations in the United States have fewer than 50 cows.

a. Percentage of operations by familiarity with BVDV and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Level of Familiarity	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Fairly knowledgeable	26.6	(1.6)	38.2	(2.8)	47.4	(2.9)	57.4	(2.7)	31.6	(1.3)
Knew some basics	31.2	(1.7)	37.6	(2.9)	33.7	(2.7)	31.9	(2.6)	32.4	(1.3)
Recognized the name, not much else	26.7	(1.7)	19.0	(2.3)	15.7	(2.3)	8.1	(1.5)	23.7	(1.3)
Had not heard of before	15.5	(1.4)	5.2	(1.3)	3.2	(1.0)	2.6	(0.7)	12.3	(1.0)
Total	100.0		100.0		100.0		100.0		100.0	

The percentage of producers that had not heard of BVDV was higher in the Southeast region (15.1 percent) than in the Central and West regions (6.5 and 7.2 percent, respectively), perhaps because of the smaller average herd size in the Southeast region and less knowledge of BVDV among small operators. Average herd size in the Southeast region was 37 cows, compared with 60 cows in the Central region and 84 cows in the West region (see Appendix II, p 83).

b. Percentage of operations by familiarity with BVDV and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Level of Familiarity	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Fairly knowledgeable	36.4	(3.5)	35.8	(2.4)	29.4	(1.6)
Knew some basics	34.9	(3.7)	34.1	(2.4)	31.5	(1.7)
Recognized the name, not much else	21.5	(3.7)	23.6	(2.3)	24.0	(1.6)
Had not heard of before	7.2	(2.5)	6.5	(1.4)	15.1	(1.4)
Total	100.0		100.0		100.0	

2. Producer testing practices

Diagnostic testing of cattle for persistent infection with BVDV is a central part of any control or eradication program. Numerous tests are available for detecting BVDV in cattle.

Overall, only 4.2 percent of operations had tested any beef calves for persistent infection with BVDV in the past 3 years. A higher percentage of operations with 200 or more beef cows had tested at least some beef calves for persistent infection (15.6 percent) compared with operations with 1 to 49 beef cows (1.8 percent). The percentages of operations that had tested any calves were not different across the West, Central, and Southeast regions (data not shown).

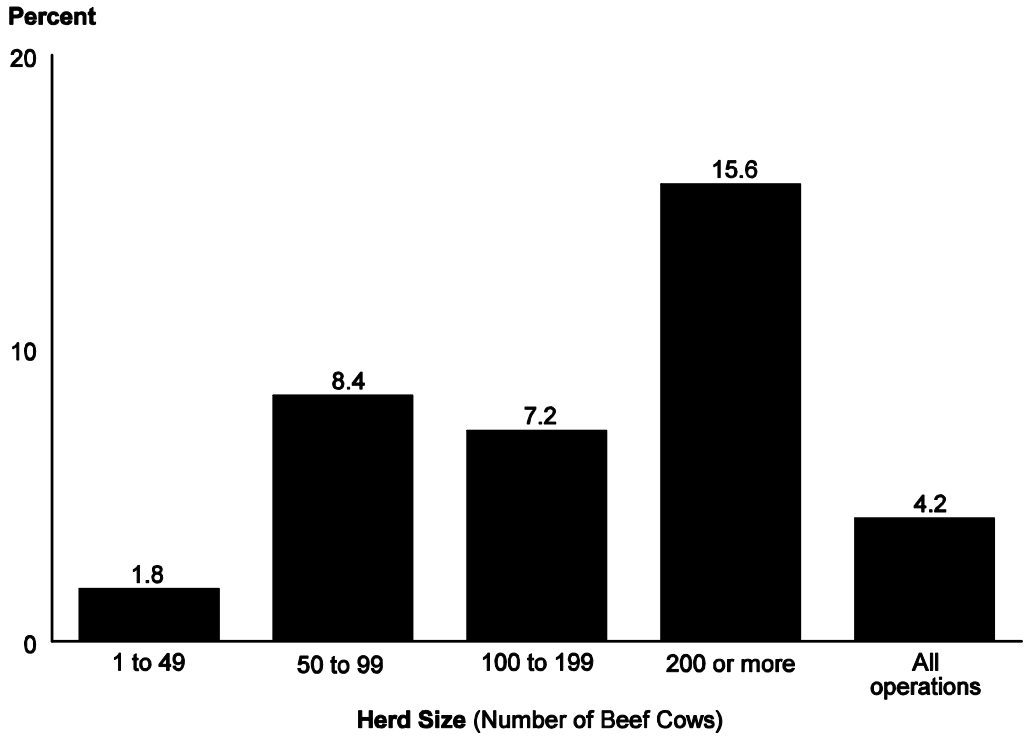
There may be several reasons for the relatively low level of BVDV testing in beef cow-calf operations. One reason could be that producers do not test because they do not believe the disease is present in their herds. Available data suggest that most operations do not have a persistently infected animal in their herds; however, herds with a previous history of signs compatible with BVDV infection are more likely to have a persistently infected animal in the herd (Wittum et al., 2001). Producers may

be correct in not implementing testing protocols in all herds, and further research may be necessary to more clearly define what herd criteria justify a testing program. Alternatively, some producers may not test calves because they do not believe BVDV causes important health, performance, or value issues. Other producers may not have sufficient knowledge of BVDV and its possible impacts. The latter two reasons for not testing may be best addressed with research focused on the production, performance, and value impacts of BVDV in cow-calf operations and the dissemination of those results to producers.

a. Percentage of operations that tested any *beef calves* for persistent infection with BVDV during the previous 3 years, by herd size

Percent Operations									
Herd Size (Number of Beef Cows)									
1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
1.8	(1.2)	8.4	(3.1)	7.2	(2.2)	15.6	(4.0)	4.2	(1.0)

Percentage of Operations that Tested any Beef Calves for Persistent Infection with BVDV During the Previous 3 Years, by Herd Size



Of operations that tested any beef calves for persistent infection during the previous 3 years, 73.5 percent used ear-notches for testing and 35.1 percent submitted serum samples.

b. For operations that tested any beef calves for persistent infection with BVDV during the previous 3 years, percentage of operations by sample type collected

Sample Type	Percent Operations	Std. Error
Ear notch	73.5	(15.9)
Serum	35.1	(15.5)

Producers test animals for BVDV persistent infection for a number of reasons. In some cases, animals are tested to diagnose disease in a specific animal, document the status of an individual animal to meet the requirements of a show or sale, or to increase the perceived value of animals prior to marketing. In other cases, animals are tested as part of an outbreak investigation or to determine the exposure status of the herd. Finally, animals are tested as part of a control program to eliminate animals persistently infected with BVDV from the herd.

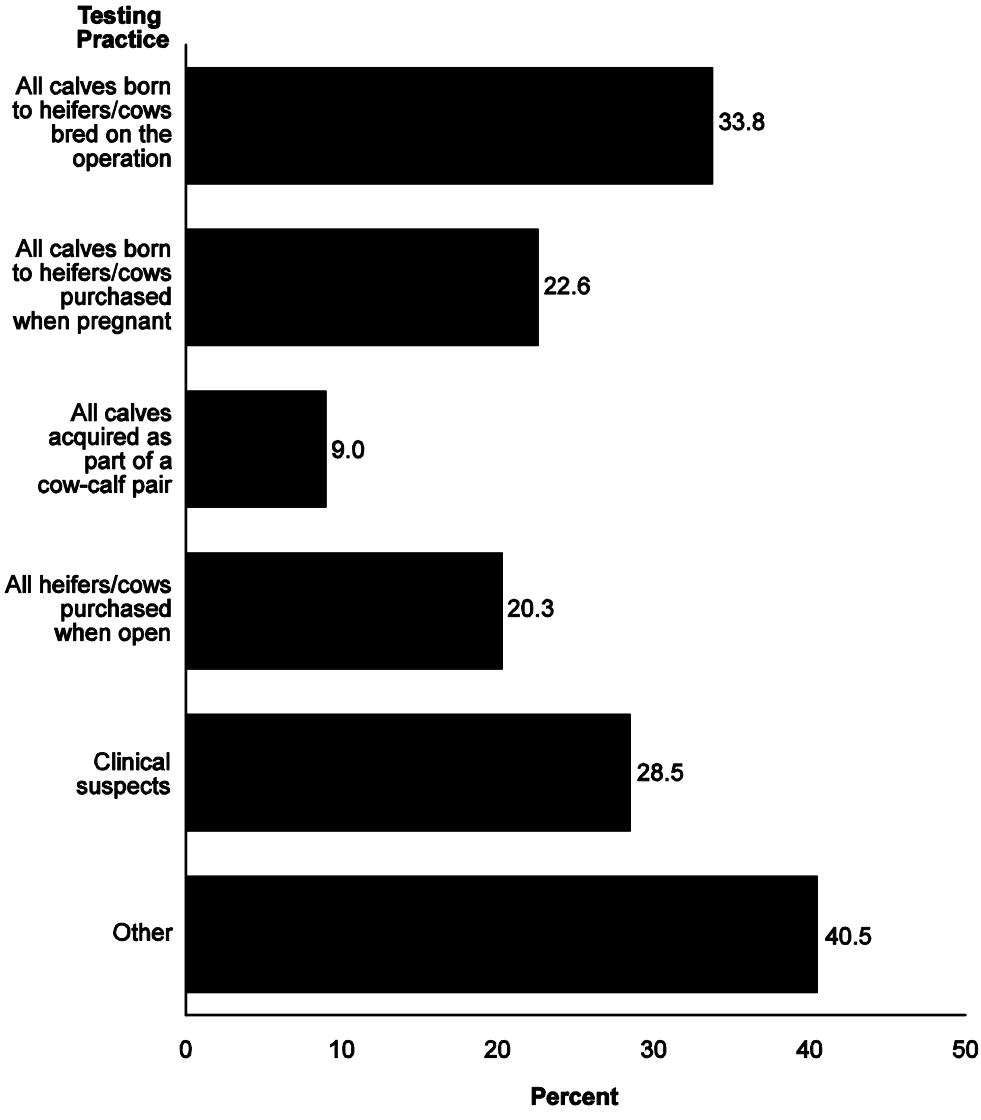
Depending on the goals of testing, different groups of animals may be targeted for the testing. Of operations that tested any beef calves for persistent infection with BVDV during the previous 3 years, about one of three (33.8 percent) tested all calves born to heifers or cows bred on the operation during 2007. More than 1 of 5 operations (22.6 percent) tested all calves born to heifers or cows purchased when pregnant, but fewer than 1 of 10 operations (9.0 percent) tested all calves acquired as part of a cow-calf pair.

Of operations that tested any beef calves for persistent infection with BVDV during the previous 3 years, more than one of four (28.5 percent) tested clinical suspects. Available evidence suggests a higher morbidity and mortality rate among persistently infected cattle. Testing sick and dead cattle as well as poor performers might be a reasonable method of targeted surveillance. Operations that specified an “other” category noted testing bulls, replacement heifers, show and sale animals, and randomly selected animals.

c. For operations that tested any *beef calves* for persistent infection with BVDV during the previous 3 years and had the specified class of cattle, percentage of operations by testing practice used in 2007

Testing Practice	Percent Operations	Standard Error
All calves born to heifers/cows bred on the operation	33.8	(14.1)
All calves born to heifers/cows purchased when pregnant	22.6	(10.6)
All calves acquired as part of a cow-calf pair	9.0	(4.7)
All heifers/cows purchased when open	20.3	(10.1)
Clinical suspects	28.5	(9.6)
Other	40.5	(11.1)

For Operations that Tested any Beef Calves for Persistent Infection with BVDV During the Previous 3 Years and had the Specified Class of Cattle, Percentage of Operations by Testing Practice



A similar percentage of females exposed to a bull on operations that tested for BVDV in the past 3 years and on operations that did not test for BVDV produced a live calf. In another study, herds had lower pregnancy rates at fall pregnancy exam if a BVDV persistently infected calf was born in the herd the subsequent calving season compared with herds without a persistently infected calf born in the herd (Wittum et al., 2001).

d. Of heifers and cows exposed to a bull and/or semen, percentage that produced a live calf, by whether the operation tested any beef calves for persistent infection with BVDV in the past 3 years

Percent Exposed Heifers and Cows					
BVDV Testing					
Yes		No		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
95.0	(0.6)	92.7	(0.7)	92.9	(0.6)

Photo courtesy of Geni Wren “Bovine Veterinarian” magazine

B. Producer Expectations of the Economic Returns and Health Effects Provided by Testing for BVDV Persistent Infection

1. Effect on calf value of testing for persistent infection with BVDV

The value of testing and removing persistently infected cattle from the herd is of central importance in the consideration of any control program. Testing and removal must ultimately have a positive economic return for any private and voluntary control or eradication program to be feasible. The positive economic return of testing and removal may be the result of either increased sale value of the test-negative cattle or improved health or growth performance of the cattle remaining in the herd.

In general, producer familiarity with BVDV did not impact producer beliefs about the value of calves remaining in the herd after the removal of any persistently infected calves (P=0.24). Of operations that were fairly knowledgeable about BVDV, 41.8 percent believed that removing calves that test positive for persistent infection with BVDV affects the value of the calves remaining in the herd.

a. Percentage of operations by whether, according to producers, removing calves that test positive for persistent infection with BVDV affects the value of the remaining *calves* in the herd, and by level of familiarity with BVDV

	Percent Operations									
	Level of Familiarity									
	Fairly Knowledge-able		Knew Some Basics		Recognized the Name, not Much Else		Had not Heard of Before		All Operations	
Affects value of remaining calves?	Pct	Std. Error	Pct	Std. Error	Pct	Std. Error	Pct	Std. Error	Pct	Std. Error
Yes	41.8	(5.2)	30.3	(4.9)	31.3	(7.3)	30.3	(12.8)	34.3	(3.2)
Do not know	39.2	(5.1)	48.8	(5.7)	46.6	(7.4)	63.7	(12.9)	46.6	(3.4)
No	19.0	(4.2)	20.9	(4.6)	22.1	(6.6)	6.0	(4.5)	19.1	(2.7)
Total	100.0		100.0		100.0		100.0		100.0	

Overall chi-square test P=0.24.

The percentage of producers that believed removing calves persistently infected with BVDV increased the value of the remaining calves (15.3 percent) was higher than the percentage of operations that had tested any calves for BVDV during the previous 3 years (4.2 percent) [see table a., p 21]. Many of these producers may have believed that testing is valuable but did not believe BVDV was present in their herds. This result could also represent a lag in testing implementation, as knowledge of BVDV and its effects has increased. Producer belief regarding the value of testing should precede the implementation of a testing program.

Producers may have also believed that the value of animals that tested negative of persistent infection with BVDV increased, but by an amount insufficient to offset the costs of testing.

Considerable uncertainty exists among producers regarding the effect that testing and removing calves persistently infected with BVDV has on the value of remaining calves in the herd. Almost one-half of operations (46.6 percent) did not know if removing calves that tested positive for persistent infection with BVDV would change the value of the remaining calves. A similar percentage of operations believed that removing persistently infected calves increased the value of remaining calves (15.3 percent), had no effect (19.1 percent), or affected the value but by an unknown amount (16.4 percent). A low percentage of operations (2.6 percent) believed that removing persistently infected calves decreased the value of remaining calves, but it is unclear why they believed this. The percentages of operations in each belief category did not differ substantially across herd sizes.

b. Percentage of operations by how, according to producers, removing calves that test positive for persistent infection with BVDV affects the value of the remaining *calves* in the herd, and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Effect on Value of Remaining Calves	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Increases value	14.2	(3.1)	16.0	(4.1)	15.7	(3.4)	27.6	(4.7)	15.3	(2.3)
Decreases value	3.3	(2.0)	1.8	(1.8)	0.0	(- -)	0.8	(0.7)	2.6	(1.4)
Has no effect	18.7	(3.6)	20.1	(4.9)	23.6	(6.4)	13.8	(3.3)	19.1	(2.7)
Do not know	48.8	(4.5)	46.6	(6.3)	37.3	(5.4)	32.6	(5.0)	46.6	(3.3)
Affects value, but amount unknown	15.0	(3.3)	15.5	(4.2)	23.4	(4.5)	25.2	(4.6)	16.4	(2.4)
Total	100.0		100.0		100.0		100.0		100.0	

Between 40 and 50 percent of producers in all three regions did not know the effect that removing calves persistently infected with BVDV had on the value of the remaining calves. However, some regional differences were apparent regarding beliefs about how removing calves persistently infected with BVDV affects the value of the remaining calves. A higher percentage of operations in the West region believed that removing BVDV persistently infected calves from the herd increased the value of the remaining calves compared with operations in the Southeast region. A lower percentage of operations in the West region believed that removing BVDV persistently infected calves from the herd had no effect on the value of the remaining calves compared with operations in the Central region.

If any voluntary control or eradication plan is to be successful, research and production data must be supportive of the economic value of the program. Further research may be needed regarding the economic impacts of BVDV, the market rewards associated with having animals that test negative for persistent infection with BVDV, and the benefits of educating producers about economic effects of BVDV.

c. Percentage of operations by how, according to producers, removing calves that test positive for persistent infection with BVDV affects the value of the remaining calves in the herd, and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Effect on Value of Remaining Calves	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Increases value	29.3	(5.6)	18.9	(3.8)	12.0	(3.0)
Decreases value	0.4	(0.4)	0.0	(0.0)	3.9	(2.2)
Has no effect	8.1	(2.4)	26.0	(4.8)	18.1	(3.6)
Do not know	47.1	(5.6)	39.8	(5.3)	49.0	(4.6)
Affects value, but amount unknown	15.1	(3.7)	15.3	(3.1)	17.0	(3.4)
Total	100.0		100.0		100.0	

d. For operations that believed removing calves that test positive for persistent infection with BVDV affects the value of the remaining calves in the herd, operation average (dollars per head) change in value

Change in Value	Operation Average (Dollars per Head)	Standard Error
Increase	32	(4.2)
Decrease	39	(7.6)

2. Effect on cattle health of testing for persistent infection with BVDV

Improved health or performance in calves following the detection and removal of calves persistently infected with BVDV may also justify a voluntary control or eradication program. Overall, the majority of operations (57.2 percent) believed that removing calves persistently infected with BVDV would affect the health of the remaining cattle. A higher percentage of operations with 200 or more beef cows believed that removing calves persistently infected with BVDV would affect the health of remaining cattle compared with operations with 1 to 49 beef cows. A lower percentage of operations with 200 or more beef cows did not know if removing calves persistently infected with BVDV would affect the health of the remaining cattle compared with operations with 1 to 49 beef cows. This difference may be related to general knowledge about BVDV. A higher percentage of operations with 200 or more beef cows also reported that they considered themselves to be fairly knowledgeable about BVDV compared with operations with fewer than 100 cows (Section II A.1.a).

a. Percentage of operations by whether, according to producers, removing calves that test positive for persistent infection with BVDV affects the health of the remaining *cattle* in the herd, and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		50-99		100-199		200 or More		All Operations	
Affects Health	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Yes	53.4	(4.6)	67.9	(6.0)	57.7	(5.9)	74.1	(4.3)	57.2	(3.4)
No	7.6	(2.6)	9.6	(3.8)	7.1	(2.5)	4.2	(1.6)	7.7	(1.9)
Do not know	39.0	(4.4)	22.5	(5.2)	35.2	(6.0)	21.7	(4.1)	35.1	(3.2)
Total	100.0		100.0		100.0		100.0		100.0	

The percentage of operations that believed removing calves that test positive for persistent infection with BVDV affects the health of the remaining cattle was higher in the West region than the Southeast region.

b. Percentage of operations by whether, according to producers, removing calves that test positive for persistent infection with BVDV affects the health of the remaining *cattle* in the herd, and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Affects Health	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Yes	76.5	(6.5)	59.6	(5.1)	53.8	(4.6)
No	3.4	(1.5)	10.2	(3.4)	7.3	(2.5)
Do not know	20.1	(6.4)	30.2	(5.0)	38.9	(4.4)
Total	100.0		100.0		100.0	

For the 57.2 percent of operations that believed removing calves persistently infected with BVDV affects the health of the remaining cattle in the herd, most expected multiple health benefits. Overall, 89.7 percent of these operations expected improved reproductive efficiency; 96.9 percent expected reduced sickness and treatment costs; and 95.7 percent expected reduced death loss. Percentages were similar across herd sizes. All producers who indicated "other" health effects expected performance effects.

These expected health and performance benefits would further justify the efforts and expense of controlling or eradicating BVDV. Despite this high expectation of health benefits resulting from testing and removal, few operations had tested any calves for BVDV during the previous 3 years. Similar to producer expectations of increased value in tested calves, the difference in expectation of health benefits and the implementation of actual testing may represent a lag, as knowledge of BVDV and its effects have increased. Producer belief regarding the value of testing in improving health would be expected to precede implementation of a testing program.

c. For operations that believed removing calves that tested positive for persistent infection with BVDV affected the health of the remaining *cattle* in the herd, percentage of operations by expected health effect and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Expected Health Effect	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Improved reproductive efficiency (fewer abortions, stillbirths)	88.1	(3.6)	95.5	(2.3)	87.1	(3.9)	91.9	(3.0)	89.7	(2.4)
Reduced sickness and/or treatment costs	95.9	(2.5)	98.5	(1.5)	99.3	(0.7)	98.9	(0.9)	96.9	(1.6)
Reduced death loss	95.3	(2.5)	98.6	(1.4)	94.5	(2.2)	93.2	(2.6)	95.7	(1.6)
Other	1.3	(0.9)	4.1	(1.9)	9.2	(4.5)	13.1	(4.7)	3.4	(0.9)

For the 57.2 percent of operations that believed removing calves persistently infected with BVDV affects the health of the remaining cattle in the herd, the percentages of operations by expected health benefits were similar across regions.

d. For operations that believed removing calves that tested positive for persistent infection with BVDV affected the health of the remaining *cattle* in the herd, percentage of operations by expected health effect and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Expected Health Effect	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Improved reproductive efficiency (fewer abortions, stillbirths)	96.2	(1.8)	84.2	(5.0)	90.9	(3.2)
Reduced sickness and/or treatment costs	99.3	(0.6)	97.3	(1.9)	96.3	(2.5)
Reduced death loss	98.9	(0.7)	98.0	(1.2)	94.1	(2.6)
Other	2.1	(1.1)	5.0	(2.3)	3.0	(1.1)

Photo courtesy of Geni Wren “Bovine Veterinarian” magazine

C. BVDV Vaccination

1. General practices

A complete BVDV control program includes controlling exposure and enhancing animals' resistance to infection. Methods for enhancing resistance can be nonspecific, such as ensuring good nutrition and minimizing stress, or specific, such as using vaccines directed against pathogens. The purpose of BVDV vaccination in cows is to increase their level of immunity and decrease the likelihood of BVDV transmission to the fetus, should exposure occur. While no vaccine is 100-percent effective, vaccination can increase immunity, decrease the probability of transmission to the fetus, and decrease the number of BVDV persistently infected calves produced. Vaccination might mitigate the impact of BVDV introduction and is the only defense against potential exposures not fully controlled by management, such as fenceline contacts.

The NAHMS program has collected data on vaccination practices on beef cow-calf operations in three studies. The three studies had somewhat different methodologies. Further information on the methods for each of the studies is available (USDA, 1994, 1997, 2008b). Briefly, the NAHMS 1992/93 CHAPA study collected data in 18 States from a sample of operations with 5 or more beef cows. For the Beef '97 study, data were collected in 23 States from a sample of operations with 1 or more beef cows, and for the Beef 2007–08 study, data were collected in 24 States from a sample of operations with 1 or more beef cows. The percentage of operations that used BVDV vaccines has increased since 1992 for most classes of animals. The percentage of operations that vaccinated cows or bulls for BVDV was higher during the Beef 2007–08 study compared with each of the previous studies.

a. Percentage of operations that vaccinated for BVDV, by cattle class vaccinated

	Percent Operations					
	1992/93 CHAPA[1,2]		Beef '97[3]		Beef 2007–08[4]	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Calves 1 to 21 days	0.9	(0.8)	1.5	(0.6)	3.0	(0.9)
Calves 22 days through weaning	14.5	(1.8)	25.3	(2.3)	33.1	(2.8)
Weaned replacement heifers through breeding	13.0	(2.1)	16.3	(1.9)	25.1	(2.4)
Bred replacement heifers through calving	6.4	(1.6)	9.2	(1.5)	13.7	(1.7)
Cows	12.9	(2.3)	17.4	(2.0)	28.1	(2.6)
Bulls	7.8	(1.8)	13.2	(1.9)	24.3	(2.5)

[1]Cow/calf Health and Productivity Audit.
[2]Population: spring calving operations with 5 or more cows in 18 States.
[3]Population: all cow-calf operations in 23 States.
[4]Population: all cow-calf operations in 24 States.

BVDV is one of several etiologic agents associated with respiratory disease in beef calves. In the Beef '97 and Beef 2007–08 studies, data were collected on the percentage of operations that vaccinated calves for respiratory diseases 0, 1, 2, or 3 or more times. Similar regional trends were evident in the frequency of vaccination of calves prior to sale in both of the studies.

b. Percentage of operations by number of times calves were typically vaccinated against respiratory disease from birth to sale, and by region

	Percent Operations							
	Number of Times Vaccinated							
	0		1		2		3 or More	
Region	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
	Beef '97[1]							
West	49.5	(6.5)	28.0	(5.1)	20.0	(3.7)	2.5	(0.8)
North Central	40.1	(4.1)	37.2	(4.5)	20.2	(3.5)	2.5	(0.8)
South Central	73.0	(6.0)	22.1	(5.9)	4.4	(2.2)	0.5	(0.2)
Central	54.6	(5.7)	27.7	(4.7)	17.7	(4.8)	0.0	(0.0)
Southeast	78.2	(4.8)	11.8	(3.1)	9.8	(4.0)	0.2	(0.1)
All	64.3	(2.6)	22.8	(2.3)	12.2	(1.8)	0.7	(0.1)
	Beef 2007–08[2]							
West	42.5	(7.8)	26.1	(7.0)	28.9	(6.0)	2.5	(0.9)
Central	33.1	(5.1)	30.1	(4.6)	30.7	(4.3)	6.1	(1.8)
Southeast	73.3	(3.6)	10.3	(2.4)	14.8	(2.8)	1.6	(0.7)
All	60.6	(3.0)	16.6	(2.2)	20.0	(2.2)	2.8	(0.7)

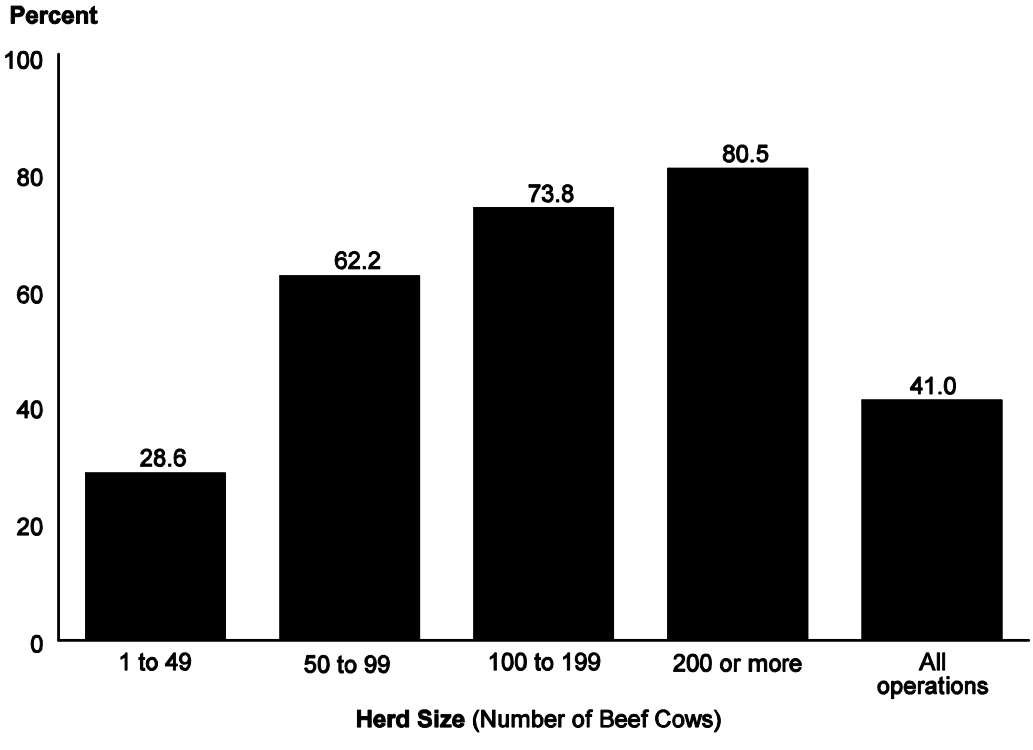
[1]Population: all cow-calf operations in 23 States.
[2]Population: all cow-calf operations in 24 States.

About 4 of 10 operations (41.0 percent) vaccinated at least some cattle against BVDV in 2007. This percentage is roughly equivalent to the 39.4 percent of operations that did not typically vaccinate calves for respiratory disease (see previous table). A higher percentage of operations with 50 or more beef cows vaccinated at least some cattle against BVDV compared with operations with fewer than 50 cows.

c. Percentage of operations that vaccinated any cattle or calves against BVDV in 2007, by herd size

Percent Operations									
Herd Size (Number of Beef Cows)									
1-49		50-99		100-199		200 or More		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
28.6	(3.8)	62.2	(6.3)	73.8	(5.3)	80.5	(4.5)	41.0	(3.1)

Percentage of Operations that Vaccinated Any Cattle or Calves Against BVDV in 2007, by Herd Size



A higher percentage of operations in the West and Central regions (56.4 and 67.9 percent, respectively) vaccinated at least some cattle against BVDV in 2007 compared with operations in the Southeast region (28.9 percent).

d. Percentage of operations that vaccinated any cattle or calves against BVDV in 2007, by region

Percent Operations					
Region					
West		Central		Southeast	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
56.4	(7.6)	67.9	(5.2)	28.9	(3.8)

2. Vaccination by cattle group

Vaccinating the breeding herd reduces the risk of producing calves persistently infected with BVDV. Cows with high levels of immunity to BVDV are less likely to transmit the BVDV infection to their fetuses. Vaccinating calves may have some effect in priming immunity for replacement heifers and in decreasing transient infections within calves.

Of the 41.0 percent of operations that vaccinated at least some cattle against BVDV in 2007, the highest percentage (80.7 percent) vaccinated calves between 22 days of age and weaning, followed by weaned replacement heifers before breeding (61.2 percent) and bulls (59.4 percent). Less than one-half of operations that vaccinated at least some cattle vaccinated cows prebreeding or precalving (44.5 and 41.5 percent, respectively). A higher percentage of operations with 200 or more beef cows vaccinated weaned replacement heifers before breeding (76.5 percent) compared with operations with 1 to 49 beef cows (50.5 percent). For all other specific cattle groups, the percentages that were vaccinated did not differ substantially across herd sizes.

a. For operations that vaccinated any cattle or calves against BVDV in 2007, percentage of operations by cattle class vaccinated and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		50-99		100-199		200 or More		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Calves 1 to 21 days	8.6	(3.9)	2.4	(2.1)	9.7	(3.6)	8.2	(2.7)	7.2	(2.1)
Calves 22 days through weaning	84.5	(5.5)	78.1	(6.0)	71.3	(7.7)	84.6	(4.4)	80.7	(3.4)
Weaned replacement heifers before breeding	50.5	(7.6)	69.9	(6.7)	70.2	(5.5)	76.5	(4.5)	61.2	(4.4)
Bred replacement heifers precalving	31.8	(6.6)	37.1	(6.7)	34.4	(6.0)	37.3	(5.2)	34.1	(3.8)
Cows prebreeding	46.8	(7.5)	42.6	(7.0)	39.1	(6.4)	47.2	(5.5)	44.5	(4.2)
Cows precalving	43.2	(7.4)	39.7	(6.8)	37.0	(6.2)	44.7	(5.3)	41.5	(4.1)
Bulls	66.7	(7.1)	58.0	(7.2)	50.9	(6.8)	42.5	(5.5)	59.4	(4.1)

In the West region, the highest percentage of operations that vaccinated any cattle (90.8 percent) vaccinated calves between 22 days of age and weaning, followed by weaned replacement heifers before breeding (61.1 percent), and cows precalving (53.3 percent). The percentages of operations that vaccinated calves between 22 days of age and weaning, weaned replacement heifers before breeding, and bulls were similar in the Southeast and Central regions. In all regions, very few operations (11 percent or less) vaccinated calves 1 to 21 days of age.

b. For operations that vaccinated any cattle or calves against BVDV in 2007, percentage of operations by cattle class vaccinated and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Calves 1 to 21 days	4.7	(2.5)	10.7	(4.0)	4.8	(2.5)
Calves 22 days through weaning	90.8	(3.8)	82.4	(4.5)	76.5	(6.0)
Weaned replacement heifers before breeding	61.1	(9.5)	61.8	(5.5)	60.8	(7.5)
Bred replacement heifers precalving	47.2	(8.8)	30.4	(5.1)	33.9	(6.3)
Cows prebreeding	38.3	(8.3)	43.3	(5.5)	47.2	(7.3)
Cows precalving	53.3	(8.7)	35.0	(5.3)	44.0	(7.1)
Bulls	48.7	(8.8)	52.4	(5.6)	68.4	(6.8)

3. Timing of vaccination for replacement

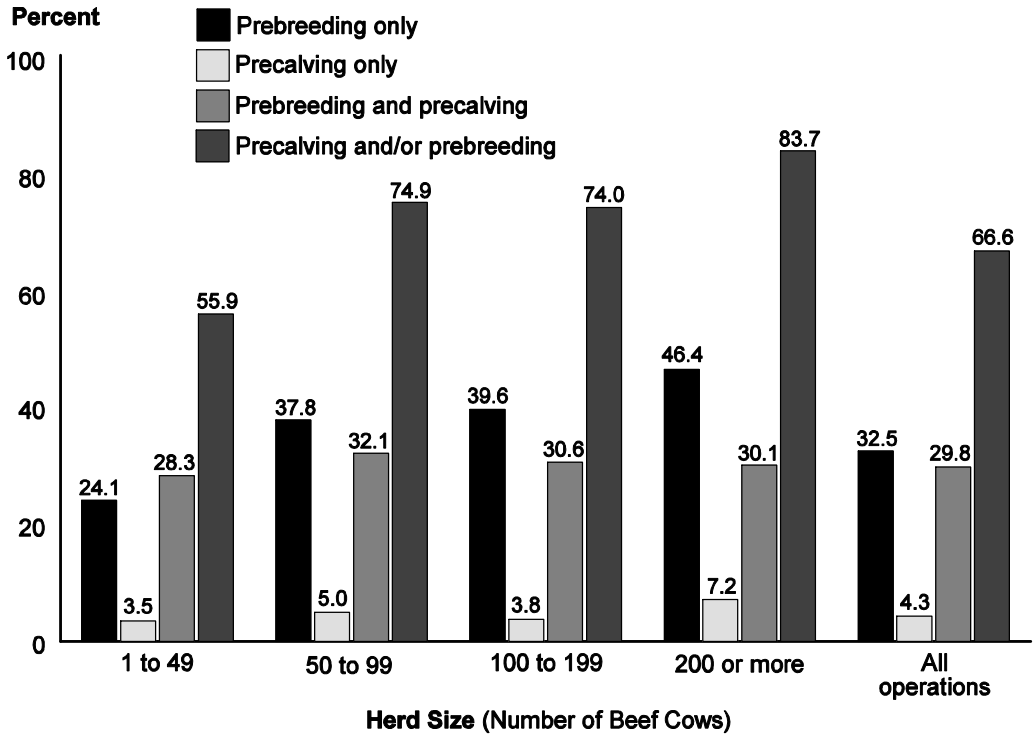
Of the 41.0 percent of operations that vaccinated at least some cattle against BVDV in 2007, a higher percentage of operations with 200 or more beef cows (83.7 percent) vaccinated replacement heifers at precalving and/or prebreeding compared with operations with 1 to 49 beef cows (55.9 percent). Two of three operations (66.6 percent) gave at least one BVDV vaccination to replacement heifers, either prebreeding or precalving.

a. For operations that vaccinated any cattle or calves against BVDV in 2007*, percentage of operations by timing of vaccination for replacement heifers and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Vaccination Timing	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Prebreeding only	24.1	(6.3)	37.8	(7.0)	39.6	(7.2)	46.4	(5.6)	32.5	(3.8)
Precalving only	3.5	(2.5)	5.0	(2.8)	3.8	(1.9)	7.2	(2.7)	4.3	(1.4)
Prebreeding and precalving	28.3	(6.4)	32.1	(6.5)	30.6	(5.8)	30.1	(4.7)	29.8	(3.6)
Precalving and/or prebreeding	55.9	(7.7)	74.9	(6.2)	74.0	(5.2)	83.7	(3.9)	66.6	(4.3)

*Operations with incomplete vaccination data were excluded.

For Operations that Vaccinated any Cattle or Calves Against BVDV in 2007*, Percentage of Operations by Timing of Vaccination for Replacement Heifers and by Herd Size



*Operations with incomplete vaccination data were excluded

The percentages of operations by timing of replacement heifer vaccination were similar across regions.

b. For operations that vaccinated any cattle or calves against BVDV in 2007*, percentage of operations by timing of vaccination for replacement heifers and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Vaccination Timing	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Prebreeding only	22.7	(5.7)	34.2	(5.2)	33.6	(6.6)
Precalving only	8.8	(5.4)	2.9	(1.4)	4.4	(2.4)
Prebreeding and Precalving	38.4	(8.4)	27.5	(5.0)	29.5	(6.1)
Precalving and/ or Prebreeding	69.9	(9.5)	64.7	(5.5)	67.5	(7.5)

*Operations with incomplete vaccination data were excluded.

4. Vaccination frequency

Of the 33.1 percent of operations that vaccinated calves against BVDV at 22 days of age through weaning in 2007, more than 6 of 10 vaccinated calves only once. The number of times operations vaccinated calves from 22 days of age through weaning was similar across herd sizes.

For operations that vaccinated any calves against BVDV at 22 days of age through weaning in 2007, percentage of operations by number of times *calves* were vaccinated and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		50-99		100-199		200 or More		All Operations	
Number of Times Vaccinated	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
1	66.7	(8.5)	63.6	(8.9)	63.9	(6.4)	45.7	(6.0)	63.1	(4.7)
2	33.3	(8.5)	30.6	(7.7)	30.2	(5.8)	49.8	(6.1)	34.1	(4.7)
3 or more	0.0	(0.0)	5.8	(5.6)	5.9	(3.0)	4.5	(2.0)	2.8	(1.4)
Total	100.0		100.0		100.0		100.0		100.0	

5. BVDV booster injections

About one of five operations gave cows and bulls an annual BVDV booster vaccination in 2007 (23.8 and 20.3 percent of operations, respectively). A higher percentage of operations with 50 or more beef cows gave booster vaccinations to cows compared with operations with 1 to 49 beef cows. Booster vaccinations are particularly important when killed virus vaccines are used.

a. Percentage of operations that gave an annual BVDV booster injection to cows or bulls in 2007, by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		50-99		100-199		200 or More		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Cows	15.9	(3.0)	37.7	(5.8)	41.9	(5.6)	54.0	(5.1)	23.8	(2.4)
Bulls	15.1	(3.0)	31.0	(5.4)	34.3	(5.4)	31.4	(4.8)	20.3	(2.3)

The percentages of operations that gave an annual BVDV booster vaccination to cows or bulls did not differ substantially across regions.

b. Percentage of operations that gave an annual BVDV booster injection to cows or bulls in 2007, by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Cows	35.5	(6.4)	33.4	(4.5)	18.7	(3.1)
Bulls	22.6	(5.4)	26.9	(4.2)	17.6	(3.0)

6. BVDV vaccine type and genotype

Of the 41.0 percent of operations that vaccinated at least some cattle against BVDV in 2007, more than 8 of 10 used a vaccine that included both type 1 and type 2 BVDV on all cattle groups vaccinated. A higher percentage of operations used a killed virus vaccine than a modified live virus vaccine on bred replacement heifers precalving, on cows precalving, and on bulls. Some commercially available modified live virus vaccines have label claims for use in pregnant animals when label directions regarding previous vaccination are closely followed. In situations in which the label directions cannot be followed, killed vaccines are safer than modified live vaccines for pregnant animals.

a. For operations that vaccinated any cattle or calves within each cattle class against BVDV in 2007, percentage of operations by BVDV vaccine type and virus genotype

	Percent Operations									
	BVDV Vaccine Type					Virus Genotype				
	Killed		Modified Live			Type 1 Only		Types 1 & 2		
Cattle Class	Pct.	Std. Err.	Pct.	Std. Err.	Total	Pct.	Std. Err.	Pct.	Std. Err.	Total
Calves 1 to 21 days	59.2	(14.2)	40.8	(14.2)	100.0	15.5	(8.7)	84.5	(8.7)	100.0
Calves 22 days through weaning	54.5	(4.6)	45.5	(4.6)	100.0	16.4	(3.4)	83.6	(3.4)	100.0
Weaned replacement heifers before breeding	51.5	(5.1)	48.5	(5.1)	100.0	10.7	(3.0)	89.3	(3.0)	100.0
Bred replacement heifers precalving	70.5	(5.1)	29.5	(5.1)	100.0	13.6	(4.0)	86.4	(4.0)	100.0
Cows prebreeding	58.2	(6.0)	41.8	(6.0)	100.0	10.3	(3.6)	89.7	(3.6)	100.0
Cows precalving	71.3	(6.3)	28.7	(6.3)	100.0	13.0	(4.0)	87.0	(4.0)	100.0
Bulls	67.8	(5.4)	32.2	(5.4)	100.0	10.6	(3.0)	89.4	(3.0)	100.0

For operations that gave a BVDV booster vaccine to cows or bulls in 2007 (23.8 and 20.3 percent, respectively), a higher percentage of operations gave killed virus vaccine boosters to cows (64.4 percent) and bulls (69.0 percent) than gave modified live virus boosters. A higher percentage of operations gave booster vaccines containing both type 1 and type 2 BVDV to cows and bulls (88.3 and 86.4 percent, respectively) than gave type 1 only BVDV vaccine.

b. For operations that gave an annual BVDV booster injection to any cows or bulls in 2007, percentage of operations by BVDV vaccine type and virus genotype

	Percent Operations									
	BVDV Vaccine Type					Virus Genotype				
	Killed		Modified Live			Type 1 Only		Types 1 & 2		
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Total	Pct.	Std. Error	Pct.	Std. Error	Total
Cows	64.4	(4.8)	35.6	(4.8)	100.0	11.7	(3.3)	88.3	(3.3)	100.0
Bulls	69.0	(5.3)	31.0	(5.3)	100.0	13.6	(3.9)	86.4	(3.9)	100.0

Of the 25.1 percent of operations that vaccinated weaned replacement heifers before breeding (see table p 50), almost one-half (47.5 percent) used a modified live virus vaccine containing both type 1 and type 2 BVDV. Of operations that vaccinated pregnant replacement heifers or cows against BVDV in 2007, approximately 6 of 10 (59.9 and 59.7 percent, respectively) used killed virus vaccines containing both type 1 and type 2 BVDV.

c. For operations that vaccinated the specified class of cattle against BVDV in 2007, percentage of operations by vaccine type

	Percent Operations[1]								
	Killed				Modified Live				
	Type 1		Types 1 & 2		Type 1		Types 1 & 2		
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Calves 1 to 21 days[2]	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0
Calves 22 days through weaning	12.7	3.0	41.9	4.8	3.7	1.9	41.7	4.5	100.0
Weaned replacement heifers before breeding	9.7	3.0	41.8	5.2	1.0	0.5	47.5	5.1	100.0
Bred replacement heifers precalving	10.6	3.6	59.9	5.9	3.0	1.9	26.5	4.8	100.0
Cows prebreeding	8.7	3.3	49.5	6.3	1.6	1.3	40.2	6.0	100.0
Cows precalving	11.6	3.8	59.7	6.4	1.4	1.4	27.3	6.2	100.0
Bulls	10.3	3.0	57.4	5.6	0.3	0.3	32.0	5.4	100.0

[1]Numbers in this table may differ slightly from the two preceding tables because of rounding.
[2]Too few to report.

Among operations that used some BVDV vaccines in calves through weaning, most used either killed virus vaccines or modified live virus vaccines rather than a combination of the two.

d. Percentage of operations by type of BVDV vaccine used for calves through weaning

	Percent Operations			
	Beef '97[1]		Beef 2007–08[2,3]	
BVDV Vaccine Type	Pct.	Std. Error	Pct.	Std. Error
Killed only	12.0	(1.4)	15.8	(2.1)
Modified live only	7.2	(1.0)	13.0	(1.6)
Killed and modified live	3.7	(1.6)	0.0	(--)
Unknown	2.5	(0.7)	4.4	(1.5)
Not vaccinated for BVDV	74.6	(2.3)	66.8	(2.8)
Total	100.0		100.0	

[1]Population: all cow-calf operations in 23 States.
[2]Population: all cow-calf operations in 24 States.
[3]Question variation: In 1997, producers were asked what type of vaccine was used for calves through weaning (killed, modified live, both killed and modified live, do not know, and do not vaccinate). In 2007–08, producers were asked to identify the specific vaccine product used most commonly for calves 1 to 21 days old and calves 22 days through weaning. Producers were not given the option to select "do not know" or to indicate "both killed and modified live." If a producer indicated that he/she did vaccinate but left the vaccine product blank, "do not know" was inferred. If a producer gave killed virus vaccine to one age group of calves and modified live virus vaccine to the other age group, the operation would have been placed in the "killed and modified live" category. Because of the question variation, any operation that most commonly used killed virus vaccines for calves in 2007–08 would appear in the" killed only" category, regardless of whether or not it sometimes used a modified live virus vaccine. Likewise, any operation that most commonly used modified live virus vaccines for calves in 2007–08 would appear in the" modified live only" category, regardless of whether or not it sometimes used a killed virus vaccine.

7. Vaccination and familiarity with BVDV

Operations that reported a higher degree of familiarity with BVDV were more likely to vaccinate any cattle for BVDV. Nearly two of three operations (61.3 percent) that reported being fairly knowledgeable about BVDV vaccinated some cattle for BVDV, whereas only 15.3 percent of operations that had never heard of BVDV vaccinated cattle for BVDV. While it seems paradoxical that producers would vaccinate for a disease that they had never heard of, it is possible that they did not recognize the specific pathogens covered by some of the vaccine products they were using. It is also possible that they only knew that the vaccine they were using was to prevent certain disease syndromes, such as respiratory disease in calves or reproductive disease in replacement heifers or cows.

Percentage of operations that vaccinated any cattle or calves for BVDV in 2007, by cattle class vaccinated and by level of familiarity with BVDV

	Percent Operations									
	Level of Familiarity									
	Fairly Knowledge-able		Knew Some Basics		Recognized the Name, not Much Else		Had not Heard of Before		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Calves 1 to 21 days	4.2	(1.8)	4.0	(1.7)	0.6	(0.6)	0.0	(--)	3.0	(0.9)
Calves 22 days through weaning	50.4	(5.2)	27.1	(4.1)	24.8	(6.6)	15.3	(9.3)	33.1	(2.8)
Weaned replacement heifers before breeding	42.8	(4.9)	23.4	(3.8)	12.4	(4.5)	0.0	(0.0)	25.1	(2.4)
Bred replacement heifers precalving	27.2	(4.0)	11.9	(2.8)	2.5	(1.8)	0.0	(0.0)	13.7	(1.7)
Cows	49.6	(5.2)	23.1	(3.8)	13.3	(5.0)	7.3	(7.0)	28.1	(2.6)
Bulls	45.8	(5.1)	16.9	(3.4)	12.0	(5.0)	7.2	(7.0)	24.3	(2.5)
Any	61.3	(5.5)	34.5	(4.6)	32.6	(7.1)	15.3	(9.3)	41.0	(3.1)

8. Vaccination and reproductive outcome

On operations that vaccinated any cattle or calves against BVDV in 2007, the percentage of heifers and cows exposed to a bull and/or semen that failed to produce a live calf was similar on operations that vaccinated heifers against BVDV and on operations that did not.

For operations that vaccinated any cattle or calves against BVDV in 2007, percentage of heifers and cows exposed to a bull and/or semen that failed to produce a live calf*, by whether or not the operation vaccinated replacement heifers against BVDV in 2007

Percent Exposed Heifers and Cows that Failed to Produce a Live Calf					
Heifers Vaccinated (Prebreeding and/or Precalving)					
Yes		No		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
8.1	(0.9)	5.2	(0.7)	7.5	(0.8)

*Includes calf born dead, known abortions, and failure to conceive.

9. Use of vaccination and testing

Of operations that vaccinated any cattle or calves against BVDV in 2007, 9.0 percent tested calves for persistent infection with BVDV during the previous 3 years, while only 0.7 percent of operations that did not vaccinate tested calves for persistent infection. These results may indicate a lack of familiarity with BVDV, a lack of concern about BVDV, or a lower level of concern for animal health in general. Table b. suggests that the difference is not due to a lack of familiarity with the disease, as the percentages of operations that tested were not substantially different for operations that were fairly knowledgeable with or knew some basics about BVDV (4.7 percent had tested during the previous 3 years) compared with operations with less familiarity (3.0 percent tested).

a. [v265, v293] Percentage of operations that tested any beef calves for persistent infection with BVDV during the previous 3 years by whether or not the operation vaccinated any cattle or calves against BVDV in 2007

BVDV Vaccinations Given	Percent Operations	Std. Error
Yes	9.0	(2.3)
No	0.7	(0.4)
All Operations	4.2	(1.0)

b. [v265, v293] Percentage of operations that tested any beef calves for persistent infection with BVDV during the previous 3 years by level of familiarity with BVDV

Level of Familiarity	Percent Operations	Std. Error
Fairly knowledgeable or knew some basics	4.7	(1.1)
Recognized the name, not much else or had not heard of before	3.0	(2.4)

D. Types and Management of Herd Additions

1. Cattle brought onto the operation

Young calves and developing fetuses are the most likely types of animals to be persistently infected with BVDV and as such represent the greatest risk to operations that import animals. The percentages of operations that brought specific classes of calves or pregnant females onto the operation during the previous 12 months varied by herd size for some cattle classes. Larger herds can be expected to have more annual turnover of animals than smaller herds. In any given year, a large herd is more likely than a smaller operation to cull and replace at least one animal of a particular class. A higher percentage of operations with 100 or more beef cows brought bred heifers and pregnant cows onto the operation during the previous 12 months compared with operations with fewer than 50 cows. A higher percentage of operations with 200 or more beef cows imported at least one of the specific classes of cattle compared with operations with fewer than 50 cows (26.8 and 11.2 percent, respectively).

a. Percentage of operations that brought the following classes of cattle onto the operation during the previous 12 months, by cattle class and by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		50-99		100-199		200 or More		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned beef calves with dam	2.9	(0.6)	3.2	(1.0)	7.7	(1.7)	4.2	(1.0)	3.4	(0.5)
Bred beef heifers	2.4	(0.6)	4.8	(1.3)	8.1	(1.5)	7.9	(1.5)	3.5	(0.5)
Beef cows (pregnant)	7.4	(1.0)	12.6	(2.0)	13.9	(2.1)	17.5	(2.4)	9.2	(0.8)
Preweaned dairy calves	0.2	(0.1)	2.2	(1.2)	0.0	(--)	0.2	(0.2)	0.5	(0.2)
Any of the above	11.2	(1.2)	20.0	(2.4)	24.8	(2.5)	26.8	(2.6)	14.5	(0.9)

A higher percentage of operations in the Central region brought on bred beef heifers compared with operations in the West and Southeast regions. A lower percentage of operations in the Southeast region brought on cattle of any class compared with operations in the Central region.

b. Percentage of operations that brought the following classes of cattle onto the operation during the previous 12 months, by cattle class and by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned beef calves with dam	5.1	(1.7)	5.2	(1.1)	2.4	(0.5)
Bred beef heifers	2.4	(0.9)	7.4	(1.3)	2.2	(0.5)
Beef cows (pregnant)	11.6	(2.4)	11.6	(1.6)	8.0	(1.0)
Preweaned dairy calves	2.4	(1.7)	0.4	(0.3)	0.2	(0.2)
Any of the above	19.0	(3.1)	20.6	(2.0)	11.5	(1.1)

Photo courtesy of Anson Eaglin, USDA

Introducing weaned stock to the herd also poses a risk for introducing cattle persistently infected with BVDV. As expected, larger herds were more likely to bring on animals in several of the postweaning animal classes. A higher percentage of operations with 200 or more beef cows brought on weaned unbred beef heifers (10.9 percent) compared with operations with 1 to 49 beef cows (5.6 percent). A higher percentage of operations with 200 or more beef cows brought weaned beef bulls onto the operation compared with operations with fewer than 100 cows, and a lower percentage of operations with fewer than 50 cows brought on beef bulls than all other operation sizes.

c. Percentage of operations that brought the following classes of cattle onto the operation during the previous 12 months, by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
Cattle Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Beef heifers weaned, but not bred	5.6	(0.9)	6.8	(1.4)	8.3	(1.6)	10.9	(1.5)	6.2	(0.7)
Weaned beef bulls	14.9	(1.3)	25.7	(2.5)	33.6	(2.7)	43.1	(2.6)	19.5	(1.0)
Weaned steers (all types)	2.9	(0.6)	2.8	(1.0)	4.3	(1.1)	4.9	(1.0)	3.1	(0.5)
Weaned dairy heifers and cows	0.2	(0.1)	1.6	(0.9)	0.4	(0.3)	0.3	(0.2)	0.4	(0.2)
Weaned dairy bulls	0.6	(0.3)	0.0	(--)	0.0	(--)	0.5	(0.2)	0.4	(0.2)
Any of the above	20.5	(1.5)	31.5	(2.7)	40.9	(2.8)	51.6	(2.6)	25.4	(1.2)

A higher percentage of operations in the West and Central regions (32.8 and 29.8 percent, respectively) brought weaned beef bulls onto the operation compared with operations in the Southeast region (13.6 percent).

d. Percentage of operations that brought the following classes of cattle onto the operation during the previous 12 months, by region

	Percent Operations					
	Region					
	West		Central		Southeast	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Beef heifers weaned, but not bred	8.5	(2.4)	7.6	(1.2)	5.4	(0.8)
Weaned beef bulls	32.8	(3.7)	29.8	(2.1)	13.6	(1.2)
Weaned steers (all types)	7.6	(2.4)	3.4	(0.8)	2.4	(0.6)
Weaned dairy heifers and cows	1.2	(1.0)	0.7	(0.4)	0.2	(0.2)
Weaned dairy bulls	0.9	(0.7)	1.0	(0.6)	0.1	(0.1)
Any of the above	43.0	(4.0)	36.7	(2.3)	18.6	(1.4)

2. Quarantine of cattle brought onto the operation

Isolation alone can prevent introduction of BVDV by transiently infected cattle if the isolation period is of sufficient length. Cattle persistently infected with BVDV may not express clinical signs during a quarantine period. Isolation as a biosecurity method for preventing entry of cattle persistently infected with BVDV is effective only if combined with a testing program. For testing to be effective, imported cattle must be isolated from the breeding herd until test results are returned. Isolation is particularly important during the breeding season and early gestation when cows are at risk for transmitting BVDV to their developing fetuses.

Of operations that brought specific classes of cattle onto the operation during the previous 12 months, the majority quarantined none of the imported cattle. Over all classes of cattle, two of three operations (66.3 percent) quarantined none of the cattle they brought on.

a. For operations that brought any of the following classes of cattle or calves onto the operation during the previous 12 months, percentage of operations that quarantined or separated all, some, or none of the new cattle

	Percent Operations						
	Level of Quarantine						
	All		Some		None		
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Total
Preweaned beef calves with dam	33.6	(6.8)	6.3	(3.8)	60.1	(7.1)	100.0
Beef heifers weaned, but not bred	35.0	(5.1)	2.5	(1.6)	62.5	(5.2)	100.0
Bred beef heifers	46.5	(6.7)	2.7	(2.0)	50.8	(6.7)	100.0
Beef cows (pregnant)	30.0	(3.9)	2.0	(1.1)	68.0	(4.0)	100.0
Beef cows (not pregnant)	23.4	(6.3)	1.6	(1.0)	75.0	(6.4)	100.0
Weaned beef bulls	30.0	(2.6)	0.8	(0.4)	69.2	(2.6)	100.0
Weaned steers (all types)	33.5	(7.6)	0.0	(--)	66.5	(7.6)	100.0
Preweaned dairy calves	25.9	(18.0)	0.0	(--)	74.1	(18.0)	100.0
Weaned dairy heifers and cows	2.6	(2.4)	0.0	(--)	97.4	(2.4)	100.0
Weaned dairy bulls	2.3	(1.9)	0.0	(--)	97.7	(1.9)	100.0
All cattle and calves	28.0	(1.9)	5.7	(1.0)	66.3	(2.0)	100.0

Ideally, a quarantine period should be long enough to exceed the longest expected incubation period for the disease of concern, which would allow an animal recently infected with a disease agent to manifest signs of disease. In the case of animals transiently infected with BVDV, an incubation period of up to 14 days could be expected. In the case of persistently infected animals—which continuously shed large quantities of BVDV and might only show nonspecific or no clinical signs of disease—quarantine alone would probably not be an effective means of avoiding herd exposure, no matter how long the quarantine period.

Of operations that brought cattle onto the operation and quarantined them, approximately one of four (24.6 percent) quarantined cattle for 1 to 13 days. For cattle transiently infected with BVDV, 13 days would not always be sufficient based on the possible duration of virus shedding following transient infection. About one-half of operations that quarantined cattle did so for 21 days or more (52.6 percent), which is adequate for transiently infected cattle but not for persistently infected cattle or females carrying a persistently infected calf.

b. For operations that brought any of the following classes of cattle onto the operation and quarantined them, percentage of operations by cattle class brought on and by days quarantined or separated

	Percent Operations									
	Days Quarantined									
	1-13		14-20		21-40		41-49		150 or More	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned beef calves with dam	34.3	(11.2)	39.0	(11.5)	13.7	(6.8)	10.5	(6.8)	2.5	(2.2)
Beef heifers weaned, but not bred	15.5	(5.5)	23.1	(7.5)	36.9	(8.1)	18.7	(6.3)	5.8	(4.7)
Bred beef heifers	20.5	(8.5)	16.1	(7.8)	30.7	(8.4)	29.0	(8.7)	3.7	(1.8)
Beef cows (pregnant)	33.5	(7.1)	17.9	(5.4)	27.9	(6.7)	18.3	(5.7)	2.4	(1.4)
Beef cows (not pregnant)	45.3	(14.1)	28.2	(12.7)	20.6	(10.9)	5.9	(3.5)	0.0	(--)
Weaned beef bulls	26.4	(4.7)	17.8	(3.9)	37.0	(4.6)	18.0	(3.6)	0.8	(0.4)
Weaned steers (all types)	22.3	(11.1)	35.9	(13.9)	17.0	(9.6)	13.6	(6.4)	11.2	(10.0)
Preweaned* dairy calves	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Weaned dairy heifers and cows*	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Weaned dairy bulls*	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
All classes	24.6	(3.2)	22.8	(3.2)	28.9	(3.1)	21.0	(2.8)	2.7	(1.1)

*Too few to report.

3. Testing of herd additions

A higher percentage of operations that had not tested beef calves for persistent infection with BVDV during the previous 3 years brought on pregnant beef cows (11.9 percent) compared with operations that had tested (2.6 percent). In addition, a higher percentage of operations that had not tested beef calves brought on preweaned beef calves with their dam compared with operations that had tested beef calves. This difference may indicate that operations that were aware of the risks of BVDV and tested for it are also implementing other practices to control exposure risk, such as limiting some high risk imports. Alternatively, operations that tested during the previous 3 years may have done so in response to a diagnosis of BVDV in the herd and may also have adjusted animal addition practices.

a. Percentage of operations that brought the following classes of cattle onto the operation by whether or not the operation tested any beef calves for persistent infection with BVDV during the previous 3 years

	Percent Operations					
	BVDV Testing					
	Yes		No		All Operations*	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned beef calves with dam	0.1	(0.1)	3.6	(1.0)	3.5	(1.0)
Bred beef heifers	9.8	(5.1)	5.4	(1.4)	5.6	(1.3)
Beef cows (pregnant)	2.6	(1.7)	11.9	(2.2)	11.5	(2.1)
Preweaned dairy calves	0.0	(--)	0.8	(0.5)	0.8	(0.5)
Any of the above	12.5	(5.5)	18.7	(2.5)	18.4	(2.4)

*The population estimates for the percentage of all operations bringing various classes of cattle or calves onto the operation here differ from those shown on table a., p 53 because these estimates are derived from only those operations participating in Phase II of the study.

Testing beef calves for persistent infection with BVDV was uncommon on operations that brought on the following classes of cattle.

b. For operations that brought the following classes of cattle onto the operation, percentage of operations that tested any beef calves for persistent infection with BVDV during the previous 3 years

	Percent Operations BVDV Testing				
	Yes		No		
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Total
Preweaned beef calves with dam	0.1	(0.1)	99.9	(0.1)	100.0
Bred beef heifers	7.3	(3.9)	92.7	(3.9)	100.0
Beef cows (pregnant)	0.9	(0.6)	99.1	(0.6)	100.0
Preweaned dairy calves	0.0	(0.0)	100.0	(0.0)	100.0
Any of the above	2.8	(1.2)	97.2	(1.2)	100.0

Section III: BVDV Persistent Infection Testing

1. Study methods for biological sampling for persistent infection with BVDV

Producers with predominantly spring calving herds (at least 70 percent of their calves were expected to be born between November 2007 and June 2008) were invited to collect ear-notch samples from their entire calf crop (or as much of the calf crop as was available) by July 15, 2008.

Producers that ordered sample collection kits were shipped materials to notch one ear of each calf, record information about the animal (age and identification), and instructions for processing and shipping the samples to the laboratory. Producers could collect samples from calves throughout the calving season as the calves were born, or at a single event such as when the calves were vaccinated or branded. A total of 44,150 ear-notch samples were collected on the 205 operations. Samples were frozen dry and shipped overnight to the laboratory for processing. At the laboratory, samples were logged in and processed using a commercially available ELISA kit for detection of BVDV antigen (IDEXX Laboratories Inc., Westbrooke, ME) according to the manufacturer's instructions.

Results of the sample testing were returned to the producers. Producers with one or more test-positive animals were encouraged to submit whole-blood samples from the animals for virus isolation. Producers were offered kits with all materials needed to collect samples and to ship them overnight to the laboratory.

Whole-blood samples were processed for virus isolation using standard methods (Ridpath et al., 2008). BVDV isolates were further characterized by phylogenetic analysis comparing the 5' untranslated region sequences generated by cycle sequencing of polymerase chain reaction amplicons as described previously (Ridpath et al., 2005). Segregation into subgenotypes was based on comparison of subgenotype sequences previously reported by Vilcek et al. (Vilcek et al., 2001, 2004 [BVDV1 subgenotype]; Flores et al., 2001 [BVDV2 subgenotype]).

2. Operations that submitted ear-notch samples for testing

A higher percentage of operations with 200 or more beef cows submitted samples than operations with 1 to 49 beef cows. Regional differences in participation were also present, as a higher percentage of operations in the West region submitted samples than operations in the Southeast region.

a. Percentage of operations that submitted ear-notch samples for BVDV testing, by herd size

	Percent Operations									
	Herd Size (Number of Beef Cows)									
	1-49		**50-99**		**100-199**		**200 or More**		**All Operations**	
	Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Submitted samples	16.5	(3.6)	32.9	(5.7)	35.8	(5.5)	41.2	(4.8)	22.2	(2.7)
Eligible but did not submit samples	61.1	(4.3)	51.4	(5.9)	50.6	(5.9)	45.1	(5.1)	57.7	(3.2)
Ineligible*	22.4	(3.7)	15.7	(3.7)	13.6	(5.7)	13.7	(3.5)	20.1	(2.7)
Total	100.0		100.0		100.0		100.0		100.0	

*Ineligible operations were those that did not have at least 70 percent of their calves born between November 2007 and June 2008.

b. Percentage of operations that submitted ear-notch samples for BVDV testing, by region

	Percent Operations					
	Region					
	West		**Central**		**Southeast**	
	Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Submitted samples	43.8	(8.0)	29.2	(4.0)	16.7	(3.6)
Eligible but did not submit samples	44.3	(8.2)	54.7	(5.0)	60.7	(4.3)
Ineligible*	11.9	(3.2)	16.1	(4.0)	22.6	(3.7)
Total	100.0		100.0		100.0	

*Ineligible operations were those that did not have at least 70 percent of their calves born between November 2007 and June 2008.

Eligible operations that vaccinated at least some cattle for BVDV in 2007 had 3.1 times higher odds of submitting BVDV samples, and eligible operations that tested at least some beef calves for BVDV persistent infection in the past 3 years had 2.9 times higher odds of submitting BVDV samples. Among operations that submitted BVDV samples, 88.8 percent had vaccinated at least some cattle for BVDV in 2007, and 16.8 percent had tested at least some beef calves for BVDV persistent infection in the past 3 years. Additionally, 89.8 percent of operations that submitted BVDV samples were fairly knowledgeable or knew some basics about BVDV, compared with 64.0 percent of operations in the general population.

c. For eligible operations, association between BVDV management practices and whether or not the operation submitted samples for BVDV testing

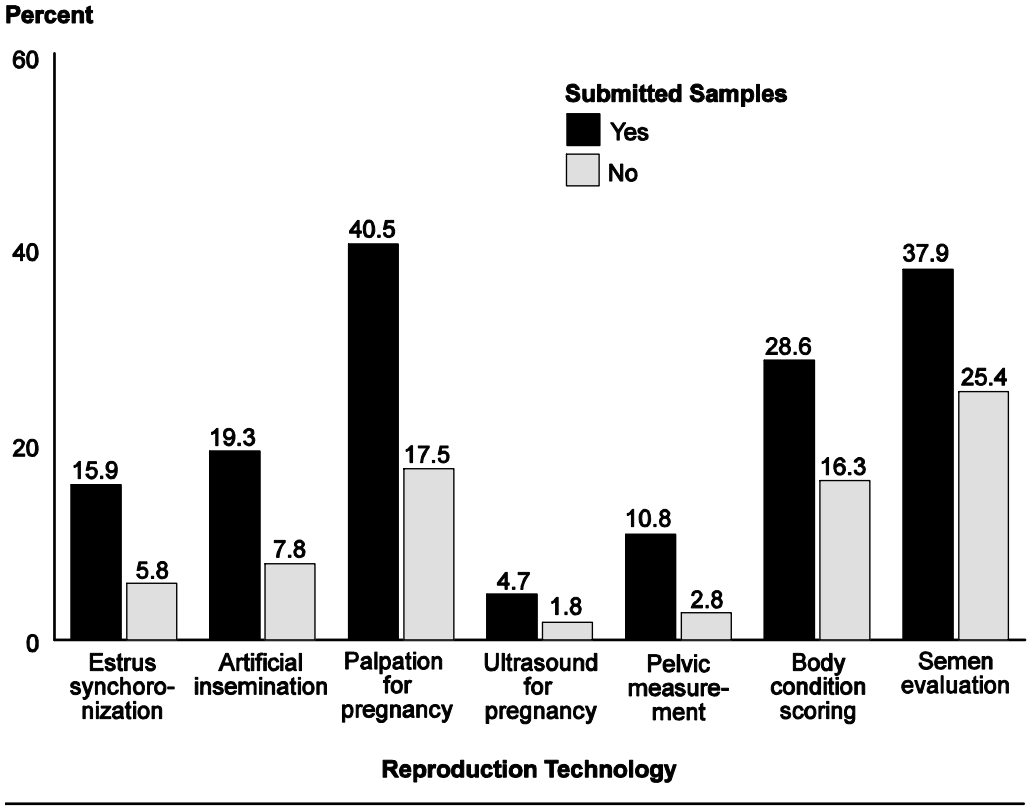
	Submitted BVDV Samples		
	Yes		No
Management Practice	Odds Ratio	95-percent Confidence Interval	Odds Ratio
Vaccinated cattle for BVDV in 2007	3.1	1.6–6.1	referent
Tested beef calves for BVDV persistent infection in past 3 years	2.9	1.1–7.6	referent

A higher percentage of eligible operations that submitted BVDV samples used a variety of reproduction technologies compared with eligible operations that did not submit samples.

d. For eligible operations, percentage of operations by reproduction technologies used and by whether or not operations submitted samples for BVDV testing

	Percent Operations Submitted BVDV Samples			
	Yes		No	
Reproduction Technology	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Estrus synchronization	15.9	(3.6)	5.8	(1.3)
Artificial insemination	19.3	(4.0)	7.8	(1.9)
Palpation for pregnancy	40.5	(6.2)	17.5	(2.4)
Ultrasound for pregnancy	4.7	(1.2)	1.8	(0.7)
Pelvic measurement	10.8	(2.9)	2.8	(1.0)
Body condition scoring	28.6	(4.8)	16.3	(3.2)
Semen evaluation	37.9	(5.7)	25.4	(3.7)

For Eligible Operations, Percentage of Operations by Reproduction Technologies Used and by Whether or not Operations Submitted Samples for BVDV Testing



3. Sample testing results

The following sample test results and characteristics of positive operations represent a subset of operations from which the population estimates (presented in Section II) were generated. Specfically, the subset is comprised of 205 operations that participated in the voluntary BVDV sampling study (see Appendix I for sample profile). Data presented in items 3 and 4 are not adjusted to represent the U.S. beef population. Rather, they describe the attributes of the 205 operations in terms of production and management practices. As such, a demographic comparison of participating operations to nonparticipating operations was included in item 2, p 63.

Of 44,150 ear-notch samples collected from the 205 cattle operations, 53 individual samples were positive for BVDV antigen, resulting in an individual calf persistent infection prevalence of 0.12 percent. The prevalence of calves test-positive for persistent infection with BVDV was similar across calf ages (P=0.40). Eighteen operations had at least one positive animal, resulting in an estimated herd-level prevalence of 8.8 percent. Within-herd test-positive prevalence in positive operations ranged from 0.24 to 16 percent. Prevalence was 1.00 percent or higher on 10 of 18 positive operations and 3.0 percent or higher on 4 of 18 positive operations.

a. BVDV persistent infection results by age of calf

Calf Age	Number Samples Tested	Number Positive	Percent Positive
Less than 3 weeks	5,635	8	0.14
3 weeks to 3 months	29,228	37	0.13
More than 3 months	4,424	6	0.14
Unknown	4,863	2	0.04
Total	44,150	53	0.12

b. Within-herd prevalence of BVDV persistent infection

Within Herd Prevalence (Percent)	Number of Operations	Percent Operations
0	187	91.2
0.01 to 0.49	5	2.4
0.50 to 0.99	3	1.5
1.00 to 1.99	4	1.9
2.00 to 3.00	2	1.0
Higher than 3.00	4	2.0
Total	205	100.0

Of the 53 animals that tested positive via ELISA, whole-blood samples were submitted for 5 animals from 3 operations. Virus isolation confirmed that four of the five animals were positive. The animal that was negative on the confirmatory testing may have been transiently infected with BVDV at the time the ear notch was collected. Typing of the four BVDV isolates showed that three were type 1b and one was type 2a. (Because of the small number of animals positive on the ELISA that were retested to confirm that they were persistently infected with BVDV, further references to BVDV persistently infected animals will be for all 53 animals that were positive on the ELISA.)

4. Characteristics of positive operations

The small number of positive operations identified in the survey (18) makes it difficult to identify differences in demographics and management practices between positive and negative operations. For operations that submitted samples for BVDV testing, the percentage of operations positive for BVDV persistent infection was lower in the Central region than in the West and Southeast regions. Operations with 100 or more beef cows were more likely to have at least 1 calf positive for BVDV persistent infection compared with operations with fewer than 100 cows.

About 1 of 10 operations (10.7 percent) that had not tested any beef calves for persistent infection with BVDV during the previous 3 years had at least 1 calf positive for BVDV persistent infection, whereas no operations that had done some testing during the previous 3 years had a BVDV persistently infected calf identified. Animal prevalence among operations that had not tested any cattle for BVDV persistent infection during the previous 3 years was 0.16 percent. Operations that had tested during the previous 3 years may have identified and removed positive animals previously. Alternatively, operations may have been more diligent regarding general biosecurity practices that decrease the likelihood of the presence of BVDV persistent infection.

a. For operations that submitted samples for BVDV testing, percentage of operations that had animals test positive for persistent infection with BVDV, by operation characteristics

Operation Characteristics	Number Operations Tested	Number Operations Positive	Percent Operations Positive
Herd size (number of beef cows)			
1 to 99	64	1	1.6
100 or More	141	17	12.1
Region			
West	73	8	11.0
Central	88	4	4.5
Southeast	44	6	13.6
Level of Familiarity with BVDV			
Fairly knowledgeable or knew some basics	184	18	9.8
Heard name only or never heard of	21	0	0.0
Vaccinated any cattle against BVDV in 2007			
Yes	182	15	8.2
No	23	3	13.0
Tested beef calves for persistent infection with BVDV in the past 3 years			
Yes	34	0	0.0
No	168	18	10.7

Only 49 operations that submitted samples for BVDV testing had brought any cattle onto the operation during the previous 12 months. The percentage of operations positive for BVDV was similar, overall, between operations that brought on any of the cattle classes and those that did not (10.2 and 8.3 percent, respectively).

b. For operations that submitted samples for BVDV testing, percentage of operations that had animals test positive for persistent infection with BVDV, by whether or not the following classes of cattle were brought on during the previous 12 months

	Brought on Cattle or Calves					
	Yes			No		
Cattle Class	Number Ops. Tested	Number Ops. Positive	Percent Ops. Positive	Number Ops. Tested	Number Ops. Positive	Percent Ops. Positive
Preweaned beef calves with dam	12	0	0.0	193	18	9.3
Bred beef heifers	22	4	18.2	183	14	7.7
Beef cows (pregnant)	29	3	10.3	176	15	8.5
Preweaned dairy calves	1	0	0.0	204	18	8.8
Any of the above	49	5	10.2	156	13	8.3

The percentage of calves born dead or that died before weaning was similar between operations that tested positive for BVDV persistent infection and those that tested negative.

c. For operations that submitted samples for BVDV testing, percentage of calves born dead or that died prior to weaning, by BVDV persistent infection status of operation

Percent Calves		
BVDV Results		
Positive	Negative	All Operations
Percent	Percent	Percent
6.0	6.2	6.2

Section IV: Conclusions

In this study, the prevalence of BVDV persistent infection in U.S. calves was low (0.12 percent of calves) and the herd prevalence (those with at least one BVDV persistently infected animal identified) was modest (8.8 percent). The single-sample testing for most of the positive animals in this study did not allow confirmation of persistent infection with BVDV, so some transient infections may be included.

Previous studies on weaned calves entering feedlot or stocker operations have detected a BVDV persistent infection prevalence of 0.3 percent (6/2,000, 95-percent confidence interval 0.14–0.65 percent) [Loneragan et al., 2005], 0.32 percent (3/938, 95-percent confidence interval 0.1–0.94 percent) [Larson et al., 2005b], and 0.4 percent (86/21,743, 95-percent confidence interval 0.32–0.49 percent) [Fulton et al., 2006]. In each study, sampling and testing designed to identify persistently infected animals may have also allowed inclusion of transiently infected animals. The reasons for the difference in prevalence estimates between this survey and previous studies are not clear. This study sampled younger calves, which would be expected to have a higher prevalence of persistent infection than older animals, as persistently infected calves have an increased mortality rate (Houe, 1995). In this study, no BVDV persistently infected calves were found on operations that had tested for BVDV during the previous 3 years. History of previous testing in herds was not reported in the previous studies. The proportion of operations that had tested for BVDV persistent infection during the previous 3 years may have been higher in this study than in previous studies and might account for some of the difference in prevalence. Estimates in table a., p 21 show that only 4.2 percent of all cow-calf operations tested calves for persistent infection with BVDV during the previous 3 years, but among operations that participated in BVDV sampling for this study, 16.8 percent had tested calves during the previous 3 years. The operations that submitted ear-notch samples in this survey were larger and more likely to implement testing, vaccination, and reproductive technologies than the nonsubmitters and may represent a population less likely to have BVDV persistently infected animals compared with populations in previous studies. Animal prevalence in this study for operations that had not tested any cattle for BVDV during the previous 3 years was 0.16 percent.

Previous studies have detected a herd prevalence of persistent BVDV infection of 9 percent (6/66 herds, 95-percent confidence interval 3.4–18.7 percent) [Bolin et al., 1985], and 10.2 percent (13/128 herds, 95-percent confidence interval 5.5–16.7 percent) [Wittum et al., 2001], which is similar to the prevalence found in this study (8.8 percent). Wittum et al. (2001) found a 19-percent BVDV persistently infected herd prevalence in herds in which the attending veterinarian suspected BVDV persistent infection (10/52 herds, 95-percent confidence interval 10–33 percent) and a 2.7-percent herd prevalence in randomly selected herds (2/75, 95-percent confidence interval 0.5–10 percent). In this study, herd prevalence on operations that had not tested for BVDV persistent infection during the previous

3 years was 10.7 percent (18/168 herds). No BVDV persistently infected positive operations were found among operations that had tested for BVDV persistent infection during the previous 3 years.

The prevalence of BVDV persistent infection was similar across all calf age groups in this study. As stated previously, persistently infected calves are expected to have increased mortality rates, which would produce a decreased prevalence with age. This, however, was not observed, and the percentages of calves that were born dead or died prior to weaning were similar between BVDV persistently infected positive and negative operations. The morbidity and mortality associated with different strains of BVDV persistent infection is variable and, along with the low prevalence of herd infection detected in this study, may account for the lack of observed effect.

The low prevalence of BVDV persistent infection detected in this study limits the ability to detect associations between management practices and BVDV persistent infection risk. One general biosecurity practice was found to be associated with BVDV persistent infection: no positive animals were found on operations that reported testing during the previous 3 years. Although this does not suggest testing performs perfectly in eliminating BVDV persistent infection, it is supportive of the effectiveness of BVDV testing. Effects of BVDV infection on positive operations were not clear, as no differences could be detected in the proportion of calves that were born dead or died prior to weaning.

Generally, producers knew at least the basics about BVDV persistent infection but were uncertain about the value of testing. Vaccination is the most commonly practiced intervention against BVDV persistent infection. While breeding females are the most important group to vaccinate to prevent the production of additional persistently infected calves, calves aged 22 days to weaning were just as likely to be vaccinated as other classes of cattle. Fewer than one of four operations (23.8 percent) gave a BVDV booster to cows. Most operations do not vaccinate breeding females for BVDV, potentially leaving them more vulnerable to BVDV exposure. Management practices such as quarantine and testing of cattle brought onto the operation are necessary to prevent disease from BVDV. Most operations quarantined none of the new cattle brought onto the operation during the previous 12 months, and very few tested any calves for BVDV persistent infection during the previous 3 years. Vaccination can clearly provide protection against introducing BVDV infection into the herd; however, with low levels of testing, no quarantine of incoming cattle, and modest vaccination levels it appears many operations have no biosecurity and biocontainment plan for BVDV.

Additional efforts are needed to increase producer education, to quantify the economic cost of BVDV infection and the value of testing programs, and to better understand the indications for herd testing and targeted surveillance, quarantine, and vaccination in cow-calf herds. There are likely several reasons for the low level of testing and quarantine. For some producers, lack of knowledge of effective BVDV control methods is likely important.

Other producers may not believe the value of quarantine and testing is sufficient to warrant the effort and expense. Some producers may understand the importance of BVDV in cow-calf herds but do not believe that it is present in their herd or that they are at risk for bringing it onto the operation and, thus, do not test.

Section V: Methodology

A. Needs Assessment

The National Animal Health Monitoring System (NAHMS) develops study objectives by exploring existing literature and contacting stakeholders about their informational needs and priorities during a needs assessment phase. Stakeholders for NAHMS studies include industry members, allied industry representatives, other government agencies, animal health officials, and many others. The objective of the needs assessment for the NAHMS Beef 2007–08 study was to collect information about the most important health and productivity issues of cow-calf production. A driving force for the needs assessment was the desire of NAHMS to receive as much input as possible from a variety of producers, as well as from industry experts and representatives, veterinarians, extension specialists, universities, and beef organizations. Information was collected via interviews with key industry figures and through a Needs Assessment Survey.

The Needs Assessment Survey was designed to identify the most critical information gaps regarding animal health, and health and production management from producers, veterinarians, extension personnel, university researchers, and allied industry groups. The survey, created in SurveyMonkey, was available online from September 9, 2006, through February 15, 2007. The survey was promoted via electronic newsletters, magazines, and Web sites. Organizations/magazines promoting the study included "Beef Magazine," "Drovers," "Feedstuffs," "Bovine Veterinarian," and "The National Cattleman."

Email messages identifying the online site and asking for input were also sent to State extension personnel as well as State and Federal animal health officials. A total of 94 people completed the survey. Universities/extensions accounted for 41.5 percent of respondents, and veterinarians/consultants accounted for 31.9 percent.

Objectives for the Beef 2007–08 study, using input from interviews, literature searches, and the online survey, were drafted and circulated to stakeholder groups. Following this review, six final study objectives were identified:

1. Describe trends in beef cow-calf health and management practices.
2. Evaluate management factors related to beef quality assurance.
3. Describe record-keeping practices on cow-calf operations.
4. Determine producer awareness of bovine viral diarrhea (BVD) and management practices used for BVD control.
5. Describe current biosecurity practices.
6. Determine the prevalence and antimicrobial resistance patterns of potential food safety pathogens.

B. Sampling and Estimation

1. State selection

The preliminary selection of States to be included in the study was done in October 2006 using the National Agricultural Statistics Service (NASS) Cattle Report. A goal for NAHMS national studies is to include States that account for at least 70 percent of the animals and producer population in the United States. The initial review identified 24 States representing 87.8 percent of the Nation's beef cow inventory and 79.6 percent of operations with beef cows (cow-calf herds). The States were: Alabama, Arkansas, California, Colorado, Florida, Georgia, Idaho, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Tennessee, Texas, Virginia, and Wyoming.

A memo identifying the States was provided in November 2006 to the USDA-APHIS-VS CEAH Director and, in turn, the VS Regional Directors. Each Regional Director sought input from the respective States about being included or excluded from the study.

2. Operation selection

The list sampling frame was provided by NASS. Within each State a stratified random sample was selected. The size indicator was the number of beef cows for each operation. NASS selected a sample of beef producers in each State for making the January 1 cattle estimates. The list sample from the January 2007 survey was used as the screening sample. Those producers in the 24 States reporting 1 or more beef cows on January 1, 2007, were included in the sample for contact in October 2007.

3. Population inferences

a. Phase I: General Beef Management Report; and Phase II: VS Initial and Second Visits

Inferences cover the population of beef producers with at least 1 beef cow in the 24 participating States. As of January 1, 2008, these States accounted for 87.8 percent (28.6 million) of beef cows and 79.6 percent (603,000) of operations with beef cows in the United States. (See Appendix II for respective data on individual States.) All respondent data were statistically weighted to reflect the population from which they were selected. The inverse of the probability of selection for each operation was the initial selection weight. This selection weight was adjusted for nonresponse within each State and size group to allow for inferences back to the original population from which the sample was selected.

C. Data and Sample Collection

1. Data collectors and data collection periods

a. Phase I: General Beef Management Report
From October 22 through November 30, 2007, NASS enumerators administered the General Beef Management Report. The interview took slightly over 1 hour.

b. Phase II: VS Initial Visit Questionnaire
From January 14 through March 31, 2008, State and Federal animal health personnel administered the Beef 2007–08 VS Initial Visit Questionnaire.

c. Phase II: VS Second Visit Questionnaire
From July 1 through August 15, 2008, State and Federal animal health personnel administered the Beef 2007–08 Second VS Visit Questionnaire.

d. Phase III: Biological Sample Collection
From March 25 through August 20, 2008, producers collected ear notches from calves for submission to the laboratory.

2. Biological sample collection and testing for BVDV

During the Phase II visit, producers were trained in how to collect samples, record data, and ship samples. Producers were provided sampling kits with ear notchers and encouraged to take ear notches from all calves in the calf crop. Samples could be taken at one time or over the course of the calving season. Producers were asked to place each sample in an individual submission bag labeled with the calf's ID and age group. Calf age groups at the time of sampling were defined as: less than 3 weeks, 3 weeks to 3 months, and greater than 3 months. Samples were frozen dry and shipped overnight to the laboratory.

Submitted samples were tested with the IDEXX antigen capture ELISA according to the manufacturer's directions. Samples with an ELISA S/P ratio of less than 0.2 were categorized as negative. Samples with an ELISA S/P ratio of 0.2 to 0.39 were categorized as suspect, and samples with an ELISA S/P ratio greater than 0.39 were categorized as positive. All suspect and positive samples were retested using the IDEXX modified detector to confirm sample status as positive or negative. All samples were tested individually; no pooling was done. Results were mailed to producers within 3 weeks, and producers with positive results were offered the opportunity for followup confirmatory testing by virus isolation from a whole-blood sample.

D. Data Analysis

1. Phase I: Validation—General Beef Management Report

Initial data entry and validation for the General Beef Management Report were performed in individual NASS State offices. Data were entered into a SAS® data set. NAHMS national staff performed additional data validation on the entire data set after data from all States were combined.

2. Phase II: Validation—VS Initial and Second Visit Questionnaires

After completing both VS questionnaires, data collectors sent them to their respective State NAHMS Coordinators who reviewed the questionnaire responses for accuracy. Data entry and validation were completed by CEAH staff using SAS.

E. Sample Evaluation

The purpose of this section is to provide various performance measurement parameters. Historically, the term "response rate" was used as a catchall parameter, but there are many ways to define and calculate response rates. Therefore, the following table presents an evaluation based on a number of measurement parameters, which are defined with an "x" in categories that contribute to the measurement.

1. Phase I: General Beef Management Report

A total of 4,001 operations were selected for the survey. Of these operations, 3,648 (91.2 percent) were contacted. There were 2,872 operations that provided usable inventory information (71.8 percent of the total selected and 78.7 percent of those contacted). In addition, there were 2,159 operations (54.0 percent of total selected) that provided "complete" information for the questionnaire. Of operations that provided complete information, 1,033 (47.8 percent) consented to be contacted for consideration/discussion about further participation in Phase II (VS collection) of the study.

Responses for Phase I: General Beef Management Report

			Measurement Parameter		
Response Category	**Number Operations**	**Percent Operations**	**Contacts**	**Usable[1]**	**Complete[2]**
Survey complete and VMO consent	1,033	25.8	x	x	x
Survey complete, refused VMO consent	1,126	28.1	x	x	x
No beef cows on October 1 and July 1, 2007	469	11.7	x	x	
Out of business	244	6.1	x	x	
Out of scope (prison and research farms, etc.)	7	0.2			
Refusal of GBMR	776	19.4	x		
Office hold (NASS elected not to contact)	46	1.2			
Inaccessible	300	7.5			
Total	4,001	100.0	3,648	2,872	2,159
Percent of total operations			91.2	71.8	54.0
Percent of total operations weighted[3]			92.9	77.8	52.1

[1] Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2] Survey complete operation—respondent provided answers to all or nearly all questions.
[3] Weighted response—the rate was calculated using the initial selection weights.

2. Phase II: VS Initial Visit

There were 1,033 operations that consented during Phase I to be contacted by a veterinary medical officer (VMO) for Phase II. Of these 1,033, 567 (54.9 percent) agreed to continue in Phase II of the study and completed the VMO Initial Visit Questionnaire; 365 (35.3 percent) refused to participate. Approximately 8 percent of the 1,033 operations were not contacted, and 2.0 percent were ineligible because they had no beef cows at the time they were contacted by the VMO during Phase II.

Responses for Phase II: VS Initial Visit

			Measurement Parameter		
Response Category	Number Operations	Percent Operations	Contacts	Usable[1]	Complete[2]
Survey complete	567	54.9	x	x	x
Survey refused	365	35.3	x		
Not contacted	80	7.8			
Ineligible[3]	21	2.0	x	x	
Total	1,033	100.0	953	588	567
Percent of total operations			92.2	56.9	54.9
Percent of total operations weighted[4]			91.1	49.1	45.9

[1]Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—no beef cows at time of interview, which occurred from January 14 through March 31, 2008.
[4]Weighted response—the rate was calculated using the turnover weights.

3. Phase II: VS Second Visit

There were 567 operations that completed the VS initial visit. Of these 567, 470 (82.9 percent) agreed to continue in Phase II of the study and completed the VMO Second Visit Questionnaire; 60 (10.6 percent) refused to participate further. A total of 5.1 percent of the 567 operations were not contacted, and 1.2 percent were ineligible because they had no beef cows at the time they were contacted by the VMO during Phase II for the second visit.

Responses for Phase II: VS Second Visit

			Measurement Parameter		
Response Category	**Number Operations**	**Percent Operations**	**Contacts**	**Usable[1]**	**Complete[2]**
Survey complete	470	82.9	x	x	x
Survey refused	60	10.6	x		
Not contacted	29	5.1			
Ineligible[3]	8	1.4	x	x	
Total	567	100.0	538	478	470
Percent of total operations			94.9	84.3	82.9
Percent of total operations weighted[4]			93.9	77.7	75.8

[1]Useable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—no beef cows at time of interview, which occurred from July 1 through August 15, 2008.
[4]Weighted response—the rate was calculated using the turnover weights.

Appendix I: Sample Profile

Responding Operations

a. Number of responding operations, by herd size			
Herd Size (Total Beef Cow Inventory)	**Phase I: General Beef Management Report**	**Phase II: VS Initial Visit**	**BVDV Sampling**
1 to 49	819	163	27
50 to 99	386	96	37
100 to 199	381	125	56
200 or more	573	183	85
Total	2,159	567	205

b. Number of responding operations, by region			
Region	**Phase I: General Beef Management Report**	**Phase II: VS Initial Visit**	**BVDV Sampling**
West	370	138	73
Central	612	196	88
South Central*	483	233	44
East*	694		
Total	2,159	567	205

* Regions were combined for VS portion of study.

Appendix II: U.S. Beef Cow Population and Operations

Number of Beef Cows on January 1, 2008*			
Region	**State**	**Beef Cow Inventory Jan. 1, 2008** (Thousand Head)	**Beef Cow Operations 2007**
West	California	655	11,200
	Colorado	730	9,900
	Idaho	460	7,100
	Montana	1,523	11,000
	New Mexico	460	5,900
	Oregon	605	11,500
	Wyoming	733	4,800
	Total	5,166	61,400
Central	Iowa	1,015	25,000
	Kansas	1,511	26,000
	Missouri	2,080	54,000
	Nebraska	1,883	20,000
	North Dakota	922	10,500
	South Dakota	1,644	14,500
	Total	9,055	150,000
Southeast	Alabama	677	23,000
	Arkansas	943	26,000
	Florida	936	15,500
	Georgia	553	17,500
	Kentucky	1,159	38,000
	Louisiana	513	12,100
	Mississippi	519	18,500
	Oklahoma	2,053	48,000
	Tennessee	1,079	42,000
	Texas	5,240	130,000
	Virginia	692	21,000
	Total	14,364	391,600
Total (24 States)		28,585	603,000
Percentage of U.S.		87.8	79.6
Total U.S. (50 States)		32,553	757,900

*Source: NASS Cattle report, February 1, 2008, and NASS Farms, Land in Farms, and Livestock Operations 2007 Summary report, February 2008. An operation is any place having one or more head of beef cows, excluding cows used to nurse calves, on hand at any time during the year.

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Appendix IV: Study Objectives and Related Outputs

1. Describe trends in beef cow-calf health and management practices
- Part I: Reference of Beef Cow-calf Management Practices, October 2008
- Part II: Reference of Beef Cow-calf Management Practices, February 2009
- Part III: Changes in the U.S. Beef Cattle Industry, 1993–2008, May 2009
- Part IV: Reference of Beef Cow-calf Health and Health Management, February 2010
- Part V: Reference of Beef Cow-calf Management Practices, April 2010
- Bull Management Practices on U.S. Beef Cow-calf Operations, info sheet, February 2009
- Calving Management Practices on U.S. Beef Cow-calf Operations, info sheet, February 2009
- Mortality of Calves and Cattle on U.S. Beef Cow-calf Operations, info sheet, May 2010
- Parasite Control Practices on U.S. Cow-calf Operations, 2007–08, info sheet, December 2009
- Parasites on U.S. Beef Cow-calf Operations, 2007–08, info sheet, December 2009
- Use of Nutritional Supplements on U.S. Beef Cow-calf Operations, info sheet, May 2010
- Vaccination of Cattle and Calves on U.S. Beef Cow-calf Operations, info sheet, December 2009
- Vaccination of Calves for Respiratory Disease on U.S. Beef Cow-calf Operations, info sheet, December 2009

2. Evaluate management factors related to beef quality assurance
- Part I: Reference of Beef Cow-calf Management Practices, October 2008
- Injection Practices on U.S. Beef Cow-calf Operations, 2007–08, info sheet, December 2009

3. Describe record-keeping practices on cow-calf operations
- Part I: Reference of Beef Cow-calf Management Practices, October 2008
- Part III: Changes in the U.S. Beef Cattle Industry, 1993–2008, May 2009
- Cattle Identification Practices on U.S. Beef Cow-calf Operations, info sheet, February 2009
- Record Keeping, info sheet, expected summer 2010

4. Determine producer awareness of bovine viral diarrhea (BVD) and management practices used for BVD control
- Part IV: Reference of Beef Cow-calf Health and Health Management, February 2010
- **BVD Control on U.S. Beef Cow-calf Operations, Interpretive Report, July 2010**
- Beef Producers' Perceptions About the Value of Testing for Persistent Infection with Bovine Viral Diarrhea Virus in Calves, info sheet, June 2009
- Persistent Infection of Calves with Bovine Viral Diarrhea Virus on U.S. Beef Cow-calf Operations, info sheet, June 2009

5. Describe current biosecurity practices on cow-calf operations

- Part IV: Reference of Beef Cow-calf Health and Health Management, February 2010
- Biosecurity on U.S. Beef Cow-calf Operations, info sheet, December 2009
- Producer Disease Awareness, info sheet, expected summer 2010

6. Determine the prevalence and antimicrobial resistance patterns of potential food-safety pathogens

- Antimicrobial Drug Use and Antimicrobial Resistance on U.S. Cow-calf Operations, 2007–08, Interpretive Report, expected summer 2010
- *Campylobacter* on U.S. Beef Cow-calf Operations, 2007–08, info sheet, June 2009
- *Enterococcus* on U.S. Beef Cow-calf Operations, 2007–08, info sheet, June 2009
- *Salmonella* on U.S. Beef Cow-calf Operations, 2007–08, info sheet, June 2009