

Direct Contact Fomite Transmission-Beef

S
l
i
d
e

Practical Applications for Managing Biological Risks

Direct Contact and Fomite Transmission
Beef Producers

This presentation will review some key points of biological risk management, general prevention steps that can be applied to every farm to decrease the risk of disease introduction and spread, and specific steps to reduce the chance of direct contact transmission on farm.

S
l
i
d
e

Biological Risk Management (BRM)

- Overall process of awareness education, evaluation, and management
- Designed to improve infection/disease control
 - Foreign and domestic diseases
- Provide tools to minimize risk



Center for Food Security and Public Health
Iowa State University 2006

Biological risk management is a term used to describe the overall process of evaluating a farm or an animal housing facility based on the risk of infectious disease entry and spread. BRM is designed to help livestock producers understand the need for risk management strategies not only for foreign animal disease threats but domestic diseases as well. Biological risk management is designed to help assess the potential of an infectious disease entering and spreading within a facility and provide the tools to minimize the risk. (Photo courtesy of: DB Weddle)

S
l
i
d
e

Biological Risk Management (BRM)

- Disease risk cannot be totally eliminated
 - Animal, its environment
 - Decrease exposure
 - Infectious agent interactions
- Minimize threat to animals and humans
- No one-size-fits-all answer




Center for Food Security and Public Health
Iowa State University 2006

BRM recognizes that disease risk cannot be eliminated, but that the risk can be managed through effective control measures. As animal caretakers, it is our duty to be knowledgeable of the animal and its environment to minimize the risk of disease and keep the people working with them safe. It may seem hopeless to try to completely eliminate exposure to infectious diseases, especially diseases that are always present (endemic). For nearly all diseases there is a relationship between dose and severity. A threshold dose is required to establish infection, and low doses may cause subclinical or only mild infections. For endemic diseases, reducing the dose of infectious agent the animal is exposed to can positively affect the economic impact and help justify the cost of implementing BRM. Many different solutions exist and because all cattle facilities are different, there is not a one-size-fits-all answer. Photo depicts cattle in a pasture and the owner walking through them monitoring for illness (courtesy of USDA image #96cs0511, taken by Bill Tarpennig).

S
l
i
d
e

Routes of Transmission

- Spread of disease agents
 - Animal ↔ animal
 - Animal ↔ human
- Different modes of transmission
 - Aerosol
 - Direct contact
 - Fomite
 - Oral
 - Vector-borne
 - Zoonotic



Center for Food Security and Public Health
Iowa State University 2006



The approach that was taken in the development of the biological risk management tools was to look at diseases based on their route of transmission to the animal, or human in the case of zoonotic diseases. Disease agents can be spread from animal to animal, or animal to human, through a variety of transmission modes. Many infectious agents can be transmitted by more than one route of infection. This presentation will focus on how to prevent direct contact transmission between animals and from animals to humans. This photo shows cow-calf pairs being herded to another pasture in Oregon (courtesy of USDA, image # 95cs0779 CD0109-045, taken by Doug Wilson).

Direct Contact Fomite Transmission-Beef

S
l
i
d
e
5

Direct Contact

- Pathogen in animal or environment
 - Blood, saliva, nose to nose, rubbing, biting
 - Open wounds, mucous membranes, skin
- Reproductive transmission
 - Breeding
 - Gestation

Center for Food Security and Public Health
Iowa State University 2006

Transmission by **direct contact** requires the presence of an agent or organism in the environment or within an infected animal. A susceptible animal becomes exposed when the agent directly touches open wounds, mucous membranes, or the skin through blood, saliva, nose to nose contact, rubbing or biting as could occur when a newborn calf is being licked off by its mother (photo courtesy of USDA). It is important to note that depending on the disease agent, it is possible for direct contact transmission to occur between animals of different species as well as to humans. For the purposes of the BRM information, reproductive transmission will encompass those diseases spread through venereal and in-utero routes. **Reproductive transmission**, a type of direct contact, is the spread of pathogenic agents from animal to animal through breeding. **In-utero** transmission, another type of direct contact, is the spread of pathogenic agents from dam to offspring during gestation. The bottom photo depicts a time when reproductive transmission could occur- breeding (courtesy of USDA, Image Number: 01cs0192 taken by: Bill Tarpenning).

S
l
i
d
e
6

Selected Diseases Spread by Direct Contact

| | |
|--|---|
| <p>Foreign diseases</p> <ul style="list-style-type: none"> • Foot and mouth disease • Contagious bovine pleuropneumonia • Malignant catarrhal fever • Rinderpest • Vesicular stomatitis | <p>Present in U.S.</p> <ul style="list-style-type: none"> • Anthrax • Brucellosis • BVD • IBR • Leptospirosis • Mastitis • Q Fever • Rabies |
|--|---|




Center for Food Security and Public Health
Iowa State University 2006

There are many diseases transmitted by the direct contact route, both diseases that are foreign animal diseases (FADs) and those that are present in the US (endemic). Some examples of foreign animal diseases include foot and mouth disease (FMD), contagious bovine pleuropneumonia (CBPP), malignant catarrhal fever (MCF), rinderpest and vesicular stomatitis. The diseases that are already present in the US include anthrax, brucellosis, bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR or red nose), leptospirosis, mastitis, Q fever, rabies and others. The main point to drive home is that they are all transmitted by the same route and prevention practices aimed at one will protect against others. For a complete listing of all diseases transmitted by the aerosol route, please refer to the Bovine Routes of Transmission Handout- Direct Contact.

S
l
i
d
e
7

Fomite Transmission

- Contaminated inanimate object
- Carries pathogens to other animals
 - Brushes, needles
- Traffic
 - Vehicle, trailer, humans

Center for Food Security and Public Health
Iowa State University 2006

A component of direct contact transmission are fomites. A **fomite** is an inanimate object that can carry pathogenic agents from one susceptible animal to another. Examples of fomites include contaminated brushes, clippers, needles, balling guns (middle picture; photo courtesy of DB Weddle) clothing, milking units, teat dip cups, feed or water buckets, and shovels. These items must be managed as fomites but they will transmit disease when they have direct contact with a susceptible animal. The top photo depicts a situation in which disease transmission may occur via a fomite, grooming equipment; photo source USDA. **Traffic transmission** is a type of fomite transmission in which a vehicle, trailer, or human spreads organic material to another location, like the pickup and trailer pictured here (courtesy of Bryan Buss, ISU).

S
l
i
d
e
8

Routes of Transmission

- Apply to all infectious agents
- Animal must be exposed to develop disease
- Understand different routes of transmission = Gain control
- Risk areas must be identified
 - Design protocols to minimize exposure

Center for Food Security and Public Health
Iowa State University 2006

Every disease has to enter into an animal by some route, so looking at disease prevention through the routes of transmission makes sense. One advantage to this approach is that it will also help protect against new or unexpected infectious diseases. This classification system is effective and easy to understand without requiring knowledge about a wide range of diseases, like all those listed at the beginning of this presentation. While disease agents and the infections they produce vary, they all have one thing in common: the animal must be exposed to them to develop disease. Once it is understood that different diseases can be acquired by various routes of transmission (i.e. aerosol, oral, fomite, direct contact, vector), it is easier to gain control over them. From a management standpoint, it may be easier to identify risk areas, such as fomites, and

then design protocols to minimize exposure.

S
1
i
d
e
9

Disease Transmission

- Animals may not exhibit obvious clinical signs of disease
- Awareness of all routes of transmission is essential
 - Develop strategy to minimize disease risk for livestock operation



Center for Food Security and Public Health
Iowa State University 2006

It is important to remember that disease transmission can occur without animals exhibiting obvious clinical signs of disease. That is why awareness of the various routes of transmission becomes so essential when assessing and developing a strategy to minimize the risk of disease for a facility or operation. The photo shows a calf lying in a pasture (photo source USDA).

S
1
i
d
e
1
0

General Prevention Steps

Overview

- Farm perimeter
- Animal identification
- Animal health
- Sick/dead animals
- Isolation/quarantine
- Supply handling
- Neonatal management


Center for Food Security and Public Health
Iowa State University 2006

There are many general prevention steps that every farm could implement that would help prevent against a variety of diseases that are transmitted in various ways. Things such as knowing what is in the area of your farm perimeter- farms, neighboring livestock, wildlife; individual animal identification, animal health protocols, recognizing and dealing with sick and dead animals, isolation/quarantine, supply handling, and neonatal management. This next section will provide some general prevention recommendations for those areas.

S
1
i
d
e
1
1

General Prevention Steps

- Limit contact with animals
 - Neighbor's livestock
 - Wildlife, birds
 - Roaming cats, dogs
- Maintain fences
- Establish biosecurity protocols for delivery vehicles, personnel
- Lock gates



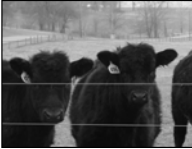
Center for Food Security and Public Health
Iowa State University 2006

Limit contact with animals that may present a disease risk by coordinating with your neighbors to avoid fence line contact between herds. Prevent cats and dogs from roaming between farms. By maintaining fences (repairing/replacing posts, tightening wires), you minimize the risk of animals escaping, or other animals entering, and mixing with other livestock or wildlife species, which increases their risk of disease exposure. You should establish biosecurity protocols for delivery vehicles and personnel to follow on your farm. Gates are installed as a barrier to human entry and should be locked to prevent animal contact and subsequent disease exposure. Photo courtesy of DB Weddle, ISU.

S
1
i
d
e
1
2

General Prevention

- Identify individual animals
- Important for:
 - Communicating health status
 - Treatment needs
 - Location on farm
 - Record keeping



Center for Food Security and Public Health
Iowa State University 2006

If more than one person works on an operation, individual animal identification is imperative for proper communication of health status, treatment needs, antibiotic withdrawal/residue prevention status, and location on farm. Individual animal identification is imperative to proper record keeping (vaccinations, treatments, pregnancy status) which is an integral part of managing animals and minimizing disease risk on farm. Keeping treatment records is an integral part of minimizing disease risk on farm because protocols can be tracked over time with your veterinarian and used to determine whether things are working in various disease situations. If these black Angus heifers did not have identification tags in their ears, it would be hard to communicate health status to someone else because they all look alike (photo source: DB

S
1
i
d
e
1
3

General Prevention Steps

- Keep health records on every animal
- Review vaccination and treatment programs
 - Annually, bi-annually
 - Protocol versus actual
- Investigate unusual signs, unresponsive cases
 - Neurologic, downers, sudden death



Center for Food Security and Public Health Iowa State University 2006

To monitor health status, it is imperative to keep health records on every animal. There are many computer programs out there that can simplify this for producers as the photo depicts (courtesy of Dale Moore, UC Davis VMTRC). It is important to work with your clients to review treatment and vaccination records so alterations can be made to the animal health protocols on farm; this will also help ensure what you think is happening is actually happening. Producers should work with their veterinarian to investigate those animals that present with unusual symptoms or are unresponsive to treatment, especially neurologic cases, downers and those that die suddenly.

S
1
i
d
e
1
4

General Prevention Steps

- Train farm personnel to report sick animals
 - Inspect animals daily
 - Clean equipment, boots, clothing
- Euthanize terminally ill animals promptly and appropriately
 - Removed or rendered
- Perform necropsy on animals that died from unknown causes



Center for Food Security and Public Health Iowa State University 2006

Educate all employees on how to recognize sick animals and have a reporting system so that treatment decisions can be made or the veterinarian can be contacted. It is important to clean any equipment, boots, clothing that is used between groups of animals with differing health status. Animals that are not going to recover can serve as a reservoir for many disease organisms and should be euthanized humanely and in a timely manner. Dead animals can also serve as a reservoir for many disease organisms and should be promptly removed from the operation. Dead animals need to be rendered, composted or buried so predators, wild birds, etc do not spread disease. Unusual diseases may not present in a manner you are used to, so have a veterinarian necropsy those odd cases to help identify a potentially infectious disease before it becomes widespread on your facility. Photo depicts a steer being necropsied by veterinary students at a feed yard (courtesy of Dan Thomson, KSU).

S
1
i
d
e
1
5

General Prevention Steps

- Isolate ill animals immediately
 - No shared ventilation, direct contact with other animals
- Quarantine newly introduced animals
 - New purchases, returning animals
- Time determined with veterinarian
- Test for key diseases before placing with rest of herd

Center for Food Security and Public Health Iowa State University 2006

Cattle that are identified as ill should be removed from the rest of the herd immediately and placed in an isolation area where ventilation, feed/water, and other equipment are shared and direct contact with other animals does not occur in order to minimize the risk of disease spread. Newly introduced animals, including show cattle/calves that have been away from the farm, may be carrying diseases that your home herd is not immune to, so quarantine them for a period of time. Time spent in isolation and quarantine varies depending on the risk so this should be determined together with your herd veterinarian. Before taking animals out of isolation or quarantine, it is a good risk management plan to test them for key diseases (determined together with your herd veterinarian) and make sure they are not carrying diseases that could be introduced into the home herd.

Direct Contact Fomite Transmission-Beef

S
l
i
d
e

1
6

General Prevention Steps

- Store non-refrigerated vaccines and antibiotics out of sunlight as it can deactivate them
- Monitor refrigeration temperature monthly
 - Ideal temp 36-46°F
- Restrict access to medication to only properly trained personnel



Center for Food Security and Public Health
Iowa State University 2006

Sunlight can deactivate vaccines resulting in inadequate protection; it can also reduce effective treatment by rendering antibiotics ineffective. When using these in your animals, make sure you read the label and store them properly. Vaccines and medicines that need to be refrigerated are susceptible to changes in temperature and may not be effective if they get too warm (greater than 46 degrees Fahrenheit) or too cold/frozen (less than 36 degrees Fahrenheit); monitoring your refrigerator at least monthly can help ensure the products are adequately stored. Work with your veterinarian to teach proper handling procedures to all people who routinely deal with vaccines and medicine and restrict access to only trained personnel. The photo depicts a refrigerator with a thermometer- purchased for less than \$3 at a large retail store (photo courtesy of DB Weddle, ISU).

S
l
i
d
e

1
7

General Prevention Steps

- Ensure adequate ingestion of disease-free colostrum in first 6 hours of life
- Prevent contact with older calves, contaminated environments



Center for Food Security and Public Health
Iowa State University 2006

Adequate ingestion of colostrum is the most important consideration for calf's resistance to disease and all calves should receive colostrum within 6 hours of birth. A calf's immune system depends on the antibodies in colostrum. After 6 hours of life, the calf's ability to absorb antibodies from colostrum diminishes. Once a calf is born, subsequent milk production in the cow will dilute colostrum and therefore require the calf to consume more for maximum antibody absorption and immune function. Another good practice is to prevent contact of the neonate with older animals and also contaminated environments. This will decrease the pathogen load to the newborn and give the colostrum the ability to provide protection. (Photo courtesy of USDA, image # 95cs0931, taken by Fred S. White)

S
l
i
d
e

1
8

Direct Contact and Fomite Control

Now that we have discussed some general prevention steps, let us look specifically at direct contact and fomite transmission and control measures you can apply on your cattle farm to minimize disease spread.

S
l
i
d
e

1
9

Direct Contact, Fomite

- Basic prevention steps involve:
 - Isolating sick animals
 - Keeping environment clean, dry
 - Keeping equipment clean
 - Establishing a reproductive program using reputable semen sources, test negative bulls

Center for Food Security and Public Health
Iowa State University 2006


There are various prevention steps that can help ensure direct contact and fomite transmission are minimized, and this presentation will discuss these. One essential step in prevention is to isolate all sick animals immediately so that they do not contact other susceptible animals. Another is to keep the animal housing environment as clean and dry as possible to minimize risk of environmental exposure. Finally, as reproductive diseases are spread through direct contact, it is essential to use only semen from reputable sources in your artificial insemination programs or purchase bulls that have been tested for diseases of concern and are negative. These basic steps will go a long way in preventing direct contact disease transmission.

Direct Contact Fomite Transmission-Beef

S
1
i
d
e
2
0

Farm Perimeter

- Prevent fence to fence contact with other livestock, differing ages
- Maintain fences to keep your animals in, others out
- Minimize wildlife contact
- Post signs limiting animal access to unauthorized visitors



Center for Food Security and Public Health
Iowa State University 2006

It is important to prevent fence to fence contact with other livestock or those on farm of differing ages due to the increased risk of disease spread by direct contact from neighboring animals. Young stock are generally more susceptible to disease, especially those from neighboring farms that might be carrying diseases this population has no immunity against. By maintaining fences (repairing/replacing posts, tightening wires), you minimize the risk of animals escaping, or other animals entering, and mixing with other livestock or wildlife species, which increases their risk of disease exposure. Wildlife can transmit many diseases to cattle (e.g. leptosporosis, salmonellosis, brucellosis in some areas) and contact should be minimized. Posting signs with clear instructions regarding your farm policy for visitors and locking gates will help limit unauthorized access to your animals, feed, and equipment. (Photo courtesy of DB Weddle, ISU)

S
1
i
d
e
2
1

Farm Vehicles

- Designate a vehicle parking area
 - Away from primary animal traffic
- Minimize vehicle traffic on farm
 - Load/unload, rendering at perimeter
 - Have separate vehicles for “on-farm” and “off-farm” use


Center for Food Security and Public Health
Iowa State University 2006

By having a designated parking area away from animal traffic areas with posted signs, visitors and employees have no reason to drive personal vehicles onto the farm and introduce disease agents on their tires, wheel wells. Minimize vehicular traffic on farm by loading/unloading animals and keeping rendering piles only at the perimeter of the operation. Rendering trucks can visit several farms in one day picking up animals that may have died from contagious diseases. By having the dead pile at the perimeter of the operation, the risk of disease introduction is minimized. Another way to minimize the disease introduction is to designate certain vehicles for use on-farm only and other vehicles for off-farm only. If this is not possible, vehicles used off-farm should be cleaned and disinfected appropriately before coming into contact with animals or their travel paths on farm. In warmer climates, golf carts make excellent on-farm vehicles to minimize disease spread (photo courtesy of: DB Weddle, ISU).

S
1
i
d
e
2
2

Farm Vehicles

- Do not share equipment with other farms
 - Tractors, livestock trailers
- If shared, completely rinse, wash with soap, scrub, rinse and disinfect before contacting animals
- Do not allow feed truck drivers to cross animal paths




Center for Food Security and Public Health
Iowa State University 2006

Do not share equipment with other farms, such as tractors for cleaning barns or livestock trailers, because the risk for disease introduction increases. If equipment is shared, it should be inspected for cleanliness and cleaned appropriately (washed down, soap washed, rinsed, disinfected and allowed to dry) before use. It is also good prevention to prevent feed truck drivers from driving in areas where animals will cross the tire path or come into contact with the truck. Photo courtesy of Bryan Buss, ISU.

S
1
i
d
e
2
3

Farm Visitors

- Require prior authorization before entering the premises
- Sign in and disclose recent cattle contact
- Require clean clothes, clean footwear
 - Provide if necessary



Center for Food Security and Public Health
Iowa State University 2006

Since visitors and sales people have had unknown animal contact prior to visiting your farm, require them to make appointments or notify you prior to their visit. Have visitors sign in and disclose their last known cattle contact so you can decide what, if any, animal contact they should have on your farm. Collecting this information is also important with regard to disease tracking, should an outbreak occur on your farm or in your area. Clean clothes and footwear should be required of anyone entering your operation and if not, entry should be denied as the risk of disease introduction increases. By providing clean clothing (coveralls, tyvek suits) and clean boots (disposable or rubber) to all persons, including employees and herd veterinarians, you can help ensure they will not introduce disease organisms. Photo courtesy of: Dr. Sandy Amass, Purdue University.

Direct Contact Fomite Transmission-Beef

S
1
i
d
e
2
4

Farm Visitors

- Make sure all visitors know BRM plan
 - Post signs, employee meetings, discuss with visitors
- Limit access to those who traveled to foreign countries
 - Previous 7-10 days should have NO animal contact



Center for Food Security and Public Health
Iowa State University 2006

In order to have an effective Biological Risk Management plan, anyone who enters your farm should understand the protocols. This can be done through posting signs (as pictured here), employee meetings, sending letters to those people who frequent your facility, and verbalizing your protocols to anyone on your farm. Many foreign countries have diseases that animals in the United States have no immunity against. By limiting access of people who have recently (last 7-10 days) been to a foreign country, the risk of disease introduction is minimized; often times a devastating disease. Photo courtesy of: DB Weddle, ISU.

S
1
i
d
e
2
5

Animal Housing

- Provide clean, dry housing
- Slope outside lot 2-4% for drainage
- Provide mounds outside
 - 4-6 ft high, 1-5 inch slopes



Center for Food Security and Public Health
Iowa State University 2006

It is important to provide a dry place for animals to lay down when outside so that their udders do not become covered with mud/feces as this can lead to infections/mastitis. Mounds should be included in pens where there is a tendency for water buildup after a rain to give animals a high and dry place to lay. The slope of the entire pen should be 2-4% to allow for drainage with occasional low, flatter mounds (4-6 feet high, 1 to 5 inch slopes, 35 sqft per head) for animals to lay on and keep dry. (Photo courtesy of Bryan Buss, ISU)

S
1
i
d
e
2
6

Breeding/Repro

- Establish a disease free breeding program
 - AI - obtain semen from reputable source that tests bulls for diseases
 - Natural - all bulls must be tested for repro and other diseases; quarantine upon arrival
- Investigate abortions above threshold
 - Work with producer to establish protocol



Center for Food Security and Public Health
Iowa State University 2006

Semen can carry disease causing organisms resulting in unbred cows, infected calves or cows, abortions, and other fertility problems so it is best to establish a disease free breeding program. Artificial insemination (AI) poses less of a disease spread risk than natural breeding if semen is obtained from a reputable source and good hygiene is practiced at the time of insemination (new, clean obstetrical sleeves, sanitary lubrication, clean pipette, and clean vulvar area). Reputable semen companies test their bulls for various infectious diseases and have minimum health requirements for their animals; this information should be provided to you upon request so as to ensure high quality, disease free semen is being brought onto your farm. If natural breeding is used, all bulls must be tested for reproductive diseases of concern and quarantined for a period of time (determined together with your veterinarian) before introducing into the herd. Abortions can be caused by a variety of things so if more occur than expected (as determined together with your herd veterinarian), it may be worthwhile to submit samples to a diagnostic laboratory to identify the cause and best course of treatment. Photo depicts a liquid nitrogen tank used to store frozen semen.

S
1
i
d
e
2
7

Calving

- Calve cows separately from heifers to minimize disease exposure
- Clean pens between uses to minimize exposure



Center for Food Security and Public Health
Iowa State University 2006

Calving cows/heifers individually and following proper hygiene procedures between animals, such as cleaning pens and putting in fresh bedding, will help minimize the risk of disease exposure. Photo courtesy of Bryan Buss, ISU.

Direct Contact Fomite Transmission-Beef

S
1
i
d
e
2
8

Neonatal Management

- Do not house sick animals in calving pens
 - Sick animals spread disease
 - Calves are most susceptible animals on farm



Center for Food Security and Public Health
Iowa State University 2006

Calving pens should be designated for this purpose and not used to house sick animals due to the risk of disease organisms being shed into the environment and exposing stressed animals at calving. Photo courtesy of Bryan Buss, ISU.

S
1
i
d
e
2
9

Summary

- Direct contact, fomite transmission occurs everyday on farms
 - Leptospirosis, BVD
- Foreign animal diseases can also be spread via direct contact
 - FMD, MCF, rinderpest
- Prevention steps as described here can help minimize your risk

Center for Food Security and Public Health
Iowa State University 2006

Direct contact transmission does occur on farms with everyday diseases like leptospirosis and Bovine Viral Diarrhea (BVD). Should a foreign animal disease occur in the US, such as Foot and Mouth Disease (FMD), Malignant Catarrhal Fever (MCF), or Rinderpest they too can be spread through direct contact transmission. Taking some of the basic prevention steps as described in this presentation can help you decrease your risk of disease introduction and spread on your farm.

S
1
i
d
e
3
0

Key Learning Objectives

- Biological risk management is important
- All diseases are transmitted by a few common routes
- Disease risk can be managed
- Awareness education is essential
- You play a critical role!

Center for Food Security and Public Health
Iowa State University 2006

Throughout this presentation, we have stressed that biological risk management is important. All diseases are transmitted by a few common routes and by managing disease exposure, the level of disease will decrease. While disease risk cannot be completely eliminated, it can be managed. Awareness education is critical for assessment and response and each of YOU play a critical role!

S
1
i
d
e
3
1

Questions?

www.cfsph.iastate.edu/BRM
brm@iastate.edu
515-294-7189

CFSPH
Iowa State University,
College of Veterinary Medicine
Ames, IA 50011

Center for Food Security and Public Health
Iowa State University 2006

Acknowledgments

Development of this presentation was funded by a grant from the USDA Risk Management Agency to the Center for Food Security and Public Health at Iowa State University.



Center for Food Security and Public Health
Iowa State University 2006

S
1
i
d
e
3
2

S
l
i
d
e

3
3

Acknowledgments

Authors: Danelle Bickett-Weddle, DVM, MPH
Bryan Buss, DVM, MPH

Reviewer: James Roth, DVM, PhD