FORAGE FEEDING AND BIOSECURITY ISSUES FOR CATTLE

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Introduction

For the purpose of this paper, **biosecurity** refers to the risk of introduction of pathogens or toxins that have potential to damage either the health of the cattle or the safety and quality of food products coming from them. Are there biosecurity issues related to feeding forages to cattle? What measures can be taken to assess associated health risks? Are there effective and economic biocontainment practices that will control the spread of disease when the risk of infection cannot be completely eliminated? The purpose of this paper is to introduce a list of infectious agents that could be introduced to cattle through forage feeding. For each of the agents listed, the ensuing discussion will examine how forages can become contaminated with the agents, the significance of the risk, and measures that can minimize risk and/or control spread of disease amongst cattle or prevent introduction into the food chain.

Agents Capable of Introducing a Health Hazard through Forage Feeding

The agents or toxins that can pose a potential forage biosecurity risk are some of the following. Not all of the organisms represent important risks but they are listed here because of public awareness, human health or animal health issues.

- *Bacillus anthracis* (Anthrax)
- *Campylobacter jejuni*
- *Clostridium botulinum* (Botulism)
- *Clostridium tyrobutyricum* (butyric-acid producing)
- *Cryptosporidium parvum*
- *E. coli* O157:H7
- *Giardia*
- *Listeria* (Listeriosis)
- *Mycobacterium paratuberculosis* (Johnes disease)
- *Mycobacterium bovis* (tuberculosis)
- *Neospora*
- *Salmonella enterica* (Salmonellosis)
- *Yersinia enterocolitica*

How Do Forages Become a Source of Infection?

Fecal pollution is the principle means by which forages become contaminated with most of the above agents. Contamination can occur through manure application to the field in which the forage grows or from manure pollution of harvested feed. Unfortunately, there are many opportunities for accidental introduction of manure to feeds. Feeding equipment that transports manure into feed storage or feeding areas on the wheels or in the bucket. Manure covered boots that inadvertently walk through feed or are used to push feed up to cattle are other potential source of forage contamination. **Farm animals, rodents, birds or flies** can contaminate forages with their own contaminated feces or serve as a vector for introduction

of cow manure to forage. With regard to bird contamination of forages, of particular concern are those that are commonly found near farms and are known to feed on dead animal tissue (carcasses, placentas, mucosal shreds), animal feeds or on material in livestock feeds (corn). Crows, ravens, magpies, starlings, blackbirds and pigeons can readily contaminate feed. In addition to feces, forages can become contaminated from **other feed ingredients, saliva, milk, milk fat film, bedding or blood.** Feed ingredients associated with biosecurity risks (particularly *Salmonella*) are vegetable protein and fat sources and animal fat sources. The ban on ruminant to ruminant protein feeding has significantly reduced the risk of introduction of agents into mixed rations.

The duration of pathogen survival in the environment and with different manure handling systems is a subject of important research. Many variables such as type of manure, slurry, presence of bedding, pH, dry matter content, storage temperature, numberand type of pathogens present have to be considered. In general, micorbial survival is limited by sunlight, drying, freezing and thawing cycles, high temperatures, high and low pH and, for some organisms, exposure to oxygen.

Forage fermentation and storage issues pose another level of biosecurity risks. *Clostridium* and *Listeria* are the agents of principle concern under these categories. Concerns are an inability to limit oxygen, lower pH to appropriate level of acidity or inadvertent storage of dead animals or animal excrement. Other issues are animals like rodents and raccoons living amongst bales of hay that leave large fecal deposits for later ingestion by susceptible cattle.

Anthrax *(Bacillus anthracis)*
The risk to human health from this agent that could potentially contaminated either feed or forage is negligible.

Botulism *(Clostridium botulinum)*
This disease, characterized by weakness, paralysis of the tongue and chest muscles, abdominal breathing, recumbency, watery diarrhea and death, is due to ingestion of the preformed *Clostridium botulinum* toxin. The spores from this organism have caused severe herd mortality when they develop in hay bales or haylage. In some settings, the cause is fermentation failure. Stored haylage failed to become acidic enough to lower the pH to 4.5, the level below which *C. botulinum* growth is inhibited. Another source of forage contamination is a dead animal carcass. This is a relatively rare problem but affected cows rarely survive. The contamination of feed or forages with *Clostridium botulinum* presents no risk for human health.

Campylobacter jejuni
At this point in time, it appears that there is minimal likelihood that this organism either represents a disease problem amongst cattle or that there is a significant risk of transmission from cattle to human beings. The organism poses a significant human health risk and it can be isolated from cattle feces so vigilance must be maintained.

Clostridium tyrobutyricum

These organisms pose a forage quality issue but not an animal health issue. In a comparative analysis of strains of Clostridium spp. isolated from cattle slurries and fresh forage grasses fertilized with slurries, the results showed an unexpectedly low occurrence of Clostridium tyrobutyricum, with only one of the 24 strains isolated from slurry belonging to this species. This microorganism can cause anaerobic spoilage of silage, spores of C. tyrobutyricum can cause problems in cheese making but poses little animal health risk.

Cryptosporidium parvum

This protozoan parasite causes gastrointestinal illness in a wide variety of mammals, including cattle, people, sheep, goats, pigs and horses. It also occurs in various wildlife species like deer, raccoons, opossums, rabbits, wild mice and brown rats. In cattle, diarrhea is usually limited to calves in the first month of life. Adult, asymptomatic cattle can however, shed the organism and cattle are often perceived as being the leading environmental source of the organism, particularly in water. An effective treatment does not exist.

Transmission of *C. parvum* occurs when an infected individual sheds oocysts that are ingested by a susceptible host. Once shed, the oocysts are immediately infective to another individual and are transmissible amongst species. *C. parvum* oocysts in the environment are susceptible to drying and 10 or more days of freezing but they remain viable in manure. The infectious dose, however, appears to be low, making it difficult to eliminate an environmental source of infection. Surface water detection of *Cryptosporidium* oocysts is common but problems of false positive results (non-C. parvum oocysts) and false negative results plague the tests. A causal link between grazing practices and elevated levels of infective *C. parvum* oocysts in nearby surface water is not clear. Forages are not considered to be a reservoir of infection. The zoonotic potential for this protozoan of most concern to public health officials is water transmission but farm workers may become infected through contact with infected animals.

E. coli O157:H7

This organism, which is not associated with any recognizable disease in cattle, is distributed across the US in both dairy and beef cattle operations. It exists, at least intermittently, on the majority of cattle farms. Typically, less than 5% of cattle shed the organism in their feces and are not considered to be a long-term reservoir of infection. Cattle are colonized and shed the organism for no longer than 1-2 months. O157 prevalence in a herd is not associated with manure application to grazing land or harvested forages. It can, however, multiply prolifically in moist cattle feeds like total mixed rations.

O157 is widespread in nature. Besides cattle, it is ubiquitous in birds, deer and other wildlife. Because of this, eradication is not possible. Ecological control measures focus on control of bacterial intake in feed and water. In mixed rations, there is an indication that naturally occurring propionic acid is inhibitory to growth of the bacteria (including *E. coli* and *Salmonella*).

Giardia

This protozoan can cause diarrhea in people and in animals. In cattle, it is rarely a cause of a serious diarrhea outbreak at any age but calves 2 months old and younger are most

susceptible. Transmission is by the fecal oral route, by contact with infected individuals or by consumption of contaminated drinking water or food. Forages are not considered to be a reservoir of infection. The cysts can resist many environmental pressures, which enables them to remain viable in the environment for at least a year.

Johnes disease (*Mycobacterium paratuberculosis)*
This topic is covered elsewhere in this conference.

Listeriosis (*Listeria monocytogenes)*

This organism causes disease in cattle as well as in people. The syndrome in cattle is a neurologic disorder, characterized by circling, unilateral inability to blink, move an ear or chew effectively. The bacteria, commonly believed to gain access to the brain via ingestion in contaminated silage, lives naturally in plant and soil environments and poorly fermented silage. Asymptomatic cattle shed the organism in feces. Shedding may be more prevalent in the winter and is correlated with silage feeding. People have become infected from consuming raw dairy products, with ice cream that had been infected during processing and ingestion of raw vegetables fertilized with sheep manure.

Neospora caninum (Neosporosis)
Neospora caninum is an important cause of abortion in cattle. Cows that have a positive blood test have a high risk of abortion compared to their negative herdmates. While forages pose minimal risk of introducing this organism into a herd, hay or forages contaminated with fecal material from infected dogs has been associated with an abortion storm.

Salmonellosis
These comments are not intended to review salmonellosis in cattle. Rather, comments will be limited to those that convey the importance of this organism as a biosecurity issue of forages. Salmonellosis is one of the most important biosecurity issues for cattle. *Salmonella* species of bacteria contain a large number of serovars, capable of infecting most animals, people, birds and flies. The gram-negative bacteria most commonly causes diarrhea but the bacteria and their toxins can cause multiple organs or body systems to become infected and fail. Calves, calving cows and sick animals are more likely to develop systemic disease than healthy, adult cows. The majority of salmonella infections in a herd over time are subclinical. These asymptomatic animals usually are more numerous than clinically ill cattle and shed enough organisms to infect others. Some strains of bacteria are more pathogenic and the fecal-oral route is the primary means of transmission. The common salmonella serotypes that are important in cattle are *S. anatum, dublin, montivideo, typhimurium, uganda*). All of these are now classified into a single species, *Salmonella enterica*.
In a herd outbreak of salmonellosis, all animals and people on the farm are at risk of infection. Transmission amongst the groups can be by manure on medication equipment, boots, clothing, farm equipment, feeding equipment, feed or hands. Transmission can also occur through saliva contamination of water troughs, feeding surfaces and feed waste. Taking waste feed from a group of infected cattle to another group of susceptible animals enhances the chance of transmission. Flies, rodents, birds and farm animals can enhance the spread of salmonella in a herd. The severity of the herd problem depends on the innate resistance or

health of the herd of cattle, the infective dose that the animal ingests and the infectivity and severity of the strain of *Salmonella*. In the face of an outbreak, daily monitoring of rectal temperatures in at-risk groups can be an effective way to identify and treat sick animals early in the course of the disease. Handle all animals as if they were shedding the disease, not just the sick ones. Healthy adult cows that remain on feed and keep a healthy rumen environment may create an effective barrier to ingested salmonella.

In a herd salmonellosis problem, a feed source of infection is most likely vegetable protein, vegetable fat or animal fat. Manure contamination of forages is less likely as a primary source but mixed, moist rations amplify and disseminate the bacteria. Once contaminated, feedstuffs, feeding surfaces, and biological multipliers like cats, dogs, birds and flies facilitate and perpetuate the infection. Under warm conditions, TMR batches should be limited to what can be fed and consumed within hours.

Salmonella replicates well in composted manure solids once it becomes wet and warm. It survives well in lagoons and can be recycled back to the herd in flush water. Empty slurry pits can remain a source of salmonella on a farm.

The risk of a herd salmonellosis problem is minimized by good feeding and management practices, particularly amongst groups of stressed cattle. Sanitation, disinfection protocols and isolation of sick cattle are practices that minimize the risk of a serious herd outbreak. Herds vaccinated with gram negative bacterial core antigens (J-Vac, J-5 vaccines and Endovac-bovi), while not protected from salmonella infection, may have less severe disease signs or number of clinically ill animals than unvaccinated herds. Currently, commercial vaccines and bacterins are not very effective at protecting herds from an outbreak nor are they good at attenuating disease signs in the face of an outbreak. Sick animals that are identified early and given fluid and electrolyte support and anti-inflammatory drugs like aspirin or banamine can recover with mild to moderate signs of disease. Antibiotic use, particularly in adult cows, may not be warranted and may be contraindicated. Antibiotics may facilitate salmonella overgrowth in the intestine by killing the more sensitive, competitive bacterial flora. In our experience, many *Salmonella* strains have minimal or no susceptibility to the antibiotics used for treatment. In those instances, other bacteria acquire serious antibiotic resistance, making respiratory and other infections on that farm untreatable.

Tuberculosis *(Mycobacterium bovis)*

The risk to human health from this agent that could potentially contaminated either feed or forage is negligible.

Yersinia enterocolitica

At this point in time, it appears that there is minimal likelihood that this organism either represents a disease problem amongst cattle or that there is a significant risk of transmission from cattle to human beings. The organism poses a significant human health risk and it can be isolated from cattle feces so vigilance must be maintained.

Summary

The cost and benefits of forage biosecurity is not known for dairy cattle. Weighing the risk of disease introduction against the relative effectiveness and cost of biosecurity measures will determine which measures are worthwhile. Plans must be specific for type of operation, source of feeds and feeding methods. Application of testing procedures may not achieve the

desired goal of preventing disease. In general, risks are minimized by the provision of clean, unstressful environment and the careful handling and spreading of manure, with particular attention to stressed, sick and young animals. Animal and other tests for biosecurity are not well developed and test performance may not be sensitive or specific enough to screen populations of cattle that have a low prevalence of infection.