

Vector Transmission-Beef

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Practical Applications for Managing Biological Risks

Vector 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 vector transmission on farm.

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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



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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)

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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



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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 Tarpensing).

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Routes of Transmission

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



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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).

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Vector Transmission

- Insect
- Acquires pathogen from one animal
- Transmits to another animal
 - Biological vectors
 - Midges, ticks, mosquitoes
 - Mechanical vectors
 - Flies



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Vector transmission occurs when an insect acquires a pathogen from one animal and transmits it to another. Midges, ticks, and mosquitoes are common biological vectors of disease, meaning they take the disease agent into their body and have to inject into the next animal. Flies are a common mechanical vector as they carry the disease agent on their body rather than taking it into their body. The top photo shows a calf with two old insecticide ear tags and numerous face flies, while the bottom photo shows an adult deer tick, *Ixodes scapularis* (photos courtesy of USDA).

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Selected Diseases Spread by Vectors

Foreign diseases	Present in U.S.
• Akabane	• Anaplasmosis
• Bluetongue	• Anthrax
• Heartwater	• Contagious mastitis
• Lumpy skin disease	• Pink eye (<i>Moraxella bovis</i>)
• Rift Valley fever	• Vesicular stomatitis

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There are many diseases transmitted by the vector-borne route, both diseases that are foreign animal diseases (FADs) and those that are present in the US (endemic). Some examples of the foreign animal diseases include akabane, bluetongue, heartwater, lumpy skin disease, and Rift Valley fever. Some diseases that are already present in the US include anaplasmosis, anthrax, contagious mastitis, pink eye (*Moraxella bovis*) and vesicular stomatitis. 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 vector route, please refer to the Bovine Routes of Transmission Handout- Vector.

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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

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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.

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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



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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).

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S l i d e 9	<h3>General Prevention Steps</h3> <p>Overview</p> <ul style="list-style-type: none">• Farm perimeter• Animal identification• Animal health• Sick/dead animals• Isolation/quarantine• Supply handling• Neonatal management <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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.</p>
S l i d e 1 0	<h3>General Prevention Steps</h3> <ul style="list-style-type: none">• Limit contact with animals<ul style="list-style-type: none">- Neighbor's livestock- Wildlife, birds- Roaming cats, dogs• Maintain fences• Establish biosecurity protocols for delivery vehicles, personnel• Lock gates  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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.</p>
S l i d e 1 1	<h3>General Prevention</h3> <ul style="list-style-type: none">• Identify individual animals• Important for:<ul style="list-style-type: none">- Communicating health status- Treatment needs- Location on farm- Record keeping  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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 Weddle, ISU).</p>
S l i d e 1 2	<h3>General Prevention Steps</h3> <ul style="list-style-type: none">• Keep health records on every animal• Review vaccination and treatment programs<ul style="list-style-type: none">- Annually, bi-annually- Protocol versus actual• Investigate unusual signs, unresponsive cases<ul style="list-style-type: none">- Neurologic, downers, sudden death  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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.</p>

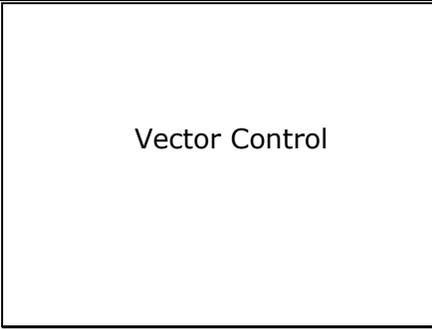
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S 1 i d e 1 3	<p>General Prevention Steps</p> <ul style="list-style-type: none">• Train farm personnel to report sick animals<ul style="list-style-type: none">- Inspect animals daily- Clean equipment, boots, clothing• Euthanize terminally ill animals promptly and appropriately<ul style="list-style-type: none">- Removed or rendered• Perform necropsy on animals that died from unknown causes  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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, or 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).</p>
S 1 i d e 1 4	<p>General Prevention Steps</p> <ul style="list-style-type: none">• Isolate ill animals immediately<ul style="list-style-type: none">- No shared ventilation, direct contact with other animals• Quarantine newly introduced animals<ul style="list-style-type: none">- New purchases, returning animals• Time determined with veterinarian• Test for key diseases before placing with rest of herd  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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 not 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.</p>
S 1 i d e 1 5	<p>General Prevention Steps</p> <ul style="list-style-type: none">• Store non-refrigerated vaccines and antibiotics out of sunlight as it can deactivate them• Monitor refrigeration temperature monthly<ul style="list-style-type: none">- Ideal temp 36-46°F• Restrict access to medication to only properly trained personnel  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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).</p>
S 1 i d e 1 6	<p>General Prevention Steps</p> <ul style="list-style-type: none">• Ensure adequate ingestion of disease-free colostrum in first 6 hours of life• Prevent contact with older calves, contaminated environments  <p><small>Center for Food Security and Public Health Iowa State University 2006</small></p>	<p>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 Bryan Buss, ISU).</p>

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

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Vector Control

- Source reduction
 - Flies, midges, mosquitoes
- Control adults
 - Flies, mosquitoes
- Minimize animal interaction
 - Ticks, midges
- Treatment protocols

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Vector control begins with an understanding of the insect's life cycle. Insect life stages vary and so do the specific, effective control measures. For instance, the egg laying grounds for flies are different than that of mosquitoes and midges and one approach does not work for all. We will discuss options in future slides. Controlling adult insects, be it flies or mosquitoes, often involves the use of insecticides. This is often less effective, so more effort should be focused on controlling breeding areas. Finally, minimize the opportunities for insects to even interact with animals, such as ticks or midges. Treatment protocols for each of the areas will be discussed in the next slides.

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Source Reduction

- Flies
 - 4 life stages
 - Egg, larva, pupa, adult
 - Cycle as short as 10 days in warm weather
 - Lay eggs in organic matter
 - Manure, feed, wet bedding
 - Disturb weekly to prevent development
 - Clean up spilled feed, feed bunks



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Flies have a four stage life cycle. The adult female fly lays her eggs in organic matter, be it manure, feed or wet bedding. These eggs then develop into larva, which change to pupa and finally emerge as adult flies. This process can be as short as 10 days in warm weather. One way to decrease the prevalence of flies is to minimize areas where they can lay their eggs by disturbing the piles of organic matter weekly. Flies lay their eggs in organic matter, be it manure, feed or wet bedding. One way to decrease their prevalence is to minimize these areas by disturbing them weekly to prevent eggs from developing. Keep pastures rotated, drag dry lots to break up the fecal pats, clean up spilled feed, clean around feed bunks. The photo depicts an excellent area for flies to lay their eggs- old feed (courtesy of Bryan Buss, ISU).

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Source Reduction

- Fly larvicides
 - Feed additives
 - All animals on farm, 3 weeks prior to season
 - Parasitic wasps feed on fly pupa
 - Predatory mites, beetles feed on larva
- Adulticides
 - Knockdowns for high concentrations
 - Residuals for barn walls, ceilings
 - Baits, fly traps in conjunction with other methods

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Feed additives (larvicides) have some effectiveness but the key is to get it in the feed at least 3 weeks before fly season, feed it to ALL animals on farm and maintain it in the feed until the end of fly season. This should be in addition to some of the other hygiene procedures of cleaning yards, barns and feeding areas. Parasitic wasps, predatory mites and beetles feed on pupae/larvae living in manure, bedding, vegetation. Certain insects can only be used in certain areas because they may feed on other beneficial insects, so check with your local extension specialist for recommendations. Adulticides such as knockdowns that kill a fly on contact should be applied in areas of high fly concentrations because they do not last long in the environment (1-2 hours). Residual sprays can be applied to shaded surfaces (barn walls, ceilings) where flies rest to kill them through contact. To avoid insecticide resistance, it is a good idea to alternate between area and residual sprays. Baits and fly traps work against house flies but should be part of an integrated pest management system for best efficacy.

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Control Adult Flies

- Target key areas on farm

Animals



Barns



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Target key areas on farm with insecticides to minimize cost. Animals can have impregnated ear tags put in each ear, a pour-on applied to their back as the photo on the left shows, made to walk through dusters, oilers or backrubbers with insecticides on them or have an Insect Growth Regulator bolus placed in their rumens. Barns can be sprayed with products approved for food animals and is a cost effective way to spend money on insecticides. The photo on the left depicts cattle receiving pour-on for insect control (courtesy of Bryan Buss, ISU) and the photo on the right depicts a cattle barn that was recently sprayed for flies (courtesy of DB Weddle, ISU).

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Disease Transmission

- Flies can spread:
 - Contagious mastitis
 - Dermatophilus (rain rot)
 - Grubs
 - Lumpy skin disease
 - Pink eye (*Moraxella bovis*)
 - Screwworm



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Flies are capable of spreading contagious mastitis, *Dermatophilus* (rain rot), grubs, lumpy skin disease, pink eye (*Moraxella bovis*) pictured here, and screwworm. Photo courtesy of Addison Biological Laboratories.

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Source Reduction

- Biting midges
 - Lay eggs in decaying vegetation, wet soil, mud
 - Larvae need moisture, organic matter
 - Adults fly 1-2 miles from source
 - Manage settling ponds, stagnant water



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Biting midges, or no-see-ums, lay their eggs in decaying vegetation or wet soil or mud, and larvae need moisture and organic matter to survive. Adults stay pretty close to their breeding sites, so manage those areas by agitating settling ponds and minimize stagnant water. It is more difficult to manage the larval sites due to their vastness and hard to treat regions. Photo is a biting midge, courtesy of Ed T. Schmidtman, USDA/ARS http://creatures.ifas.ufl.edu/aquatic/Biting_midges_02.htm

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Disease Transmission

- Biting midges can spread:
 - Bluetongue virus



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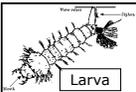
The biting midge, *Culicoides variipennis* or *sonorensis* transmits bluetongue virus which causes erosions around the muzzle of cows, as pictured here. Photo courtesy of The Foreign Animal Diseases, "The Gray Book" available at http://www.vet.uga.edu/vpp/gray_book/.

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Source Reduction

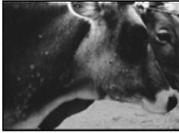
- Mosquitoes
 - Lay single eggs in damp soil
 - Lay eggs on water surface
- Larvae, pupae live upside down in water;
 - Breathe via siphon, trumpet at water surface
 - Larvae need organic matter for development



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There are about 200 different species of mosquitoes in the United States, all of which live in specific habitats, exhibit unique behaviors and bite different species of animals. Some lay single eggs on damp soil that is later flooded by water; others lay an egg raft on the water's surface. Eggs hatch to larvae then to pupae, both of which live in the water and come to the surface to breathe by utilizing a siphon tube or trumpet while hanging upside down from the surface of the water. The larva require large amounts of nutrients for maturation and feed on organic matter in the water.

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S 1 i d e 2 6	<h3>Disease Transmission</h3> <ul style="list-style-type: none">• Mosquitoes can spread:<ul style="list-style-type: none">– West Nile virus– Rift Valley fever– Lumpy skin disease– Vesicular stomatitis  <p>Center for Food Security and Public Health Iowa State University 2006</p>	<p>Since there are over 200 species of mosquitoes, they are not all capable of spreading disease, only certain types can spread certain diseases. Some of the diseases they can spread include West Nile virus, Rift Valley fever, lumpy skin disease (as pictured here) and vesicular stomatitis. Photo courtesy of USDA APHIS.</p>
S 1 i d e 2 7	<h3>Source Reduction</h3> <ul style="list-style-type: none">• Eliminate mosquito larval habitats• Fill tree holes• Empty containers that hold water weekly• Circulate lagoons, water tanks• Drill holes in or use half tires for silage piles   <p>Center for Food Security and Public Health Iowa State University 2006</p>	<p>Source reduction consists of eliminating larval habitats or making them unsuitable for larval development. Tree holes can be good breeding grounds for some mosquitoes, so those should be filled. Containers that hold water, like stock tanks or water troughs, should be emptied weekly or agitated weekly to keep mosquitoes from laying eggs there. By minimizing standing water through circulating lagoons or water tanks, a lot can be done to minimize their breeding areas. Another problem on farms is containers that hold water or old tires used for silage piles, as pictured on the bottom (courtesy of DB Weddle). Not only do mosquitoes transmit disease to animals, but to humans too and a farm walk through to identify and eliminate mosquito breeding sites is good prevention.</p>
S 1 i d e 2 8	<h3>Mosquito Larvicides</h3> <ul style="list-style-type: none">• Use when source reduction and biological control not feasible• More effective and target-specific• Less controversial than adulticides• Applied to smaller geographic areas<ul style="list-style-type: none">– Larvae concentrate in specific locations  <p>Center for Food Security and Public Health Iowa State University 2006</p>	<p>Larvicides are used when immature mosquito populations become larger than source reduction can manage or biological control can handle. They are often more effective and target-specific than adulticides, making them less controversial. They can be applied to smaller geographic areas than adulticides because larvae are often concentrated in specific locations, such as standing water. Photo depicts a swampy area in the distance that is too big to drain but could be treated with larvicides to reduce the number of adult mosquitoes that emerge in this area (courtesy of USDA image # 96cs0506, taken by Bill Tarpenning).</p>
S 1 i d e 2 9	<h3>Control Adult Mosquitoes</h3> <ul style="list-style-type: none">• Insecticides/adulticides• Less efficient than source reduction• Require multiple applications• Require proper environmental conditions<ul style="list-style-type: none">– Light wind, no rain• Small droplets to contact adults  <p>Center for Food Security and Public Health Iowa State University 2006</p>	<p>Insecticides are often the least efficient control program and often require multiple applications. Effective adult mosquito control with adulticides requires small droplets that drift through mosquito areas and come in contact with adults to kill them as pictured here. Insecticides are applied in a concentrated form at very low volumes such as 1 oz (29.6 mL) per acre. Excessive wind and updrafts reduce control, but light wind is necessary for drifting spray droplets.</p>
S 1 i d e 3 0	<h3>Minimize Animal Interaction</h3> <ul style="list-style-type: none">• Ticks<ul style="list-style-type: none">– Mow pastures– Acaricides• Midges<ul style="list-style-type: none">– No effective animal treatment– Increase distance from source– Confine animals   <p>Center for Food Security and Public Health Iowa State University 2006</p>	<p>While source reduction will help decrease numbers of insects in the area, often times it is necessary to minimize the interaction with animals. This could involve environmental management such as mowing pastures, as the top picture depicts, to reduce tick habitats to chemical treatments with acaricides (tick killing chemicals) every 2-4 weeks during tick season. Other ways to minimize interaction is to confine the animals to an insect proof structure. In the case of vesicular stomatitis outbreaks or bluetongue, it is necessary to confine the animals in a stall as the bottom photo illustrates, until the insect season has passed. This can be difficult to do depending on the farm or types of animals raised. But if it is the only way to prevent disease, temporary structures could be put up. Both</p>

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Disease Transmission

- Ticks can spread:
 - Anaplasmosis
 - Babesiosis
 - *Dermatophilus* (rain rot)
 - Heartwater
 - Q fever



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There are many different species of ticks and some are capable of spreading diseases such as anaplasmosis, babesiosis, dermatophilus (rain rot- pictured here), heartwater and Q fever. Photo courtesy of DB Weddle, ISU.

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Summary

- Vector borne transmission occurs everyday on farms
 - Mastitis, pink eye, anaplasmosis
- Foreign animal diseases can also be spread via vectors
 - Rift Valley Fever, heartwater
- Prevention steps as described here can help minimize your risk

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Vector-borne transmission does occur on farms with everyday diseases like mastitis, pink eye, and anaplasmosis. Should a foreign animal disease occur in the US, such as akabane, Rift Valley Fever, or heartwater, they too can be spread through vector-borne 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.

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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!

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Throughout this presentation, we have stressed that biological risk management is important. All diseases are transmitted by a few common routes and managing disease exposure will help decrease the level of disease. 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!

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Questions?

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Acknowledgments

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