

1 **Title:** Practical On-Farm Biosecurity

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4 **Abstract:** This manuscript will cover practical approaches to biosecurity on the farm.
5 Biosecurity practices based on route of disease transmission will be emphasized, as well as a
6 review of basic principles of biosecurity. Biosecurity principles commonly described as
7 “everyday” and “enhanced” will be summarized in a practical, succinct way. Additional
8 discussion on biosecurity risks, barriers, and strategies will occur, and resources on helping
9 veterinarians help their clients create a site-specific biosecurity plan, as well as related topic-
10 specific resources like disinfection, will be shared.

11 **Keywords:** Biosecurity, Disease

12 **Introduction:** The introduction of infectious diseases into a livestock herd can occur in a number
13 of ways. Natural introductions can occur sporadically, particularly in endemic areas, from the
14 environment or contact with infected wildlife. Additionally, microorganisms are constantly
15 evolving and adapting, which can result in changes in the distribution, host range, or virulence of
16 a pathogen. The accidental introduction of disease pathogens can occur through the movement of
17 animals (e.g., new animals to a herd or flock), food products (e.g, contaminated meats from areas
18 or countries where a disease occurs), or can be transferred by people, vehicles, or equipment
19 contaminated by infected animals. Pathogens of livestock or poultry can also be introduced
20 intentionally (e.g., acts of bioterrorism, agroterrorism, or warfare). Disease spread occurs when
21 the agent leaves its reservoir or host through a portal of exit, is transferred by some mode of
22 transmission, and enters through an appropriate portal of entry to infect a new susceptible host.

23 This sequence is sometimes called the chain of infection. The disease-causing organism has
24 various factors which influence its ability and likelihood for causing disease, including its
25 pathogenicity, the infectious dose required for disease to develop, the reservoir host, and the
26 source of the organism, as well as the route by which the disease-causing organism can spread
27 and factors pertaining to the new host, such as individual host factors, nonspecific resistance, and
28 immunity. The spread of infectious disease agents can be broken down into 5 possible routes of
29 transmission: direct contact (horizontal or vertical), inanimate objects in the environment or
30 fomites, ingestion, aerosol and vectors. It is important to remember that individuals (animals and
31 humans) may be infected without obvious signs of illness and can possibly serve as a source of
32 infection to others. Equally important is knowing that not all pathogens are spread by all routes
33 of transmission. Understanding the portals of exit and entry and modes of transmission helps to
34 determine appropriate prevention and control measures. Many diseases have a public health
35 impact since they are zoonotic. Disease outbreaks have both direct and indirect costs for farmers.
36 Farmers have fewer animals to sell, transporters have fewer animals to haul, slaughterhouses and
37 processing plants have less animals and products to process, and the public pays a higher price
38 for milk, meat, or eggs. Additionally, there is a longer time to finishing and farmers must pay any
39 costs associated with treatment.

40 **Principles of Biosecurity:** Broadly, biosecurity is defined as on-farm management practices
41 designed to prevent disease introduction (keeping disease off the farm, also known as
42 bioexclusion) and control disease spread (keeping disease on the farm from spreading within the
43 herd/flock and to other farms, also known as biocontainment). Biosecurity principles are
44 commonly described as “everyday” and “enhanced.” Everyday biosecurity measures are meant
45 to protect animals from endemic disease, while the term “enhanced biosecurity” is most often

46 applied to measures for the prevention of highly contagious foreign animal diseases, such as Foot
47 and Mouth Disease. This manuscript describes the eleven categories commonly used in
48 biosecurity guidance resources, briefly summarizing existing “everyday” and “enhanced”
49 biosecurity measures, and distilling to a simple and practical recommendation for each.

50 **Biosecurity Measures:**

- 51 **1. Biosecurity Manager and Written Plan:** Farms designate a biosecurity manager, who is
52 familiar with the facility, develops a biosecurity plan with a veterinarian, communicates
53 biosecurity measures, and monitors to ensure compliance. A written, site-specific
54 biosecurity plan includes a labeled premises map including items such as parking, the
55 perimeter buffer area, and the line of separation (described later), is communicated to
56 employees and be accessible to others, and is reviewed annually and as changes occur.
57 Items on the biosecurity plan are assessed as either “in place,” “in progress,” or “not in
58 place,” in the biosecurity plan and implemented on the dairy operation as evidenced by
59 visual inspection or by signed and/or dated documentation, as applicable. In practical
60 terms, “someone should be in charge, and a plan should be written down.”
- 61 **2. Training:** The Biosecurity Manager and essential personnel are trained at least annually
62 on how to keep FMD out of the herd. The training must be in a language understood by
63 the individuals receiving training. Effective training ensures that individuals are aware of
64 the concepts and procedures that apply to their specific areas of responsibility; training
65 occurs at least annually and is documented. The Biosecurity Manager also ensures that all
66 contractors, truck drivers, and service personnel are aware of and adhere to the
67 biosecurity measures in the biosecurity plan. In practical terms, “go over what you wrote

68 down with animal caretakers, and if someone's new or something changes, go over it
69 again."

70 3. **Farm Access:** For daily biosecurity, recommended practices include gates, fencing, and
71 barriers, signage, limiting entry to essential personnel, recording movements, and parking
72 away from animal areas. Enhanced Biosecurity farm access measures include a Line of
73 Separation (LOS), which is an outer control boundary to minimize contamination near
74 animals and separates off-farm from on-farm movements of vehicles, people, animals OR
75 is the walls of building which separate animals from all possible sources of infection, and
76 a Perimeter Buffer Area (PBA), which is an outer control boundary to minimize
77 contamination near animal building(s) and separates off-farm from on-farm movements
78 of vehicles, people, animals. The LOS and PBA should have a minimum number of
79 access points, which can be determined by thinking about the inputs/outputs that occur
80 regularly on the operation over a 30-day period. In practical terms, "make sure not just
81 anybody gets in or goes near animals, and design "traffic flow" thoughtfully." Once this
82 is done, "try to keep the "ins" in and the "outs" out, and if something from the outside
83 needs to go in, be thoughtful about where and how it enters (and make sure it's clean)."

84 4. **Vehicles/Equipment:** Avoid or minimize sharing vehicles and equipment. If sharing is
85 required, the vehicle or equipment should stay outside of the PBA/LOS; if it must enter, it
86 is cleaned and disinfected. Routes minimize contact with animals, feed, and manure. In
87 practical terms, "don't share stuff, or if you have to, clean and disinfect (C&D) it first; the
88 stuff shouldn't touch animals, feed, or manure (unless that's what it's for), and think
89 about biosecurity when loading and unloading animals." Cleaning involves four steps:
90 dry clean, wash, rinse, and dry. Before disinfecting, be sure to read the product label so

91 that you understand mixing, application, contact time, and safety. Disinfection involves
92 four steps as well: apply the disinfectant, wait for the appropriate contact time, rinse, and
93 dry. It's also important to consider the type of surface that is being disinfected. Smooth
94 surfaces are the easiest to disinfect, porous surfaces are more difficult to disinfect, and
95 dirt surfaces are the most challenging to disinfect. In practical terms, "if you are going to
96 C&D, do it right by cleaning before you disinfect, use the right product for the situation,
97 give it time to work, and use it safely."

98 5. **Personnel:** Prior to arriving at the dairy, access is limited to individuals who are essential
99 to the operation of the dairy. Everyone crossing the LOS on foot or exiting their vehicle
100 inside the LOS arrives at the operation having showered and wearing clean clothing and
101 footwear since last contacting susceptible animals. All individuals crossing the LOS have
102 a signed agreement on file agreeing to follow these instructions. An entry logbook, and
103 written biosecurity entry and exit procedures should be followed. All individuals who
104 cross an LOS Access Point on foot or exit their vehicle inside the LOS ensure that visible
105 contamination on their footwear, clothing, or exposed skin does not enter or exit the
106 operation, following the biosecure entry and exit procedures as specified in the
107 biosecurity plan. In practical terms, "wash your hands, wear clean clothes and shoes,
108 avoid contact with outside livestock if possible, and visitors, delivery people, and service
109 persons who don't need to enter livestock areas should be asked to go elsewhere."

110 6. **Animal Movement:** Daily biosecurity practices include recordkeeping, such as
111 identification, movement logs, and source documentation, as well as animal health
112 protocols, established in collaboration with a veterinarian, and which should include
113 protocols for quarantine and isolation and animal flow. Enhanced biosecurity practices

114 pertain to incoming animals, whereby animals only come from sources with documented
115 biosecurity practices and no current or previous evidence of FMD infection, and follow a
116 pre-movement isolation period, whereby no animals from an FMD Control Area are
117 introduced onto the operation for at least 7 days prior to moving animals to another
118 production site with susceptible animals. In practical terms, “establish quarantine and
119 isolation protocols, and follow them... always.”

120 7. **Animal Product Movement:** Semen and embryos come from sources with documented
121 biosecurity protocols and no current or previous evidence of FMD infection. Semen and
122 embryos are transported in containers that can be cleaned and effectively disinfected to
123 minimize the risk of virus transmission. Colostrum should be fed from the source herd or
124 pasteurized. A milk disposal plan exists in the event raw milk cannot be moved to
125 processing off-farm. In practical terms, “Check on biosecurity practices for wherever
126 your products are coming from (or going to, if they’re picked up on farm).”

127 8. **Carcass Disposal:** Dead cattle are disposed of in a manner that prevents the attraction of
128 wildlife, rodents, and other scavengers. Rendering trucks and other vehicles hauling dead
129 animals to a common disposal site do not cross the LOS. In practical terms, “Be smart
130 about where you put carcasses and how you move them and ensure carcasses don’t attract
131 scavengers.”

132 9. **Manure Management:** Manure is stored and removed in a manner that prevents
133 exposure of susceptible animals (either on or off the premises of origin) to disease agents
134 and meets state, local, and Responsible Regulatory Officials’ regulations. Manure
135 handling equipment is separate from feed handling equipment, or is C&D between use. In

136 practical terms, “Regularly remove manure from animal areas, and use separate
137 equipment for manure and feed (or clean between use).”

138 **10. Rodents, Wildlife, and Other Animals:** Three steps are followed: clean, exclude, and
139 control. Cleaning includes general farm maintenance, weed/grass control around
140 buildings, sanitation, and drainage, which are important because it reduces attraction of
141 wildlife and rodents. Trash should be regularly removed and feed spills cleaned up
142 immediately. Waste milk and dead cattle should be disposed of/removed promptly.
143 Outdoor raised animals are at risk of wildlife contact. Sturdy, double fencing at a height
144 that accounts for jumping deer and aggressive feral pigs surrounding dry lots, pastures,
145 and buildings housing cattle is one option that could be implemented for exclusion.
146 Complete exclusion of wildlife may not be possible. Bird control should follow local or
147 state regulations. Dogs and cats should be secured during an outbreak to prevent contact
148 with cattle and feed areas. Ask your neighbors to do the same to prevent roaming.
149 Rodent control options could include designating an on-farm monitor or using a
150 company. In practical terms, “control/deter wild birds, rodents, and wildlife, and don’t
151 allow pets, etc. in animal areas if possible.”

152 **11. Feed and Water:** Daily biosecurity practices include feed storage and handling that
153 prevents contamination, cleaning of feed spills immediately, including disposal methods
154 and routes in plan/labeled on map, and separating manure handling equipment from feed
155 handling equipment (or C&D between use). C&D feed delivery vehicles if cross LOS,
156 and finished feed is stored in closed bins or buildings. In practical terms, “Store feed
157 securely, clean up feed spills promptly, and use separate equipment for feed and manure.”

158 **Biosecurity Planning and Resources:** The Secure Milk Supply Plan (securemilk.org) describes
159 enhanced biosecurity for Foot and Mouth Disease prevention. A variety of other advanced
160 biosecurity resources are available, including training materials on Secure Food Supply
161 biosecurity, and checklists and videos pertaining to specific topics such as setting up and
162 operating a cleaning and disinfection station on a livestock premises. This manuscript
163 recommends the Biosecurity Your Way resource for practical, on farm biosecurity
164 (farmbiosecurity.cfsph.iastate.edu). This tool provides resources to learn about biosecurity,
165 design a biosecure farm, and make a customized plan. Offered are checklists, tip sheets, videos,
166 lessons, templates, and more. The resources are also available in Spanish.

167 **Biosecurity Barriers and Strategies:** Although many biosecurity measures are effective, there
168 may be barriers to implementing them on the farm. These can include social and cultural
169 acceptability, risk perception, and access to biosecurity information. Additionally, the cost of
170 biosecurity measures can be a barrier. It may be helpful to provide cost-benefit data to farmers –
171 this enables them to see how biosecurity can improve their livelihood. Remember that some
172 biosecurity costs are due to set-up while others are recurring. In some countries there may be
173 public programs that share the cost of biosecurity implementation, since animal health impacts
174 national economies. The public sector has the ability to impact farm biosecurity through
175 regulation and penalties. However, incentives are a powerful tool to increase compliance in a
176 positive way. Trust between farmers and the public sector is critical for animal health. While
177 explanations, recommendations, and messaging are important, the public sector must listen and
178 advocate for rural communities to achieve farmer buy-in. In addition, farmers must advocate for
179 the importance of animal health. Education, especially of animal owners, can be critical in
180 preventing and controlling disease. Sharing specific interventions that can impact animal health

181 can be helpful. In addition, reminding animal owners that preventing and controlling animal
182 diseases can also have impacts on food security, public health, and finances can provide
183 additional benefits.

184 **Conclusions:** The introduction of infectious diseases into a livestock herd can occur in a number
185 of ways. Understanding the portals of exit and entry and modes of transmission helps to
186 determine appropriate prevention and control measures. Broadly, biosecurity is defined as on-
187 farm management practices designed to prevent disease introduction (keeping disease off the
188 farm, also known as bioexclusion) and control disease spread (keeping disease on the farm from
189 spreading within the herd/flock and to other farms, also known as biocontainment). Biosecurity
190 principles are commonly categorized into eleven areas: biosecurity manager and written plan,
191 training, farm access, vehicles and equipment, personnel, animal movement, animal product
192 movement, carcass disposal, manure management, rodents, wildlife and other animals, and feed
193 and water. While all categories may include measures that are complex, it is also possible to
194 distill practices into simple, practical recommendations. A useful resource for practical
195 implementation of biosecurity is the Biosecurity Your Way website, which includes lessons,
196 checklists, templates, tip sheets, videos, and more, available in English and Spanish.

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