



Canadian Food
Inspection Agency

Agence canadienne
d'inspection des aliments

Animal Biosecurity

The National Sheep On-Farm Biosecurity Standard



© 2013 Her Majesty the Queen in Right of Canada
(Canadian Food Inspection Agency), all rights reserved.
Use without permission is prohibited.

CFIA P0847E-13
Catalogue No: A104-111/2013E
ISBN: 978-1-100-21856-4

Cette publication est aussi disponible en français.

Cover Photos: Ontario Agriculture Photo Library / Tracy Hagedorn



Table of Contents

1 Introduction	3
1.1 Biosecurity and Why it is Important to the Sheep Industry in Canada	3
1.2 Development of the Standard	5
1.3 Use of the Standard	6
1.4 Structure of the Standard	7
2 National Sheep On-farm Biosecurity Standard	9
2.1 Principle 1: Animal Health Management Practices	9
2.1.1 Strategy 1: Prepare and use a flock health program	10
2.1.2 Strategy 2: Sourcing sheep	12
2.1.3 Strategy 3: Manage sheep that leave and return to the home farm	13
2.1.4 Strategy 4: Isolate sick sheep, flock additions and returning sheep	14
2.1.5 Strategy 5: Manage contact with neighboring/other livestock	15
2.1.6 Strategy 6: Plan sheep movement through the production unit	15
2.1.7 Strategy 7: Implement sheep health protocols for specific situations	16
2.1.8 Strategy 8: Limit access by pests, dogs and cats, predators and wildlife	16
2.1.9 Strategy 9: Implement health standards for guardian and working animals	17
2.2 Principle 2: Record Keeping	17
2.2.1 Strategy 1: Maintain and review farm records	18
2.2.2 Strategy 2: Record Education and Training Activities	19
2.2.3 Strategy 3: Develop a Response Plan for Disease Outbreaks	19
2.3 Principle 3: Farm, Facilities and Equipment	20
2.3.1 Strategy 1: Create a diagram of the farm layout and identify risk areas	22
2.3.2 Strategy 2: Clean and Disinfect Facilities, Equipment and Vehicles	23
2.3.3 Strategy 3: Reduce risk in barns/pens	24
2.3.4 Strategy 4: Reduce risk from equipment	25
2.3.5 Strategy 5: Reduce risk from vehicles	25
2.3.6 Strategy 6: Manage Manure	26
2.3.7 Strategy 7: Manage Feed, Water and Bedding	27
2.3.8 Strategy 8: Apply Shearing Protocols	27
2.3.9 Strategy 9: Manage Needles and Sharps	28
2.3.10 Strategy 10: Manage Deadstock	29

2.4 Principle 4: People	29
2.4.1 Strategy 1: Conduct Risk Assessments for all people entering the farm	30
2.4.2 Strategy 2: Develop and enforce risk management practices for all people visiting the farm, using the risk assessment outcomes.	32
2.4.3 Strategy 3: Know what people are on the premises.....	32
2.4.4 Strategy 4: Train farm workers and communicate with them about biosecurity; inform all visitors and service providers.....	33
2.4.5 Strategy 5: Recognition of Zoonotic Risks.....	34
3 Acknowledgements.....	35
Appendix A – Glossary of Terms	37
Appendix B – List of Reference Documents.....	42



1: Introduction

1.1 Biosecurity and Why it is Important to the Sheep Industry in Canada

*Biosecurity*¹ is often thought to be important only in avoiding catastrophic or *foreign animal diseases* (FADs). However, in the National *Sheep On-Farm Biosecurity Standard* (the “Standard”), in addition to having a positive impact on the prevention of FADs, biosecurity is intended to be proactive in helping to reduce the risks of *endemic diseases*. These are diseases that commonly occur at some level on farms in Canada, and if they can be reduced, flock productivity and the financial well-being of the industry can be improved. Biosecurity *practices* are also designed to reduce the risk of disease transmission when *emerging diseases* are discovered.

Farm-level biosecurity is about a series of management practices designed to minimize, prevent or control:

- a) The introduction of infectious *pathogens* onto a farm;
- b) Spread within a farm production operation;
- c) Export of these pathogens beyond the farm, which may have an adverse effect on the economy, the environment and human health.

Canadian Food Inspection Agency (CFIA)

In order to proactively guard against flock health problems, sheep producers need to be aware of the diseases of concern on their farms, and the risks of both endemic diseases and FADS occurring in their flocks. Certain disease risks commonly occur from time to time in farmed animal production, but they can be managed by practical biosecurity measures applied at the farm-level.

On a sheep farm, a biosecurity plan focuses on:

- 1) **Exclusion:** reduce the introduction of pathogens on sheep farms.
- 2) **Management:** reduce the spread of pathogens within a sheep farm.
- 3) **Containment:** reduce the spread of pathogens between sheep farms or from sheep farms to other animal populations.

¹ Italicized terms are defined in the glossary

Biosecurity addresses risks that could exist, whether they are immediately evident or not. An animal infected with a pathogen may or may not show signs of disease (e.g. off feed, fever, diarrhea). Nevertheless, the pathogen can be reproduced in the animal's body and be shed through excretions, including saliva, nasal and vaginal secretions, faeces, urine, milk, or aerosols from the respiratory system. These pathogens may not be visible and can contaminate the surfaces in the surrounding environment, including facilities, equipment, tools, and other animals.

Biosecurity particularly addresses disease transmission risks. Pathogens can be transmitted by several means:

- directly, by contact between animals, including transmission of pathogens shed by one sheep to another, or
- indirectly, from contact with contaminated tools, equipment and instruments (such as needles, syringes, feeders and pen walls, or hoof trimmers), from people having contact with sheep, and from insects, *vermin* or any other *vectors*.

Biosecurity addresses risks that impact the viability of farms. Diseases and pests can:

- reduce productivity, by reducing milk production, weight gain and/or successful lambing;
- increase veterinary and labour costs for vaccination and treatment of the flock;
- impact animal welfare, causing suffering and operator/veterinary intervention;
- affect domestic consumption, introducing concern among retailers and reducing consumers' confidence in Canadian sheep products;
- reduce prices that producers receive for their animals and products, driven by concern regarding lower quality and product safety;
- close export markets;
- reduce farm incomes, due to reduced marketing;
- reduce the value of farmland, due to direct contamination (e.g. Johne's disease, scrapie) and reduced attributable revenue;
- contaminate stored feed, resulting in waste and additional cost; and
- result in condemnation of meat through contamination with such agents as *Cysticercus ovis* or caseous lymphadenitis.²

In addition to adverse effects on the agricultural economy, diseases and pests can have negative effects on the environment and on human health.

The benefits of implementing on-farm biosecurity practices are significant. They include:

- more secure financial health for producers;
- improved animal health and welfare;
- reduced use of veterinary drugs, thereby reducing medical costs and decreasing the risk of antibiotic resistance;

² Information on diseases and conditions of sheep is provided in the National Sheep Producer Biosecurity Planning Guide, a companion document to the Standard

-
- more secure market access, both local and national;
 - protection of human health; and
 - more secure financial health for farm workers and for farm service industries such as feed suppliers, processors, and veterinarians.

1.2 Development of the Standard

The Canadian Food Inspection Agency (CFIA) is developing National Biosecurity Standards for livestock and poultry in collaboration with producer organizations, provincial/territorial governments, academia and Agriculture and Agri-Food Canada. Each sector has its own operating requirements and unique practices that need to be reflected in each Biosecurity Standard.

The Canadian Sheep Federation (CSF) and the Canadian government recognize that animal health starts on the farm with an animal health program. Putting measures in place to keep animals healthy and implementing strategies to prevent the introduction and spread of diseases are the goals of an on-farm biosecurity plan.

The National Sheep On-Farm Biosecurity Standard was developed through a coordinated set of activities over a two-year period:

- 1) CFIA's Office of Animal Biosecurity (OAB) and the CSF developed a partnership to create a Standard for biosecurity in the sheep industry in Canada.
- 2) An Advisory Committee including producer representatives, academics, industry leaders and representatives of the federal and provincial governments was formed to guide the development of the Standard and the National Sheep Producer Biosecurity Planning Guide (the "Guide").³
- 3) A consultant firm was selected through a competitive bidding process and assigned the responsibility to undertake certain activities on behalf of the project sponsors.
- 4) A review of published research, biosecurity-related documents, and existing programs identified biosecurity-related programs, studies of biosecurity implementation, and best practices in use on sheep farms in Canada and elsewhere in the world. Gaps in practices for addressing known biosecurity risks and in current biosecurity programs were identified.
- 5) A benchmark measurement of practices in use on sheep farms across Canada provided a snapshot of the current level of adoption of biosecurity and animal health practices, and recorded gaps and best practices on the participant farms.
- 6) Draft versions of the Standard and the Guide were refined through consultations with the Advisory Committee and industry stakeholders and published in final form.
- 7) A communication package was developed to help producers in all regions of the country develop, implement and post their on-farm biosecurity plans.

³ The Guide has been developed along with the Standard as a resource for sheep producers as they prepare biosecurity plans for their farms.

1.3 Use of the Standard

The Standard provides the framework and scope for biosecurity planning in the sheep sector in Canada by establishing a minimum set of biosecurity standards that can be used by sheep producers in all producing regions. It is intended to assist sheep producers in developing biosecurity plans for their specific farm operations, to serve as a guide for continuous improvement, and to encourage a higher level of care.

In addition, it is intended to provide insight to sheep producers' suppliers, customers and stakeholders regarding the direction the industry is taking in designing its farm-level biosecurity program. These people can then directly support sheep producers' biosecurity efforts, design other programs to interface and coordinate with on-farm biosecurity practices, and coordinate activities between livestock sectors.

In particular, the Standard and the Guide are expected to be coordinated with and used together with producers' own animal records and on-farm flock health plans, the Canadian Sheep Federation's Food Safe Farm Practices Program, animal welfare programs and regulations, industry disease management programs, environmental farm plans, and traceability initiatives that are currently in place regionally, provincially and/or nationally in Canada. In fact, some of the content in the Standard and the Guide may be duplicated in these programs and initiatives, in order to ensure that they all are complete, as stand-alone products. Key audiences for the Standard are:

- Producers, to understand the principles and rationale of the Standard and to establish a framework for their biosecurity planning;
- Commodity sector organizations, to support market issues and disease management;
- Veterinary practitioners, for input to flock health management programs and as a guide in helping producers prepare their biosecurity plans;
- Academics, to guide plans for new research in sheep health, biosecurity and production practices, and to encourage application of current research to these areas;
- Buyers and consumers, to understand the principles sheep producers work towards and as a common basis for assessment of domestic supply and suppliers;
- Federal and Provincial governments, for international and interprovincial discussions on overall livestock farm practices and as the basis for policy and funding through public agencies;
- International Governments, for information on biosecurity practices that are recommended for use on Canadian farms; and
- Foreign delegations, as a source of information about what to expect when visiting sheep farms and to support their general understanding of practices in the Canadian industry.

This document presents the guiding principles, structure and planning approach that are the foundation of the Standard, and provides detailed descriptions of its goals and associated strategies. For those requiring a more detailed view of the farm-level plans and practices, and as a resource document for producers as they develop and implement their biosecurity plans, the Guide has been developed as a companion volume to the Standard.

1.4 Structure of the Standard

Keeping animals healthy has been a long-standing and successful practice on many Canadian farms, and sheep producers in all regions currently apply sound biosecurity practices to a greater or lesser degree. However, a number of new challenges are being experienced in agriculture:

- Increasing numbers of new and emerging pathogens
- More attention to *zoonotic diseases*
- Greater focus on prevention of disease rather than treatment
- Changing epidemiology of disease due to confluence of animals and people in intensive farming situation
- Globalization and the mass movement of people and goods
- More attention to traceability
- New production practices in agriculture

These factors are encouraging livestock producers to increase their commitment to biosecurity, and to review their current on-farm biosecurity practices.

Nevertheless, it is important that the Standard and the Guide fit into the day-to-day production practices followed by sheep producers in Canada. In order to address all of these influences, and to acknowledge that biosecurity practices need to be adopted to suit each farm's operating procedures and physical facilities, the following guidelines were considered in developing the Standard:

The Sheep Biosecurity Standard is:
A voluntary, outcome-based tool for use in developing and updating on-farm <i>biosecurity protocols</i> for sheep producers
Peer-reviewed guidance for producers in all sectors of the industry – meat, fibre and milk – and on all types of farms
A framework and a set of practices to allow producers to design biosecurity protocols that fit their own operations
Guided by the best practices that are currently being used in the sheep industry in Canada and elsewhere and by the available literature pertaining to biosecurity on sheep farms
Enhanced by the direction and assistance of an Advisory Committee that included producers, veterinarians and industry experts
A source of educational material to support training and education of farm workers, family members, service providers, and any <i>visitors</i> who are invited to the farm
A self-assessment tool and a set of guidelines for self-improvement with respect to biosecurity on sheep farms.

The Sheep Biosecurity Standard is:

A support for commercial transactions; known and disclosed biosecurity and flock health programs will increase buyer confidence in live-animal purchases

A comprehensive resource regarding the biosecurity practices for use on the farm, when taken together with those that are currently contained in the On-Farm Food Safety (OFFS) program

A way to help increase productivity on Canadian sheep farms

The Standard consists of four on-farm Biosecurity Principles:

- 1) Animal Health Management Practices
- 2) Record Keeping
- 3) Farm, Facilities and Equipment
- 4) People

For each Principle, a goal has been set and a number of Strategies have been developed to provide the overall direction for reducing disease transmission risks. This goal-driven approach provides the flexibility for producers to design biosecurity plans that will work on their farms. For each Strategy, a set of Risk Management Practices is presented in the Guide and is intended to be adapted to fit the operational focus and physical layout of each producer's farm and facilities. Therefore, the Standard and the Guide both have the flexibility that is needed to work with the range of production practices and farm types across Canada.

A glossary of terms is included in an appendix, to provide a guide to the terms that are generally used in farm-level biosecurity. The terms in the glossary are italicized the first time they appear in the Standard.



2: National Sheep On-farm Biosecurity Standard

Each of the Principles in the Standard is presented in the following sections, first in a summary table and then in a more detailed manner.

2.1 Principle 1: Animal Health Management Practices

Goal: Minimize the health risk to the flock from sheep and other animals	
Strategy:	Summary:
1. Prepare and use a flock health program	A program that describes the flock health regimens and practices is used for day-to-day flock management. It is the basis for monitoring flock health and is a key source when considering flock performance. A biosecurity plan is integral to and supportive of the flock health program.
2. Sourcing sheep	Additions are limited and, when necessary, animals are sourced from suppliers with flocks of <i>known health status</i> . As few sources as possible are used. New stock is isolated upon arrival.
3. Manage sheep that leave and return to the home farm	If sheep are moved off the farm, they have biosecurity practices consistent with their home-farm practices and, upon their return, they are treated as newly-sourced animals.
4. Isolate sick sheep, flock additions and returning sheep	Sheep showing signs of disease are moved into an <i>isolation</i> area away from the healthy flock until the disease has been resolved. Animals brought onto the farm are held in isolation until disease status has been determined or is resolved.
5. Manage contact with neighboring/ <i>other livestock</i>	Sheep in the home flock are housed, moved and pastured in such a manner that the risk of contact with neighbouring livestock or other livestock on the farm is addressed.

Goal: Minimize the health risk to the flock from sheep and other animals	
Strategy:	Summary:
6. Plan sheep movement through the production unit	Sheep are moved through and within the production unit by pathways that limit their exposure to diseased or potentially infectious animals and materials. Consideration should be given to health status, age and production stage.
7. Implement sheep health protocols for specific situations	Protocols to limit risks of disease transmission are in place for specific production activities, and farm workers understand and employ them.
8. Limit access by pests, dogs, cats, predators and wildlife	A pest control program is in place and its required procedures are followed. Dogs and cats are vaccinated and spayed and treated for diseases of concern. Their access to sheep housing areas and to manure, placentas, deadstock and other potential sources of contaminated material is controlled (e.g. reduce risk of infection with <i>toxoplasma</i> or dog tapeworms). A predator control plan is in place.
9. Implement health standards for guardian and other working animals	Guardian and working animals are vaccinated, dewormed (e.g. tapeworms) and treated for diseases of concern.

2.1.1 Strategy 1: Prepare and use a flock health program

Summary: A program that describes the flock health regimens and practices is used for day to day flock management. It is the basis for monitoring flock health and is a key source when considering flock performance. A biosecurity plan is integral to and supportive of the flock health program.

Maintaining a high standard regarding the health of their sheep is a primary goal for all sheep producers, and achieving this goal requires a flock health program with both proactive and reactive capability. A flock health program enables producers to assess risk and take appropriate precautions to prevent and control the introduction and spread of disease. Proactive elements of the plan include providing good quality food and water and suitable facilities for all aspects of production as a foundation for good health and disease resistance.

For common diseases, every farm should have a flock health program that includes the selection of appropriate vaccines and the design of appropriate vaccination and treatment programs. The flock health program is closely linked to the biosecurity plan. Producers and farm workers should be able to recognize abnormal behaviour and diseased animals and to manage them in a way that limits disease transmission. Producers and workers should be aware of zoonotic diseases and how to respond to them.

The flock health program should also include how to recognize and respond to possible FADs and emerging diseases. In most regions, a flock veterinarian can be contacted to assist in establishing the program and in responding to certain problems. If producers are unsure of how to find a veterinarian with this expertise, they are encouraged to contact their provincial veterinary associations, veterinary colleges and/or provincial agricultural extension veterinarians for guidance.

Producers who do not currently have a flock health program are encouraged to develop a program with their flock veterinarian that includes the principles and elements introduced in the Standard. Those who have a program are recommended to review their programs in the context of this information, and to regularly review and adjust program elements in response to their flock health experience, changes in the flock, and/or changes in any aspect of their operations. A flock health program is designed specifically for each operation.

The biosecurity component of a flock health program will include:

Monitoring of the flock’s disease status through routine diagnostic testing (e.g. fecal egg counts, serological testing) and including post mortems for unexpected or excessive livestock deaths.

Vaccination programs to control or prevent disease within the flock.

Metaphylactic / prophylactic medication programs to control or prevent disease within the flock (e.g. deworming, foot bathing).

Goal setting for health and productivity measures, and monitoring of those measures, e.g. mortality rates of *lambs*.

Strategies to introduce new stock or reintroduce returning stock to the flock. This will include isolation of animals with disease or unknown disease status; vaccination to synchronize vaccination status with the flock; prophylactic medications to prevent introduction of specific disease agents; diagnostic testing for disease status as appropriate.

Decision plan for isolating sheep with disease or unknown disease status, including release from isolation. This includes resident sheep, new introductions and returning sheep.

Decision plan for euthanasia of sick or suffering animals.

Treatment protocols for common ailments as appropriate. These protocols will include meat (and when necessary milk) withdrawal periods for slaughter.

Proper storage of animal health medications and vaccines.

Proper disposal of animal health medications and vaccines, including used needles and syringes.

An annual review of the plan including identifying changes in disease status and risk of disease.

Annual staff training and review of recognition of disease, and protocols for treating disease, including when to contact the flock veterinarian.

Such a Program should be written down. It should be reviewed and reassessed regularly with *farm personnel* so there is a clear understanding of the expectations of the program and the role of each staff member, and to ensure that the plan continues to meet the needs of the farm. It must comply with the requirements of any relevant public and regulatory programs, including environment, food safety, animal health and animal welfare.

2.1.2 Strategy 2: Sourcing sheep

Summary: Additions are limited and, when necessary, animals are sourced from suppliers with flocks of known health status. As few sources as possible are used. New stock is isolated upon arrival.

When establishing a new flock, producers are advised to seek information and guidance from veterinarians and other sheep information sources, including provincial extension personnel, provincial organizations, geneticists, genetics suppliers, and successful producers, to determine the make-up of the flock. This information will provide direction in acquiring sheep for the flock, and in how to reduce disease risks. Producers are also advised to apply as many as possible of the practices described here when starting a new flock:

- purchasing from suppliers whose flock health is known;
- limiting the number of (different) sources used;
- isolating and observing flock members during the first few weeks of their residence; and
- maintaining separation between the flock and other species with susceptibility to sheep diseases.

Producers are encouraged to raise as many of their own replacement stock as possible (within the limitations of reduction of co-efficient of inbreeding), and to add sheep from other sources only when necessary. Some producers work with a closed flock, meaning that all of the sheep and *rams* have been born on-site. When genetic diversity is needed, the use of capable and accredited sources for semen and embryos will allow flock additions to be generated on the farm, rather than being introduced as lambs or sheep.

When acquiring additions or replacements for an existing flock, it is recommended that producers know the health status of the source flock, and purchase from flocks with a health status equal to or better than the home flock.

Acquiring sheep from multiple sources, *commingling* them together, and introducing them into a home flock presents a significant disease risk. The number of diseases that must be accounted for is increased, and treatment protocols required upon entry are expanded. The risk is particularly high when sheep are acquired through an uncontrolled auction market or other commingled sale sites, where the sheep are likely to have been exposed to other sheep and to other species without their having been checked by a veterinarian and/or without providing health records for use in the sale.

Knowing the disease status of individual sheep being purchased and the status of the flock from which it came are key to reducing the risk of acquiring one or more diseases along with an animal. Many diseases are chronic and/or *asymptomatic* and are therefore difficult to identify at the time of sale or at on-site at suppliers' farms. Asking for individual and flock health information is particularly important, as several sheep diseases may be asymptomatic and/or may not be obvious, and since sheep may be "carriers" of disease. It is also important to know the treatments and/or vaccinations these sheep may have had, in order to establish their compatibility with the receiving flock.

Feedlots that do not keep breeding stock and where, as a result, animals spend relatively little time on-farm, may view some of these disease risks differently. Chronic disease and causes of infectious abortion are less important. Acute diseases of lambs and vaccination status may remain important.

In order to achieve the possible benefits of reduced disease risk in their operations, feedlot operators can ask their suppliers to adopt the practices proposed in this strategy:

- require information on health and vaccination status;
- reduce the number of sourcing points; and
- reduce the extent to which the lambs are commingled.

While suppliers are adjusting to these goals, feedlot operators can implement practices in their own feedlots to reduce the impact of the current level of risk:

- avoiding sales of commingled lots;
- isolating groups and/or avoid commingling of lambs when they arrive or while in the lot;
- vaccinating and treating them for the feedlot's diseases of concern; and
- removing them from the feedlot when in doubt.

2.1.3 Strategy 3: Manage sheep that leave and return to the home farm

Summary: If sheep are moved off the farm they have biosecurity practices consistent with their home-farm practices, and upon their return they are treated as newly-sourced animals.

When sheep are taken away from the farm to attend shows and fairs, to graze *community pastures*, or to be used for breeding purposes, they are frequently commingled with other sheep and/or with other animals susceptible to sheep diseases. They are at risk of becoming infected by any disease pathogens that might be present at that *location*.

The risk is both from direct contact with animals that might be infected with a disease, and from indirect contact in any of the following ways: from show or farm personnel and/or through contaminated equipment, manure, bodily fluids and/or aerosols on site. These contaminants might be present in feed and water available at the off-farm site, in bedding, on surfaces in facilities in which the sheep are housed, or in vehicles in which they are transported.

As much as possible, the biosecurity requirements of these sheep should be maintained when they are off-farm, and the time of their potential exposure to additional/new risks should be limited.

Ideally, flock health status at the off-farm location is compatible with the home farm, and feed, water, bedding and handling equipment can be supplied from the home farm. To minimize risk, sheep that have been off-farm are vaccinated and/or treated for any known or potential risks and are isolated from the *maternal flock* for a suitable period of time upon their return, as described in the following Strategy.

2.1.4 Strategy 4: Isolate sick sheep, flock additions and returning sheep

Summary: Sheep showing signs of disease are moved into an isolation area away from the healthy flock until the disease has been resolved. Animals brought onto the farm are held in isolation until disease status has been determined or is resolved.

Sick sheep: When a sheep is diagnosed or suspected of suffering from an *infectious disease*, or exhibits unusual behaviour that might be associated with disease, it should be isolated from the flock. This can be done by moving the affected sheep to a separate pen that prevents direct and indirect contact with the healthy flock. Alternatively, the healthy animals can be moved away from the sick animal if the environment is considered contaminated. Isolation lowers the risk to other flock members by reducing the possibility of infection from direct, nose-to-nose or aerosol contact. It also allows manure and other potentially-infectious materials to be handled separately, thereby ensuring that contamination of the healthy flock, its tools and equipment and its facilities is minimized.

Introduced and returning sheep: When sheep are brought onto the farm or returned from off the farm, they should be isolated from the flock in an area(s) that is located and managed separately from the rest of the farm. The isolation area reduces the potential risk of disease transmission from the isolated animals to the rest of the flock, both by direct and indirect means; isolated animals do not commingle with the rest of the flock, and the risk from people, tools and equipment is managed by *cleaning and disinfection* practices. The area will also allow isolated sheep to be regularly observed, so that uncertain disease status can be clarified, either when clinical signs do or do not develop, or by disease testing, and so that vaccination and treatment can be applied on an individual basis.

It is important to note that there are limits to the effectiveness of isolation for sheep. Some sheep diseases will not display visible clinical signs during limited isolation and are not reliably diagnosed by testing. These include Johne's disease, orf (soremouth), caseous lymphadenitis, pinkeye, and several abortion agents. This list is not exhaustive. Sheep (and other livestock) can carry many disease agents without suffering from them, but they can be transmitted to other animals; again, the disease may not be revealed during a stay in isolation.

It is also important to realize that sheep are social animals and that individual isolation may result in degradation of the isolated sheep's health status, independent of its specific or suspected disease status. Mirrors mounted outside the pen gate will provide an image of a companion and can be used when single sheep are isolated.

2.1.5 Strategy 5: Manage contact with neighboring/other livestock

Summary: Sheep in the home flock are housed, moved and pastured in such a manner that the risk of contact with neighbouring livestock or other livestock on the farm is addressed.

Sheep in many flocks will be pastured regularly during the course of their production cycles. This means they will be moved from fully- or partially-enclosed areas of the farm to open *pasture*, between pastures, and back again during these periods. This process introduces the potential for contamination of the flock from contact with other animals on the farm, with *wildlife* or with flocks on adjacent farms. In particular, introducing pathogens into an enclosed environment during these cycles is a significant risk due to the concentration of the flock.

Addressing the biosecurity risks of pastured sheep requires consideration of a number of factors:

- The disease status and biosecurity practices of other livestock on the farm, especially goats;⁴ if other livestock on the farm are not subject to the same level of biosecurity, then the biosecurity plan for sheep may be compromised;
- The disease status of sheep and other animals on adjacent farms and the biosecurity practices undertaken on them;
- The method of spread of some sheep diseases, for example the aerosol/airborne transmission of Q Fever, that cannot be managed or avoided outdoors and diseases that can be spread by nose-to-nose contact;
- Potential contact by pastured sheep with contaminated materials in the pasture, in waterways, or along common fences, etc.
- The specific diseases that are likely to be spread or carried by wildlife, such as rabies, *Salmonella*, *Campylobacter*, *Paralapostrongylus tenuis* (deer meningeal worm) and *Fascioloides magna* (deer liver fluke).

2.1.6 Strategy 6: Plan sheep movement through the production unit

Summary: Sheep are moved through and within the production unit by pathways that limit their exposure to sick or potentially infectious animals and materials. Consideration should be given to health status, age and production stage.

Movement of sheep is quite frequent during any production cycle, and some movement, such as milking, moving lambs and sheep to the *loading area* for transport, and moving sheep to and from pasture are quite repetitive. Others, such as moving older animals, moving new introductions to isolation, moving sick animals to the treatment area or moving rams and *ewes* for breeding, are less frequent and less regular. In all these cases, movement of sheep within the production unit provides a mechanism for these animals to spread any disease organisms that may have been introduced elsewhere in the facilities. Other members of the flock, using the same pathways, are at risk to being infected by them. These risks are usually higher within the *barn* or small paddock areas, given more limited space and higher frequency of use, and when considering more frequent movements.

⁴ Contact between sheep and bison is also a concern for disease transmission, but from sheep to bison, and not the reverse.

The design/identification of pathways along which sheep and lambs will travel can be an important part of a biosecurity plan. Unless new facilities or renovations are planned, producers will use existing paths and corridors and can adjust for the potential risk by implementing other practices. These alternative actions will include scheduling and order of animal movements, and cleaning and disinfection between uses, where appropriate.

2.1.7 Strategy 7: Implement sheep health protocols for specific situations

Summary: Protocols to limit risks of disease transmission are in place for specific activities, and farm workers understand and apply them.

Proactive biosecurity, designed to reduce the risk and avoid the occurrence of a disease, should include flock health protocols for specific situations. Specific flock health protocols should be considered in production activities such as lambing, abortion management, milking, disease testing, vaccination, and parasite control. Specially-designed protocols are also likely to be required on each farm to address certain diseases of concern.

It is important that producers think about these activities when biosecurity plans are being developed, and when flock health management is considered. Farm workers should understand the approaches to be taken when they encounter these special cases, in addition to understanding the more generalized biosecurity practices.

2.1.8 Strategy 8: Limit access by pests, dogs, cats, predators and wildlife

Summary: A pest control program is in place and its required procedures are followed. Dogs and cats are vaccinated and spayed and treated for diseases of concern. Their access to sheep housing areas and to manure, placentas, deadstock and other potential sources of contaminated material is limited. A predator control plan is in place.

Pests, dogs, cats, predators and wildlife represent a pool of unique risks to sheep. They are difficult to fully control, but do require attention in a biosecurity plan. In many cases very specific actions to avoid direct and indirect transmission of pathogens can be taken.

Agent	Nature of Risk
Pests (e.g. rodents, flies, other insects)	Transmission of pathogens by prior contact with other animals, manure, placentas, deadstock, etc.; direct interaction with sheep and contamination of feed, in storage or in feed bunks, and water
Dogs and cats	Infection with diseases of concern on the farm (e.g. rabies); transmission of pathogens by prior contact with other animals, manure, placentas, deadstock, etc.; direct interaction with sheep and contamination of feed and water

Agent	Nature of Risk
Predators	Direct attacks on sheep and lambs
Wildlife	Direct or indirect contact, including invasive contact by rabies infected skunks and raccoons

It is important to note that dogs are frequently employed for herding and guarding in pastures. Limitation of their involvement is not being recommended here; rather that there is concern for transmission of rabies and possible contamination of sheep and/or facilities with pathogens by physical means.

2.1.9 Strategy 9: Implement health standards for guardian and working animals

Summary: Guardian and working animals are vaccinated, dewormed (e.g. tapeworms) and treated for diseases of concern.

Guardian and working animals are essential to the operation of many farms and to the well being of the flock when sheep are pastured during any phases of production. Their health needs to be actively managed and they need to be protected from the risks that are a natural part of their environment. Specific risks associated with guardian animals and other working animals around the farm include rabies, tapeworms (sheep serve as intermediate hosts for the dog tapeworms), and *Ascarids* that can migrate from dogs and become situated in the livers of sheep.

2.2 Principle 2: Record Keeping

<i>Goal: Have records that validate the health status of the flock</i>	
Strategy:	Summary:
1. Maintain and review farm records	Farm records for production, operations, animal health and biosecurity are integrated together. Records include goals, analysis of the records to determine current flock status and strategies to reach goals, and are reviewed regularly. Records of health events and diagnostic test results are used both to initiate interventions and changes to the flock health program, and are important when selling animals to other producers.

Goal: Have records that validate the health status of the flock	
Strategy:	Summary:
2. Record education and training activities	Records of education and training of farm workers are important both for internal farm purposes and to ensure that information potentially required for labour standards is available.
3. Develop a Response Plan For <i>Disease Outbreaks</i>	A response plan is needed to guide farm activity in rapidly developing and large-scale changes in health status. Enhanced biosecurity will be required and a recovery plan needs to be prepared.

2.2.1 Strategy 1: Maintain and review farm records

Summary: Farm records for production, operations, animal health and biosecurity are integrated together. Records include goals, analysis of the records to determine current flock status and strategies to reach goals, and are reviewed regularly. Records of health events and diagnostic test results are used both to initiate interventions and changes to the flock health program, and are important when selling animals to other producers.

Biosecurity and animal health records should be maintained together with other flock and production records. Viewing production records together with movement, health and treatment records will provide a more complete understanding of flock performance; this, in turn, will enable valuable analysis of the impact of biosecurity practices to be done.

It is useful for producers to set goals for the health and productivity of the flock. Analysis of the farm records with respect to disease and treatment rates, productivity, diagnostic testing and results of certain practices are useful when looking ahead to future seasons. A review of these records with the flock veterinarian is recommended on a regular basis. Analysis and conclusions can be compared to the farm's goals, and plans can be altered to achieve the maximum benefit.

Records have low value if they are not reviewed regularly. They are also a valuable resource when an unforeseen situation or event is encountered – these historical records may contain some information that will aid analysis and understanding of the cause.

2.2.2 Strategy 2: Record Education and Training Activities

Summary: Records of education and training of farm workers are important both for internal farm purposes and to ensure that information potentially required for labour standards is available.

Farm records should contain the education and training undertaken by all family members and farm employees (see also section 2.4.4). In some provinces and regions, more attention is being paid to the training and education of employees, especially in areas of public health and workplace safety. While it is also recognized as a good operating practice, under some regulations, producers as employers need to maintain records of training given to employees.

In particular, increasing concern for zoonotic diseases, including *Campylobacter*, *Salmonella*, *Cryptosporidium*, orf, Q fever, abortion and diarrhoea agents, make records of farm worker education on personal protective behaviour, cleaning and disinfection, and other biosecurity practices essential.

2.2.3 Strategy 3: Develop a Response Plan for Disease Outbreaks

Summary: A response plan is needed to guide farm activity in rapidly-developing and large scale changes in health status. Enhanced biosecurity will be required and a recovery plan needs to be prepared.

The Standard is focused on proactive biosecurity – those practices that can be adopted to reduce the risks of disease occurrence in many aspects of sheep farming. However, it is important that producers also have a farm-based plan for response to a disease outbreak or the suspicion of an outbreak on their farm or in their region.

A response plan is a pre-determined set of actions and conditions that are enacted when one or more occurrences, called “trigger points”, are observed. The plan is developed in advance, and will include:

- preparatory steps to be taken before an outbreak occurs;
- identification of potential trigger points; and
- enhanced biosecurity protocols to be initiated on the farm under specific circumstances.

In developing such a plan, producers will need to identify the types of disease emergencies that may require a response. These could include:

- an uncontrolled outbreak of any highly infectious disease on the producer’s farm, such as an abortion outbreak;
- an uncontrolled outbreak of any highly infectious disease such as a salmonellosis outbreak in the region of the producer’s farm;
- a suspected case of a *reportable disease* or FAD on the producer’s farm;

- a suspected case of a reportable disease or FAD on an adjacent farm, or on a farm that has a link to the producer’s farm; and
- a confirmed case of a reportable disease/FAD/emerging disease anywhere in the region, and especially on a farm with which the producer’s farm has exchanged animals, loaned equipment, used shared pasture or other facilities.

Producers must know what they are to do in each of these emergency situations. It is also important that a recovery plan be in place as the next action following execution of the response plan. While recovery efforts are often disease-specific and therefore difficult to plan in advance, producers need to know what is required to be done in order to return to full production once the disease emergency has been successfully managed.

Development of an on-farm “Response Plan for Disease Outbreaks” is a large and complex undertaking; more than can be dealt with effectively in this document. However, information concerning risk management practices to apply in an emergency situation is provided in the Guide and examples are available from various organizations via the Internet, from federal and provincial government agencies and from industry associations.

2.3 Principle 3: Farm, Facilities and Equipment

<i>Goal: Minimize the effect that farm, facilities and equipment have as contributors to disease transmission</i>	
Strategy:	Summary:
1. Create a diagram of the farm layout and identify risk areas	A farm diagram is used to assist in the risk assessment, based on the diseases of concern.
2. Clean and disinfect facilities, equipment and vehicles	Cleaning and disinfection methods that are effective in reducing the risk of disease transmission are in place and are used for facilities, equipment and vehicles on the farm.
3. Reduce risk in barns/pens	Facility design and management practices reduce specific risks.
4. Reduce risk from equipment	Equipment can be dedicated for one purpose or dedicated for use in one risk area; equipment can be supplied by the farm for use by contracted service providers.

Goal: Minimize the effect that farm, facilities and equipment have as contributors to disease transmission

Strategy:	Summary:
5. Reduce risk from vehicles	Vehicle use patterns determine the relative risk of vehicles; cleaning and disinfection are the principle biosecurity tool for reducing vehicle-related disease risk. Using farm-based vehicles can improve producers' control over vehicle use patterns.
6. Manage manure	Manure is removed regularly and moved in a manner that limits exposure to the sheep. Tools and equipment used for manure handling are not used for feed or bedding and they are cleaned and disinfected between uses. Storage is secure and separated from the production area(s). Distribution is controlled.
7. Manage feed, water and bedding	Feed, water and bedding serve to support sheep health and therefore the flock's resistance to disease. Adequate and quality supplies are required, and storage is secure from contamination.
8. Apply shearing protocols	Order of shearing is important to reduce the risk of disease transmission within the flock; equipment should be cleaned and disinfected between groups when health status is different, and contract shearers should wear clean outerwear and cleaned and disinfected footwear when they enter the premises.
9. Manage needles and sharps	Needles and sharps should not be re-used; if they are re-used, an assessment is conducted to evaluate the risk. Reusable needles are available for use in multi-dose injection syringes. Proper injection practices are followed and sharps are disposed of appropriately.
10. Manage deadstock	Deadstock are removed immediately from livestock rearing areas and moved in a manner that limits <i>cross-contamination</i> with the flock. Placentas, aborted material and other tissue are managed as deadstock. The deadstock holding area is located away from the production area and is secured against dogs, cats and scavengers. Disposal respects local regulations and is done in a manner that limits disease exposure to the flock.

2.3.1 Strategy 1: Create a diagram of the farm layout and identify risk areas

Summary: A farm diagram is used to assist in the risk assessment, based on the diseases of concern.

Biosecurity plans are based on a risk assessment of the farm's operations, the people on the farm, providing service or visiting the farm facilities. An accepted approach to risk assessment is to consider the diseases of concern to the farm, and to document how those diseases are known to be transmitted. Then, identify where risk points exist in *sheep operations*, people's activities, and facilities and how they are maintained. Risk points in this context are where disease pathogens could be transmitted, both directly to sheep and also indirectly to sheep via other *fomites*.

The use of a map or diagram of the farm layout is recommended to facilitate the identification of these risks. The diagram can highlight areas of specific activity where sheep of different disease susceptibility might be exposed to one another; where people, their tools and equipment and their vehicles might come in contact with the sheep; and where contaminants might be harboured in any parts of the facilities themselves.⁵

Areas that would be highlighted on the farm diagram include:

- Access points
- Gates and barriers
- Location of signage
- Home area
- Farm buildings, including barns, sheds, service areas, farm office and utility areas
- Pens and isolation areas
- Animal loading and unloading area
- Feed storage area
- Manure storage area
- Deadstock pickup area or compost location
- Driveways and lanes
- Parking areas
- Receiving and shipping area(s); the loading chute
- Fuel delivery/storage area
- Paths and walkways
- Pastures
- Wells and other water sources
- Housing and pasture areas for other farm animals

Notes about movement of sheep and other animals around the farm, patterns of access by people and equipment, housing areas for sheep with different disease status, and storage areas for feed, bedding and equipment, can all provide a framework for the practices that might be needed to avoid or reduce the impact of the identified risks.

⁵ The Guide contains additional information on risk assessment, farm layout and farm zoning.

2.3.2 Strategy 2: Clean and Disinfect Facilities, Equipment and Vehicles

Summary: Cleaning and disinfection methods that are effective in reducing the risk of disease transmission are in place and are used for facilities, equipment and vehicles on the farm.

Cleaning is a constant activity on a livestock farm and disinfection is needed under certain circumstances, especially in dairy facilities and when required to reduce the risk of disease transmission. Cleaning the barn(s), pen areas, feeders, waterers, equipment and vehicles is required to remove *organic material* that can harbour disease pathogens or other contaminants; disinfection is required to eliminate pathogens. Chemicals used to disinfect are not effective if the surface has not been previously thoroughly cleaned of organic matter.

Five basic steps have been developed for cleaning and disinfecting on farms. They are:

- 1) De-bulking – removing visible contamination including all organic material (e.g. manure, bedding, soiling of walls, floors and equipment)
- 2) Washing – washing with soap/detergent and water
- 3) Rinsing – removing all soap residue
- 4) Disinfecting – soaking with an approved disinfectant
- 5) Rinsing (if required by disinfectant product) – removing all disinfection and allowing surfaces to dry

Feedlot operators, and others who might be concerned about the biosecurity risk in pasture areas, can also employ a downtime cycle between uses – a period of time without animals in the pasture area(s), pens, and other working areas – that is long enough to allow specific disease agents to be reduced by natural death – and will vary depending on the disease agent of concern. This will further reduce the level of contamination before introducing new animals or groups of animals. However, some organisms will live for months (e.g. orf virus, parasite larvae, and the bacteria that causes caseous lymphadenitis) to years (e.g. the bacteria which causes Johne’s disease, coccidial oocysts) to even longer (spores which cause anthrax, blackleg and pulpy kidney).

Cleaning and disinfection should be planned to address the farm’s identified risks, and a protocol should be designed for the cleaning and disinfection required in each case – for equipment, for example. This will require a clear understanding of how to properly remove organic material from the surfaces that need to be cleaned on each piece of equipment, and when use of a disinfectant is appropriate.

Protocols are required that assure effective cleaning and disinfection of the following facilities and equipment on a sheep farm:

- Barn surfaces, including floors, pens, railings, chutes, walkways, etc. and all areas of the milking parlour;
- Equipment, such as tractor/skid-steer buckets, forks, shovels, tires, etc.;
- Feed storage areas and bins, to eliminate contamination from rodents and other pests, and any manure or faeces that have been deposited in feed bunks or other feeders;

-
- Water troughs and bowls, to eliminate contamination from any manure or faeces that have been deposited there;
 - High risk vehicles, such as those that transport sheep and other animals, especially sheep and animals from other locations; and
 - Other vehicles, such as visitors' and service providers' vehicles, especially those that have driven on other farms.

2.3.3 Strategy 3: Reduce risk in barns/pens

Summary: Facility design and alternate management practices reduce specific risks.

Most practices that are contained in biosecurity plans for sheep farms are designed to reduce the risk of disease transmission between animals and from people and their tools, equipment and vehicles to animals. In addition to these activities that act more directly on the disease risks, there are also important options to consider in developing a plan.

The design and construction of facilities that house sheep can be modified to support other biosecurity practices and/or to address risks directly. For example:

- smooth, non-porous materials or finishes can be considered that both reduce the ability of organic materials and pathogens to adhere to surfaces, and make the surfaces more effectively cleanable,
- the design of the facility can reduce the distance and reduce steps in removing manure from the barn(s) and other facilities,
- divisions between pens or lots can be easily removed to allow for easy access of cleaning equipment,
- floor surfaces can be designed to be more easily cleaned,
- in meat operations, barns can be subdivided to separate groups of animals so that they are less likely to cross-contaminate.

Also, some production practices can be introduced that reduce the disease risk under certain circumstances where biosecurity practices are difficult or impractical to implement. For example, when meat production is being planned, either on a feedlot or full-scope production unit, a form of *all-in-all-out* scheduling can be used to limit potential commingling of current and added stock. If lambs can be managed in groups by purchase sequence or production lot, and the groups kept separate from one another, they are less likely to transmit disease to all of their flock-mates, thereby limiting the potential production losses to smaller groups.

2.3.4 Strategy 4: Reduce risk from equipment

Summary: Equipment can be dedicated for one purpose or dedicated for use in one risk area; equipment can be supplied by the farm for use by contracted service providers.

Cleaning and disinfecting equipment between uses is a mainstay of a biosecurity plan, and can address the risk of disease transmission both within a production area and when equipment is used in multiple production areas and for multiple tasks around the farm. However, there are additional approaches that can be used to reduce the risks attendant to the use of equipment on the farm.

Examples include:

- Equipment dedicated to certain purposes – for example, loader/skid-steer buckets for used only for deadstock or manure or feed management; forks used only for feed or manure;
- Equipment dedicated to use in one risk area – for example, forks that are used only in the isolation area;
- Equipment that is provided by the farm, rather than by service providers – for example, hoof-trimmers, shearing equipment, and handling systems.

2.3.5 Strategy 5: Reduce risk from vehicles

Summary: Vehicle use patterns determine the relative risk of vehicles; cleaning and disinfection is the principle biosecurity tool for reducing vehicle-related disease risk. Using farm-based vehicles can improve producers' control over vehicle use patterns.

Vehicles used for different purposes and coming from different sources represent different risks to the farm. Risk factors for trucks and trailers include:

- carrying multiple products – for example, sheep, other livestock, feed, manure, and deadstock; and
- travelling to multiple farms and other livestock facilities, including abattoirs, auction markets and shows.

The main concern is that producers often do not know what potential disease risks are presented by trucks arriving on the farm – what they have carried and where they have been.

Vehicles are at lower risk when they are used solely to carry people to and from the farm and do not have direct contact with animals or high-risk products such as manure or deadstock. However, these vehicles may require biosecurity practices if they travel from farm to farm or between the farm and other livestock areas – abattoirs, auction markets and shows, for example.

Cleaning and disinfection is the principal means to manage the risk related to vehicles. Inside the box or trailer are critical if sheep are being transported. The exterior of the vehicle is important if it travels across pathways taken by animals or into areas containing contaminated material that could infect other areas of the farm. The interior of the cab is a concern if the driver or passenger(s) must leave the cab and enter any area of the farm that is accessible by sheep.

During times or in locations in which washing and disinfection are not possible (e.g. extreme cold weather), it is important to understand the risk of the contaminated equipment and manage it to reduce exposure of livestock to pathogens present.

One alternative is to use only vehicles whose use is controlled by the farm. This removes the uncertainty of third-party vehicles and allows the producer to manage the biosecurity practices that are applied. Carrying sheep in a farm vehicle also has the advantage of common disease risk between the vehicle and the farm. If a third party vehicle must be used, load animals away from livestock rearing areas and do not allow the vehicle to cross any part of the premises where livestock or equipment used to manage livestock might be kept.

2.3.6 Strategy 6: Manage Manure

Summary: Manure is removed regularly and moved in a manner that limits exposure to the sheep. Tools and equipment used for handling manure are not used for feed or bedding and they are cleaned and disinfected between uses. Storage is secure and separated from the production area(s). Distribution is controlled.

Manure management includes addressing risks for removing manure from the production area, movement on the farm, storage on farm, and eventual disposal/distribution on land.

Manure should be removed from the pens or holding areas regularly, determined by the number of sheep housed in each area, and more frequently if there is any concern of disease in the pen (bedding should also be removed, the pen cleaned and disinfected, and the bedding replaced in these cases).

Manure storage should be away from the production area and be secured from access by farm animals. Its location should therefore be away from the production area(s) and situated such that runoff will not accumulate and will not contaminate livestock rearing areas, pastures, wells, feed storage or other service areas. Most local jurisdictions will have regulations for manure storage and compliance is required.

Movement off-site, if planned, requires care in accessing the storage area, respecting farm zoning practices, and avoiding spillage or other contamination of farm areas upon exit. Disposal on the farm property – composting and/or distribution on fields and pasture – will follow requirements of the environmental farm plans and nutrient management programs in effect in each area.

2.3.7 Strategy 7: Manage Feed, Water and Bedding

Summary: Feed, water and bedding serve to support sheep health and therefore the flock's resistance to disease. Adequate and quality supplies are required, and storage is secure from contamination.

Carefully managing feed and water is important to provide a strong health foundation in the flock. This health foundation improves the ability of sheep to resist disease organisms and toxins.

Both home-grown and purchased feed needs to be free of toxins that may naturally occur or that may form in storage; excessive copper remains a significant concern for sheep, as does *Listeria* bacteria often present in wet ensiled feeds and some mycotoxins. An assessment of the quality and nutritional value of the feed is useful and will guide decisions regarding the addition of supplements or minerals to ensure a complete, healthy ration.

Similarly, clean fresh water in adequate volume should be made available to all stock at all times. Water should be tested at least annually and as required by local/regional regulation to ensure its cleanliness and safety. Its source location and facility should be checked to ensure that there is no contamination from surface water or runoff.

Bedding material storage practices are different by regions and by available facilities on farms. Ideally, when weather conditions require it, bedding should be stored in a protected location such that it remains dry and uncontaminated. As much as possible, bedding material should be secure from contamination by pests, dogs, cats, and rodents. Bedding material in use should be judged by its moisture and cleanliness, cleared regularly, and replaced by dry, clean product.

2.3.8 Strategy 8: Apply Shearing Protocols

Summary: Order of shearing is important to reduce the risk of disease transmission within the flock; equipment should be cleaned and disinfected between groups when health status is different, and contract shearers should wear clean outerwear and cleaned and disinfected footwear when they enter the premises.

On some farms shearing is carried out by producers themselves, or farm workers, using the farm's equipment. On other farms, shearing is done by contract shearers who are expert at their craft, who travel from farm to farm, and who bring with them equipment that is well-suited to the task. Clearly, while there are benefits to both approaches, there are different risks that pertain to each.

Shearing by producers or farm workers presents the risk of disease transmission from one sheep to another from equipment that is not sufficiently cleaned and disinfected between uses. This risk is heightened by the possibility of nicks and skin abrasions, and the added opportunity of disease transmission by blood or other fluids from or into the nick. For example, the bacterium that causes caseous lymphadenitis (CLA), a common sheep disease causing abscesses of the lymph nodes, can invade slightly abraded skin and these abscesses, nicked during the shearing process, provide a very important risk for transmission. Careful attention must be paid to cleanliness and risk avoidance

practices during the shearing process to avoid this and other diseases and conditions. Ticks, lice and mange mites can be similarly transmitted by shearing.

Generally, sheep are grouped/penned in preparation for shearing. There is a possibility of animals coming in contact that usually are in separate areas of the farm, and also a risk of sharing facilities that might be contaminated by one member of the flock. Shearing should start with the lower risk animals and proceed through higher risk animals. If sick animals need to be sheared, they should be done last.

Shearing by a contracted service from off the farm presents all of the risks of producer / farm worker shearing, and in addition, the shearer's hands, clothing, footwear and shearing equipment, including shears, bags and boards, all carry the additional risk of being contaminated by disease organisms from other farms. Therefore, contract shearers should wear clean outerwear and footwear and wash their hands upon arrival. Shearing equipment should be cleaned and disinfected between farms, and if conditions like CLA are encountered, changing heads and cutter blades is required.

2.3.9 Strategy 9: Manage Needles and Sharps

Summary: Needles and sharps should not be re-used; if they are re-used, an assessment is conducted to evaluate the risk. Reusable needles are available for use in multi-dose injection syringes. Proper injection practices are followed and sharps are disposed of appropriately.

Reuse of needles and sharps is a high-risk activity as both become contaminated with bodily fluids and blood in which pathogens may be present or grow after use. Both the outside and inside of the needle become contaminated in this manner.

It is not possible to practically and effectively disinfect a needle including its bore; it is therefore recommended that whenever possible, needles should not be reused. The risk of reuse is higher if the needle contains blood, has been used to treat a sick animal, or has sat for any length of time between uses. Risk is lower if needles are used to administer a drug subcutaneously to a series of healthy animals at one time using one product (e.g. vaccination). Reuse of needles increases the risk of injection-site abscesses. Used needles should never be inserted into a vaccine or drug bottle as it will contaminate the product rendering it subsequently dangerous.

Used needles and other sharps (e.g. scalpel blades), should be immediately discarded in a solid sided leak- and shatter-proof container that can be sealed and discarded when full.

2.3.10 Strategy 10: Manage Deadstock

Summary: Deadstock are removed immediately from livestock rearing areas and moved in a manner that limits cross-contamination with the flock. Placentas, aborted material and other tissue are managed as deadstock. The deadstock holding area is located away from the production area and is secured from dogs and cats and scavengers. Disposal respects local regulations and is done in a manner that limits disease exposure to the flock.

Deadstock management and management of placentas, aborted material and other tissue address removing deadstock and related materials from the production area, movement on the farm, storage on farm, and eventual disposition. Permitted storage and disposal methods will be regulated under local and regional jurisdiction; each method requires its own biosecurity practices.

Deadstock can contaminate the area in which it is found by body fluids that may contain disease pathogens. These pathogens can find their way into bedding and feed, and onto pasture, and can be contacted and ingested by others in the flock. Placentas, aborted materials and other tissue may similarly contain disease pathogens that can be transmitted to other animals in the flock, to other animals, or to humans. Presence of deadstock attracts scavenger animals such as carrion-eating birds, rodents, cats, dogs and other wildlife. It also attracts flies, which can transmit disease and cause fly-strike.

The pathogens, or material containing them, may be distributed by insects and pests. In all cases, material containing disease pathogens may be moved about the farm or to other facilities by dogs, cats and scavengers, and may also be distributed in their faeces, once consumed.

Therefore, deadstock, placenta and aborted material should be removed immediately when they are seen. They should be stored away from the production area without any access to dogs, cats, wildlife and vermin.

2.4 Principle 4: People

<i>Goal: Conduct a risk assessment and develop protocols for all visitors and farm personnel</i>	
Strategy:	Summary:
1. Conduct risk assessments for all people entering the farm	All people entering a farm are subject to a risk assessment.
2. Develop and enforce risk management practices for all people visiting the farm, using the risk assessment outcomes	People working on, providing service to or visiting the farm are guided by risk management practices based on the risk assessment.

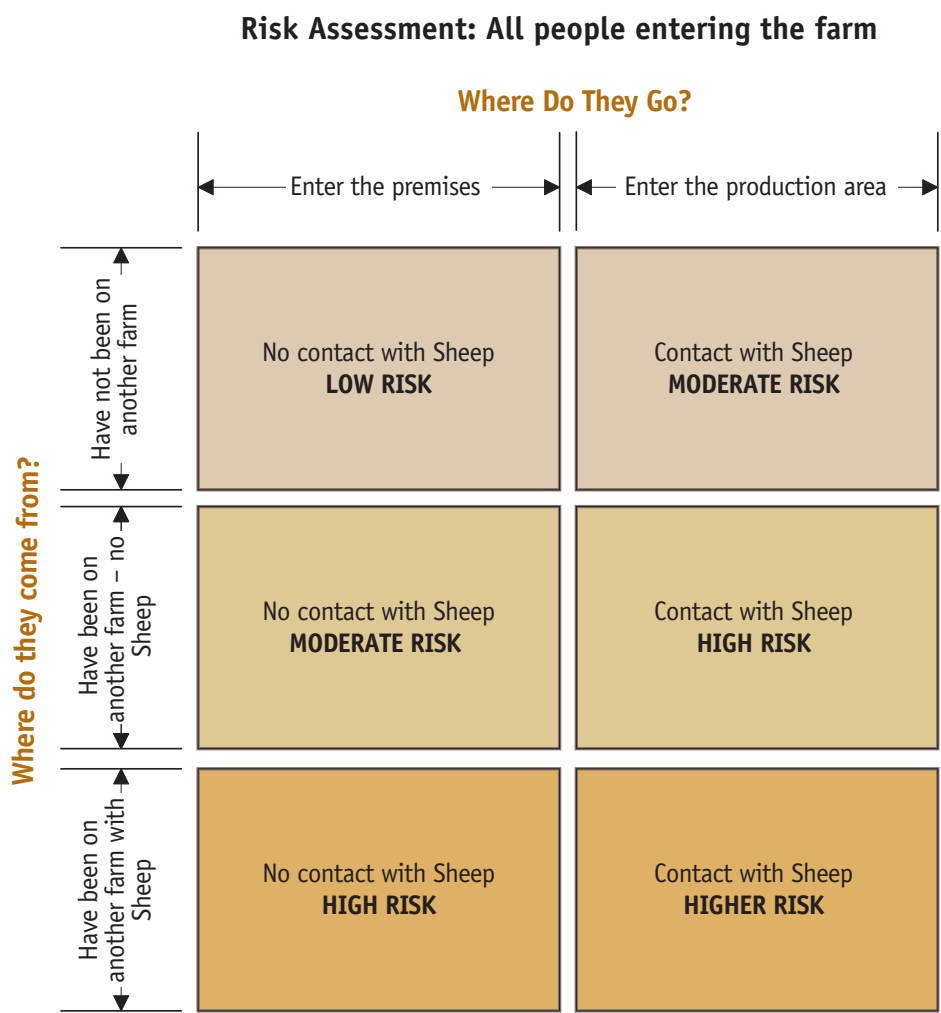
Goal: Conduct a risk assessment and develop protocols for all visitors and farm personnel	
Strategy:	Summary:
3. Know what people are on the premises	Producers know who is on the farm, where they are, and what their purpose is.
4. Train farm workers and communicate with them about biosecurity; inform all visitors and service providers	All farm workers and family members are trained in the farm's biosecurity practices. The farm biosecurity protocol is communicated to visitors and service providers and they comply with it.
5. Recognize zoonotic risks	Family members, farm workers, visitors and service providers understand zoonotic diseases and take full precautions to protect themselves.

2.4.1 Strategy 1: Conduct Risk Assessments for all people entering the farm

Summary: All people entering a farm are subject to a risk assessment.

It is recommended that producers consider a risk analysis of the attendance of all people entering the farm – family members, farm workers, service providers and visitors. This analysis assumes that their attendance at the farm is legitimate and accepted by the producer, and focuses on the specific level of disease risk they represent, based on their previous exposure to farms and to sheep in particular, and the area(s) of the farm they are intending to enter. In the latter analysis, contact with the sheep is considered.

As illustrated in the Matrix below, risk levels can be described as low, moderate and high for simplicity, and can be determined by these factors.



In general, these groups could be described as follows:

- **Low risk:** travel to a farm but do not come in direct contact with livestock and do not enter livestock rearing areas; for example, financial advisors and equipment salespersons
- **Moderate risk:** travel from farm to farm but do not directly contact the livestock; for example, fuel delivery
- **High risk:** neighbouring producers or anyone who travels farm to farm and comes in direct contact with livestock and have been in contact with livestock from other farms; for example, veterinarians, ultrasound technicians, shearers, and hoof trimmers
- A **Higher Risk** classification can be considered for anyone who has been in contact with sheep on another farm (or elsewhere), in contaminated facilities or near sick animals. If access to another flock were required, specific risk-reduction steps would be taken.

2.4.2 Strategy 2: Develop and enforce risk management practices for all people visiting the farm, using the risk assessment outcomes.

Summary: People working on, providing service to or visiting the farm are guided by risk management practices based on the risk assessment.

All people entering the farm will be aware of the relative risk of their visit and activities while there. They will know and understand the biosecurity practices that are consistent with that risk assessment, including the areas into which they are permitted to go.

The risk assessment for each individual, based on where he/she is permitted to go on the farm, will determine the biosecurity practices that will be needed upon entry onto the farm and into the production area. A combination of restrictions to access and the requirement for clean hands, clothing and footwear is the basic arsenal for visitors and service providers. A higher level of biosecurity would apply for anyone approaching and/or touching the animals, and higher again for those approaching and/or touching isolated or sick animals.

Pre-determined practices/protocols can be designed that apply to each of these classes of risk, and signs and information can be situated at zone boundaries, on building and pen entries and on special-risk pens to advise visitors where their limits to access are, and when to apply the higher-level practices. Escorting visitors will also help to ensuring that they are following the recommended biosecurity practices.

A special case exists also, concerning people who have visited a foreign country in the recent past that is a known location for a foreign animal disease, and who have had the potential to contact the pathogen. While their relative risk can be established from the matrix described in section 2.4.1, knowing the diseases of concern in the area of the world the person has visited would allow producers to establish suitable delays before visits and to apply specific protocols for visits to Canadian farms. Information on known infectious diseases by country can be sourced from the World Organization for Animal Health (<http://www.oie.int/animal-health-in-the-world/>).

2.4.3 Strategy 3: Know what people are on the premises

Summary: Producers know who is on the farm, where they are, and what their purpose is.

The presence of people on the farm – farm workers, service providers, family members and visitors – represents a significant set of risks to animal health. In a farm biosecurity plan, the following practices are recommended:

- restrict access by people to areas of the farm that require their presence,
- control the conditions of their entry to and exit from those zones and areas,
- require proper management of the tools, equipment and vehicles that accompany them, and
- guide the conditions of their contact with the flock.

In order to ensure that these controls are followed, and therefore that the health and welfare of the flock are maintained, a producer will ideally have full knowledge of who is on the farm at all times. However, many sheep flocks in Canada are managed by producers who might also be employed off-farm. In these cases, security of the facilities and of the flock need to be established by means that operate without the producer's presence, including farm gates and other security features. It is important in all cases for producers to know in advance what service providers and visitors wish to visit the farm, so that they can be instructed in advance or upon arrival in the practices and materials that will be required during their visit.

2.4.4 Strategy 4: Train farm workers and communicate with them about biosecurity; inform all visitors and service providers

Summary: All farm workers and family members are trained in the farm's biosecurity practices. The farm biosecurity protocol is communicated to visitors and service providers and they comply with it.

The success of biosecurity plans will require the involvement and cooperation of several groups and individuals: family members, farm workers, visitors, suppliers, farm service providers and the flock veterinarian.

They will all need to understand the biosecurity best practices that guide their activities on the farm, and will need to ensure that their own biosecurity plans include safeguards that coordinate with the farm plan.

Producers, their family members, farm workers and visitors will benefit from training in the specific biosecurity practices in the Standard, as they are adapted for each farm. Farm service providers will also need to be trained in the practices established for the farms they service, both to ensure that they can carry them out and so that they can accommodate them within their own operational and biosecurity practices.

Effective training and education requires repeated review and/or instruction sessions with the biosecurity information contained in the farm plan, in other literature (a bibliography is provided in Appendix B) and available from subject specialists, advisors and public sources. Information can be provided in group sessions dedicated to biosecurity, on-the-job demonstrations, and corrective actions following one-on-one observations.

2.4.5 Strategy 5: Recognition of Zoonotic Risks

Summary: Family members, farm workers, visitors and service providers understand zoonotic diseases and take full precautions to protect themselves.

Sheep may be affected by a number of zoonotic diseases, such as Q fever, *Chlamydia* and *Campylobacter* that can be passed to humans. Family members, farm workers, visitors and service providers need to understand the risks to their own health presented by these diseases and their ability to move between sheep and humans. People can be infected by direct and indirect contact and by aerosol means and a number of protective practices need to be followed that help reduce the risk of disease transmission, including hand washing, and full use of *personal protective equipment* specific to the disease risk. Personal protective equipment includes coveralls, boots, gloves and masks that are dedicated to working with high risk animals and that can be either cleaned or discarded after use.



3: Acknowledgements

Sheep Biosecurity Advisory Committee (SBAC)

The Standard is a collaborative effort between the CFIA’s Office of Animal Biosecurity (OAB) and the Canadian Sheep Federation (CSF), together with an Advisory Committee comprised of industry leaders, government representatives, sheep veterinary practitioners, and academics who were selected specifically for this assignment. Funding for the project was provided by Agriculture Agri-Food Canada through the Growing Forward framework.

Members	Affiliation
Colleen Acres	Purebred sheep producer Canadian Sheep Breeders’ Association
Stuart Greaves	Manitoba sheep producer
John Hemsted	Ontario sheep producer Ontario Sheep Marketing Agency (OSMA)
Norine Moore	Alberta sheep producer Alberta Lamb Producers (ALP)
Jennifer MacTavish	Canadian Sheep Federation
Gaston Rioux	Centre d’expertise en production ovine du Québec
Jocelyn Jansen	Ontario Ministry of Agriculture, Food and Rural Affairs
Chris Clark	University of Saskatchewan
Paula Menzies	University of Guelph
Annie Daigneault	Quebec veterinary practitioner
Virginie Rochet	Agriculture and Agri-food Canada
Katie Clow	Canadian Food Inspection Agency
Lorne Jordan	Canadian Food Inspection Agency

Members	Affiliation
Manon Racicot	Canadian Food Inspection Agency
Archie Stewart	Canadian Food Inspection Agency
Bob Burden	Serecon Consulting Inc.
Ian Richardson	eBiz Professionals Inc.

The Canadian Sheep Federation and Government of Canada thank eBiz Professionals Inc. and Serecon Consulting Inc. for leading the development of the National Sheep On-Farm Biosecurity Standard.



Appendix A – Glossary of Terms

Italicized terms in the text are defined in the glossary:

All-in-all-out	A production system in which the whole flock (all-in-all-out) or groups of lambs/sheep of similar disease risk (modified all-in-all-out) are housed and moved as a single unit(s) and are removed from the farm as a unit.
Ascarids or gastrointestinal nematode	A parasitic nematode (family Ascaridae) that typically lives in the intestines of vertebrates.
Asymptomatic disease	A disease that does not show any sign but the animal may be shedding infectious pathogens in secretions (e.g. respiratory aerosols, lacrimal discharges, saliva) or excretions (e.g. faeces, urine, uterine fluids, skin).
Barn	A farm building used for storing farm products and sheltering livestock.
Biosecurity	A health plan or measures designed to protect a population from infectious agents.
Biosecurity Protocols	Those measures specific to a sheep operation used to prevent the introduction and the spread of disease within an animal population and from that sheep operation.
Cleaning	Involves washing with detergent in order to remove all organic matter, and includes both a dry (scraping and brushing) and wet clean.
Commingling	The act of mixing sheep, either with other sheep from different farms or production facilities or with other animal species, resulting in direct or close indirect contact among them.
Community pastures	A community pasture is a public grazing area shared by more than one producer and not owned by a single producer.

Cross-contamination	The distribution of potentially-infectious material from one animal to another, or between facilities, equipment or vehicles by animals, people or things (see also fomites).
Disease outbreak	When the incidence of illness from disease rises quickly and often to a high level within a short period of time. Sometimes the disease was not previously present in the flock, and sometimes it is an increase in a disease already present.
Disinfecting; also, disinfection	The use of a disinfection agent, i.e. a chemical that can kill pathogens, on areas being cleaned.
Emerging Disease	A new infection resulting from the evolution or change of an existing pathogen or parasite resulting in a change of host range, vector, pathogenicity or strain; or the occurrence of a previously unrecognised infection or disease.
Endemic disease	Continued presence of a disease in a specific population or area usually at the same level – often a low level. Also called enzootic disease.
Ewe	A female sheep that is part of the breeding flock i.e. has been exposed to the ram for breeding purposes
Farm Personnel	Includes all full-time and part-time staff plus any family members who work at the operation.
Feedlot	As used in the Standard, feedlots are operations that purposely acquire lambs or cull adults from off-farm for the purpose of feeding but not breeding. All animals are sent to slaughter.
Fomites	Any physical entities on which infectious material can be transmitted. They would include animals, people, their footwear and clothing, any equipment and tools brought into or used within a zone, dogs and cats, pests and vermin, and vehicles. Animals that act as fomites are themselves not infected but act as a mechanical transfer of infectious material.
Foreign Animal Diseases - FADs	Diseases not present in Canada and listed by the CFIA as reportable (www.inspection.gc.ca)

Guardian animals and working animals	Includes dogs (e.g. guardian dogs, herding dogs), llamas, donkeys, horses etc that have contact with and are used to manage the sheep for purposes such as moving the sheep, or guarding the sheep from predators.
Infectious diseases	Diseases caused by an infectious disease agent e.g. parasite, bacterial, virus, fungus, prion.
Isolation	The action of restricting an animal to a location that is physically separate from other livestock. The purpose of isolating an animal is usually to prevent it from transmitting a disease to another animal, either because it is known to be diseased or because its disease status is currently unknown. It may also be to protect an animal from contacting disease from infected flock members. The location is known as an isolation facility.
Known health status	The information that should be made available about a flock or an individual animal when offered for sale or intended for commingling, including disease history and the results of any diagnostic testing; flock health management practices; vaccination program detail sufficient to determine compatibility with the home flock; and housing and movement detail sufficient to identify any potential recent disease exposure.
Lamb	A female (ewe) or male (ram or castrated) that is less than 12 months of age and is not part of the breeding flock.
Loading area	An area that is designated for the loading and unloading of animals. This is not just the ramp but it also includes any holding area used for this purpose.
Location	A single location is defined as a property used to manage sheep (or livestock) that is self-contained and not divided by land or public roadway (e.g. concession road, highway – but not private laneway or walking path).
Maternal flocks	Flocks that include breeding ewes that produce added and/or replacement lambs for the flock.
Organic material	As used in the Standard, organic material is any substance that is derived from animal or vegetal matter.

Other livestock	Domestic livestock animals, specifically goats, cattle (dairy, beef, veal), horses, bison, water buffalo, farmed deer / elk, alpacas, llamas, swine, poultry, turkeys, ducks, geese.
Pastures	Fenced areas used for livestock grazing at any time of year. Can include multi-use fields (e.g. graze after haying or aftermath feeding).
Pathogens	A bacterium, virus, parasite, prion, fungus or other micro-organism that can cause disease.
Personal Protective Equipment (PPE)	Gloves, clothing, footwear, head and face coverings, breathing apparatus and all cleansing agents, disinfectants and materials that limit, reduce or restrict contact by a pathogen to a human, by physical, airborne or any other means.
Practice	A repeatable method of carrying out a task or activity for a specific end result, including the use of equipment and products.
Protocol	This includes any formal process that a producer used to define how they manage their operations on a day to day basis. The protocol may be formally documented but it may also be non-documented process that is strictly followed. The intent is to focus on the process rather than the documentation.
Ram	A male sheep of any age that is intact and has been or is being used for breeding purposes.
Reportable disease	Reportable diseases are defined under regulations enforced by CFIA. In cases of a suspected or confirmed case of a reportable disease outbreak, and in most cases of a FAD, zoonotic or emerging disease, CFIA is responsible for ensuring that required procedures are followed. A list of reportable diseases is available on the CFIA website at http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/2012/eng/1329499145620/1329499272021
Sheep	A ewe, ram, castrated ram, or lamb.

Sheep operation	The buildings, dry lots / paddocks / corrals, and pastures used at any time of the year to manage sheep; includes any structures that are used in managing the sheep operation that don't have sheep, e.g. equipment shed, handling shed or pen, records room, clothing storage area, manure storage, feed storage. The sheep operation may have one or more than one location. It includes guardian or working animals (e.g. dogs, donkeys, llamas) and equipment (e.g. handling facilities, ATV etc) used to manage the sheep.
Vector	Anything, including an organism such as an arthropod (e.g. a tick, mosquito, fly, flea, or mite), that does not cause disease itself but that transmits a pathogen by conveying pathogens from one host to another.
Vermin (together with Wildlife)	Includes all non-livestock and non domestic animals and insects that may pose a health risk (disease and/or predatory) to the sheep flock.
Visitors	Any non-personnel that come to the operation.
Zoonotic disease	An infectious disease that can be transmitted directly or indirectly (e.g. by a vector) from non-human animals, both wild and domestic, to humans or from humans to non-human animals.



Appendix B – List of Reference Documents

- 1) Antonia M. Clavijo, B.M. "Effect of the exploitation system on the appearance of mastitis in goat in two farm in Falcon state, their etiologic agents and antimicrobial resistance." *Zootecnia Tropical* **20**, 383-395 (2002).
- 2) Bates, T.W., Thurmond, M.C. & Carpenter, T.E. "Direct and indirect contact rates among beef, dairy, goat, sheep, and swine herds in three California counties, with reference to control of potential foot-and-mouth disease transmission." *American Journal of Veterinary Research* **62**, 1121-1129 (2001).
- 3) Carpenter, T.E. et al. "Potential impact of an introduction of foot-and-mouth disease into the California State Fair." *Journal of the American Veterinary Medical Association* **231**, 1231-1235 (2007).
- 4) Dement, A.I. & Craddock, B.F. "Biosecurity for Sheep and Goat Producers." *Texas A&M University*
- 5) Farquharson, B. "A whole farm approach to planned animal health and production for sheep clients in Australia." *Small Ruminant Research* **86**, 26-29 (2009).
- 6) Ganter, M. "Veterinary consultancy and health schemes in sheep: Experiences and reflections from a local German outlook." *Small Ruminant Research* **76**, 55-67 (2008).
- 7) Ghanem, Y.M. et al. "Prevalence and risk factors of caprine arthritis encephalitis virus infection (CAEV) in Northern Somalia." *Small Ruminant Research* **85**, 142-148 (2009).
- 8) Givens, M.D. & Marley, M.S.D. "Infectious causes of embryonic and fetal mortality." *Theriogenology* **70**, 270-85 (2008).
- 9) Häusermann, C. et al. "Surveillance and simulation of bovine spongiform encephalopathy and scrapie in small ruminants in Switzerland." *BMC Veterinary Research* **6**, 20 (2010).
- 10) Howell, S.B. et al. "Prevalence of anthelmintic resistance on sheep and goat farms in the southeastern United States." *Journal of the American Veterinary Medical Association* **233**, 1913-1919 (2008).
- 11) Humann-Ziehank, E. & Ganter, M. "Preventive animal health in Small Ruminants - Results of an interdisciplinary workshop Part 2: Infectious diseases." *Tieraerztliche Umschau* **61**, 91-+ (2006).
- 12) Kabagambe, E.K. et al. "Risk factors for Brucella seropositivity in goat herds in eastern and western Uganda." *Preventive Veterinary Medicine* **52**, 91-108 (2001).
- 13) Kitching, R.P. & Hughes, G.J. "Clinical variation in foot and mouth disease: sheep and goats." *Revue Scientifique et Technique de L'Office International Des Epizooties* **21**, 505-512 (2002).

-
- 14) Kumar, S., Vihan, V.S. & Deoghare, P.R. "Economic implication of diseases in goats in India with reference to implementation of a health plan calendar." *Small Ruminant Research* **47**, 159-164 (2003).
 - 15) Menzies, P.I. "Control of important causes of infectious abortion in sheep and goats." *The Veterinary Clinics of North America Food Animal Practice* **27**, 81-93 (2011).
 - 16) Menzies, P. & Simard, C. "Ontario Maedi Visna Flock Status Program: Definitions and protocols governing the program and additional information." *University of Guelph* 1-29 (2007).
 - 17) Merkel, R.C. & Gipson, T.A. "Change in behavior of goat producers after on-line training in herd health practices." *Small Ruminant Research* **98**, 31-34 (2011).
 - 18) Merkel, R. "Introduction to a Meat Goat Quality Assurance Program and HACCP." *Langston University*
 - 19) Mobley, R. & Lyttle-N'guessan, C. "The Herd Health Handbook for Goat Producers: Biosecurity at the Farm Level." *Florida A&M University* (2009).
 - 20) Mobley, R. & Lyttle-N'guessan, C. "The Herd Health Handbook for Goat Producers: Food Safety at the Farm Gate: A Holistic Approach to Food Safety and Herd Health." *Florida A&M University*
 - 21) Mobley, R., Lyttle-N'guessan, C. & Peterson, T. "The Herd Health Handbook for Goat Producers: Control of Parasites in Goats." *Florida A&M University* (2009).
 - 22) Moore, D.A. et al. "Comparison of published recommendations regarding biosecurity practices for various production animal species and classes." *Journal of the American Veterinary Medical Association* **233**, 249-56 (2008).
 - 23) Nöremark, M., Frössling, J. & Lewerin, S.S. "Application of routines that contribute to on-farm biosecurity as reported by Swedish livestock farmers." *Transboundary and Emerging Diseases* **57**, 225-36 (2010).
 - 24) Oliveira, C.J.B. et al. "On farm risk factors associated with goat milk quality in Northeast Brazil." *Small Ruminant Research* **98**, 64-69 (2011).
 - 25) Olson, E.J. et al. "Isolation of an Adenovirus and an Adeno-Associated Virus from Goat Kids with Enteritis." *Journal of Veterinary Diagnostic Investigation* **16**, 461-464 (2004).
 - 26) Reviriego, F.J., Moreno, M.A. & Dominguez, L. "Risk factors for brucellosis seroprevalence of sheep and goat flocks in Spain." *Preventive Veterinary Medicine* **44**, 167-173 (2000).
 - 27) Seuberlich, T., Heim, D. & Zurbriggen, A. "Atypical transmissible spongiform encephalopathies in ruminants: a challenge for disease surveillance and control." *Journal of Veterinary Diagnostic Investigation* **22**, 823-842 (2010).
 - 28) Thunes, C. & Carpenter, T.E. "Biosecurity practices and travel history of individuals exhibiting livestock at the 2005 California State Fair." *Journal of the American Veterinary Medical Association* **231**, 581-5 (2007).
 - 29) Winter, A.C. "Treatment and control of hoof disorders in sheep and goats." *The Veterinary Clinics of North America Food Animal Practice* **27**, 187-92 (2011).
 - 30) Wrathall, A.E. "Risks of transmission of spongiform encephalopathies by reproductive technologies in domesticated ruminants." *Livestock Production Science* **62**, 287-316 (2000).

-
- 31) Wrathall, A.E. "Risks of transmitting scrapie and bovine spongiform encephalopathy by semen and embryos." *Revue Scientifique et Technique - Office International des Epizooties* **16**, 240-264 (1997).
 - 32) "Sheep and Goat Industries Biosecurity Plan." *Government of Western Australia Department of Agriculture* 1-64 (2002).
 - 33) "Sheep/Goat Industry Biosecurity Plan." *farmbiosecurity.com.au* 1-4 (2003).
 - 34) "Goat MAP: Rules and Guidelines of the Australian Johne's Disease Market Assurance Program for Goats." *Animal Health Australia, Goat Industry Council of Australia Inc., Nation Johne's Program* 1-67 (2009).
 - 35) "Goat 2009 Part II: Reference of Goat Health and Marketing Practices in the United States, 2009." *Animal and Plant Health Inspection Service* (2011).

