

Best Management Practices for Maine Agriculture
Section Updates: Insect Management (Page 30-32 of the BMP 2007)
Carolyn Hurwitz 2019

Insect Management (H)

1. Proper Sanitation

All agricultural infrastructures should be maintained in a clean and sanitary manner. Accumulation of animal wastes, moist bedding, spilled feed and water should be prevented. Insect pests use these moist, organic materials for sites to reproduce. These pests are a nuisance to livestock, transmit disease, decrease livestock productivity and may represent a public health risk. Effective management of water and waste materials is a critical component of successful integrated pest management (IPM) practice.

Resources:

1. New York State Integrated Pest Management (NYSIPM) Playlist - See links to instructive videos explaining Livestock IMP and many others: <https://nysipm.cornell.edu/resources/videos-and-apps/>
2. University of Maine- IPM for Dairy Barns explained: https://www.maine.gov/dacf/php/integrated_pest_management/documents/UMCEFlyIPMBulletin.pdf
3. Maine DACF Integrated Pest Management- PDF links to articles about IPM practices for equine properties, various livestock classes and poultry: https://www.maine.gov/dacf/php/integrated_pest_management/poultry_livestock.shtml
4. California Dairy Research Foundation- About livestock fly pests, color images, control strategies: <http://cdrf.org/2016/01/06/5000/>
5. University of Arkansas Division of Agriculture- Biology and Control of Flies in Poultry Facilities: <https://www.uaex.edu/publications/pdf/FSA-7063.pdf>
6. Fly Control Around Horse Barns and Stables- University of Kentucky Cooperative Extension. Fly biology in moist environments and control methods: <https://entomology.ca.uky.edu/files/efpdf3/ef514.pdf>
7. Journal of Veterinary Entomology- Development and Oviposition preference of House Flies and Stable Flies in Six Substrates from Florida Equine Facilities. A study of the effect of bedding type on fly reproduction: <https://academic.oup.com/jme/article/51/6/1144/862135>

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2. Spilled Feed and Spoil Piles

Animal feeds that have been spilled during feeding, pushed out of the feed bunk or otherwise wasted, should be removed to a waste disposal site as soon as possible. Spoil piles should also be contained and managed as waste organic material. These nutrient rich sources of farm waste are an excellent habitat for larval insect development, and will contribute to the number of pests reproducing in the farm environment.

Resources:

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1. University of Nebraska- Sanitation for Fly and Disease Management at Confined Livestock Facilities (see section titled “Breeding Areas”):
<http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2154&context=extensionhist>
2. University of Kentucky Cooperative Extension- Controlling Insects in Stored Grain. Background information about sanitation and management of stored animal feeds:
<https://entomology.ca.uky.edu/files/efpdf1/ef145.pdf>
3. Maine Department of Environmental Protection Guide to Recovering and Composting Organics in Maine- A “how to” guide for managing organic wastes. See page 31 for tips on vector (insect) management at the compost pile:
https://www.maine.gov/dep/sustainability/compost/compost_guide2016.pdf

3. Dead Animals

Animal mortalities should be properly disposed of immediately after euthanasia or upon discovery of a carcass. Proper disposal methods include a plan for prevention of access to the carcass disposal area, prevention of environmental contamination, animal disease control and continued management of the resulting organic material. There are several options for animal carcass disposal, and the selected method will depend on the number of animals to dispose of, available space, disease concerns and local regulations. When animal mortalities are not properly managed, they can attract insect pests and scavengers, cause odor and environmental issues, and promote a negative image of the agricultural industry.

Resources:

1. eXtension Managing Livestock and Poultry Mortalities-A short article describing options for livestock mortality disposal: <https://articles.extension.org/pages/19942/managing-livestock-and-poultry-mortalities>
2. Cornell University Composting Animal Mortalities- A detailed guide for preparing and
2. Cornell University Composting Animal Mortalities- A detailed guide for preparing and
2. Cornell University Composting Animal Mortalities- A detailed guide for preparing and
2. Cornell University Composting Animal Mortalities- A detailed guide for preparing and managing an animal mortality compost pile: <https://ecommons.cornell.edu/handle/1813/37369>
3. University of Wisconsin Compost Solution to Dockside Fish Waste- a detailed guide for preparing and managing a fish compost pile: <https://publications.aqua.wisc.edu/product/compost-solution-to-dockside-fish-wastes/>
4. Maine Best Management Practices for Animal Carcass Composting- An in-depth review of composting principles and descriptions for construction and management of the pile (includes small poultry flocks and equines):
https://www.maine.gov/dacf/php/nutrient_management/documents/BESTMANAGEMENTPRAC_TICESforCarcassComposting-2011Complete.pdf
5. Maine Chapter 211- Rules for the Disposal of Animal Carcasses:
https://www.maine.gov/dacf/php/nutrient_management/documents/Chapter211RulesfortheDisposalofAnimalCarcassesFinalDocumentApril28_2012.pdf
6. Penn State Odor Management in Agriculture- A thorough discussion of the conflict created by agricultural odors and description of various on-farm solutions:
https://www.agriculture.pa.gov/Plants_Land_Water/StateConservationCommission/OdorManage

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[mentProgram/Documents/PSU%20Odor%20Management%20in%20Ag%20and%20Food%20Processing%20brochure.pdf](#)

7. Bio-contained Carcass Composting for Control of Infectious Disease Outbreak in Livestock-
Journal article describing successful livestock disease containment with proper composting
technique: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3149998/pdf/jove-39-1946.pdf>

4. Feed Bunks

Livestock feeding areas must be kept in good repair and cleaned regularly. Preventing accumulation of organic materials in these locations serves to remove suitable reproductive habitat for insect populations, thereby interrupting the life cycle of arthropod farm pests. Elimination of larval habitat is a highly effective means of pest fly reduction.

Resources:

1. Fly Control Around Cattle Feeding Facilities by Steve Boyles, OSU Extension Beef Specialist- A short magazine article that describes the application of IPM strategies specifically in the feed area: <http://feedlotmagazine.com/fly-control-around-cattle-feeding-facilities/>
2. Ohio Dairy Industry Resource Center- Controlling Flies on Farms. This short article describes principles of pest management in general. See section *Sanitation*: <https://dairy.osu.edu/newsletter/buckeye-dairy-news/volume-10-issue-3/controlling-flies-farms>
3. University of Arkansas Extension Factsheet- Fly Control for Organic Dairies. Thorough summary of fly control techniques based on principles of sanitation and fly biology: <https://www.uaex.edu/publications/pdf/FSA-7072.pdf>

5. Waterers

Livestock watering areas must be inspected regularly for leaks and pooling water. Any abnormalities must be repaired as soon as possible, and leaked water should be drained or covered by absorbent materials. Standing water and leaked water contribute to the maintenance of arthropod pest reproductive sites.

Resources:

1. University of California- Managing Mosquitoes on the Farm. An in-depth article about water's contribution to maintaining fly populations on farms, and descriptions of corrective actions: <https://anrcatalog.ucanr.edu/pdf/8158.pdf>
2. Fly Control in Confined Livestock and Poultry Operations by Ralph E. Williams, Perdue University Entomologist. Concise article describing fly habitats in livestock facilities, and emphasizes methods for minimizing environmental water sources: <https://www.ocj.com/2011/06/fly-control-in-confined-livestock-and-poultry-production-operations/>
3. COBB Broiler Management Guide- This is a comprehensive guideline for commercial poultry house management. Page 4 compares open vs closed watering systems for poultry and describes

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the benefits of the closed system for managing environmental moisture and water contamination.
<http://www.cobb-vantress.com/docs/default-source/management-guides/broiler-management-guide.pdf>

6. Animal Diet

Livestock should be fed a diet that is appropriate for their species and production class. Feed products should be stored properly and be free from contamination or spoilage. Feeding according to these principles will help decrease the liquid content of animal manures, and thereby prevent accumulation of wet bedding and liquid manure runoff.

Resources:

1. Manure Characteristics- Midwest Plan Service. A detailed discussion of manure characteristics by species: http://msue.anr.msu.edu/uploads/files/ManureCharacteristicsMWPS-18_1.pdf
2. Eliminate Flies from Manure- Discussion of use of organic wastes and methods for elimination of fly larvae:
https://www.researchgate.net/publication/260981859_OVERVIEW_Eliminate_Flies_from_Manure

7. Ventilation

Proper ventilation of livestock and poultry confinement-housing is necessary to keep bedding or litter as dry as possible. If ventilation systems fail, or are not properly established, excess environmental moisture will be absorbed into bedding materials, leading to increased bacterial growth and promoting insect larvae development.

Resources:

1. NYS Cattle Health Assurance Program- Bedding Materials and Udder Health. This article outlines several factors, including ventilation, that can effect bedding quality in the barn: <https://ahdc.vet.cornell.edu/programs/NYSCHAP/docs/BeddingMaterialsUdderHealth.pdf>
2. University of Kentucky Ag “Ventilation Principles”. An in-depth review of ventilation principles and guidelines for poultry houses: <https://afs.ca.uky.edu/files/chapter7.pdf>
3. Ventilating Greenhouse Livestock Barns- Penn State Agricultural Extension. Description of ventilation challenges and solutions in greenhouse structures: <https://extension.psu.edu/ventilating-greenhouse-livestock-barns>
4. Iowa State University Extension- Choosing Fans for Livestock and Poultry Ventilation: <https://store.extension.iastate.edu/Product/Choosing-Fans-for-Livestock-and-Poultry-Ventilation-Livestock-Industry-Facilities-and-Environment>
5. Purdue University- Natural Ventilation for Livestock Housing. Overview Article on principles of ventilation for multiple housing types: <https://www.extension.purdue.edu/extmedia/AE/AE-97.html>
6. University of Georgia- Litter Quality and Broiler Performance. This article describes the problems and solutions of wet poultry bedding: https://secure.caes.uga.edu/extension/publications/files/pdf/B%201267_5.PDF

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8. Deep Pit Poultry House Manure Removal

Manure that accumulates in a deep pit system holds moisture and may not have the qualities of a healthy compost mixture. Because of this, fly larvae are able to successfully develop in this environment. Deep pit poultry houses should be cleaned as often as is practical to minimize buildup of flies and accumulation of wet manure. It may be preferable to clean the pit during cool weather when fly dispersal (due to disturbing the manure) will be less likely.

Resources:

1. Domestic Fly Problems in Deep Pit Poultry Houses- California Department of Agriculture. Review article of pest considerations for deep pit poultry housing design.
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=11&cad=rja&uact=8&ved=2ahUKEwjI_Yu4p5vgAhXo8YMKHQURDYoQFjAKegQICBAB&url=http%3A%2F%2Fcala.g.ucanr.edu%2Fdownload_pdf.cfm%3Farticle%3Dca.v032n09p16&usg=AOvVawIx9dGRikAupTkGXXKexx6EP
2. In-House Composting in High Rise, Caged Layer Facilities- Western SARE. This article explains the considerations and amendments for poultry pit waste to prepare for composting:
<https://www.sare.org/Learning-Center/Fact-Sheets/In-House-Composting-in-High-Rise-Caged-Layer-Facilities/Text-Version>
3. Purdue Cooperative Extension- Poultry Manure Management Planning:
<https://www.extension.purdue.edu/extmedia/ID/ID-206.html>
4. Clemson Agricultural Extension- Management, Handling, Transfer, Storage and Treatment of Manure and Litter From Poultry Production Facilities. A thorough review of methods and options for designing a management system for handling poultry waste:
https://www.clemson.edu/extension/camm/manuals/poultry/pch4_03.pdf

9. Empty Poultry Houses

Manure in the emptied poultry house should be removed within 6 months of depopulation of the flock. Unmanaged animal wastes do not develop the correct bacterial populations and elevated temperature necessary for proper manure management by composting. Stockpiled wet litter will attract flies.

Resources:

1. Virginia Cooperative Extension- Storing and Handling Poultry Litter. A breakdown of storage options for poultry litter based on infrastructure availability and eventual intended use:
https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/442/442-054/442-054_pdf.pdf
2. Checklist for Fly Control in Poultry Facilities- Alberta Agriculture and Forestry. This short article discusses the biology of insects in the context of the poultry house environment and common management pitfalls:
<http://www1.agric.gov.ab.ca/%24Department/deptdocs.nsf/all/epw12257/%24FILE/poultry.pdf>
3. Chapter 565 Nutrient Management Rules, Maine Department of Agriculture, Conservation & Forestry. <http://www.maine.gov/sos/cec/rules/01/001/001c565.docx>.

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10. Droppings Boards

Dropping boards beneath confined poultry cages or poultry roost areas should be cleaned frequently. In confinement-style housing systems, the dropping boards should be cleaned at least twice daily. Accumulation of waste materials degrade the poultry house environment through release of moisture and ammonia and attracts insect pests.

Resources:

1. Small Farms Profitable Poultry Production Chapter 5- "Poultry Fixtures and Devices." This chapter is an entry-level discussion of small scale poultry housing components, including coops, nesting boxes and dropping boards: http://journeytoforever.org/farm_library/ppp/ppp5.html
2. University of Georgia- Maximizing Poultry Manure Use Through Nutrient Management Planning. This article describes the properties of poultry manure, taking into account the various types of housing systems and poultry production classes: <http://extension.uga.edu/publications/detail.html?number=B1245&title=Maximizing%20Poultry%20Manure%20Use%20through%20Nutrient%20Management%20Planning>
3. eXtension- Manure Production and Characteristics. This is a short article where you can find links to more specific information tables, which describe the quantity and qualities of poultry manure produced in a commercial setting: <https://articles.extension.org/pages/15375/manure-production-and-characteristics>.

11. Natural Insect Enemies

Utilizing naturally occurring insect predators is another method for decreasing pest-fly populations on the farm without the use or overuse of chemical sprays. While manure piles do attract pest-flies, they also support beneficial insects. Using a partial manure pile clean out method will promote populations of pest-fly predators in the aged, dry layers of the pile. Alternatively, releasing commercially prepared pest-fly predators into the manure pile will result in reliable numbers of the correct type of predator for the pest-fly population.

Resources:

1. SARE Poultry Waste-Summary of results from SARE research project utilizing black soldier fly larvae for management of poultry manure volume, house fly predator, and harvestable livestock feed component: <https://www.sare.org/Learning-Center/SARE-Program-Materials/Southern-SARE-Program-Materials/Regional-Bulletins/SARE-and-Poultry-Waste>
2. Biological control of flies using fly parasites- A commercial IPM company prepares fly control strategies and pest-fly predators: <https://www.ipmlabs.com/animal-fly-management/small-farm-dairy-fly-parasites/biological-controls/>
3. University of Kentucky- Biological Control of Flies. This article explains the biology behind use of fly predators, including their limitations to specific target species: <https://entomology.ca.uky.edu/files/efpdf3/ef502.pdf>

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4. Ohio Livestock Manure Management Guide- See Chapter 9 Section: Biological Control from a discussion of how to use insect predators, and how to integrate this strategy into a chemical control program: https://agcrops.osu.edu/sites/agcrops/files/imce/fertility/bulletin_604.pdf

5. Connecticut Agricultural Experiment Station "Approaches to the Biological Control of Insect Pests"- an informative page with resources for understanding principles of environmental management and use of natural enemies of pest flies: <https://portal.ct.gov/CAES/Fact-Sheets/Entomology/Approaches-to-the-Biological-Control-of-Insect-Pests>

Commented [HM4]: Great reference overall! Ohio often has lots of good stuff.

12. Utilize Physical Fly Removal Methods

Physical fly removal methods, such as bait traps, jug traps and tape strips, play an important role in removing adult flies from the breeding population. Fly exclusion by physical barriers (screens on windows and doors, sealed garbage containers, etc.) should also be used to prevent access of adult flies to breeding areas and food sources. These methods should be used in combination with other methods of fly control that target earlier life stages, and in agricultural areas when chemical control is not permitted.

Resources:

1. University of California Agricultural and Natural Resources article- "Flies: Integrated Pest Management in and Around the Home." This article discusses the specific biology and management strategies for several common species of pest fly. The article stresses the effectiveness of sanitation and adult fly exclusion based on the specific biology of each species: <http://ipm.ucanr.edu/PDF/PESTNOTES/pnflies.pdf>

2. Pest Management Recommendations for Poultry- Combined resource from Cornell and Penn State Universities Agricultural Extension services. This publication provides an extensive overview of pest management strategies, including physical fly removal options and safe, effective use of chemical pesticides: <https://extension.psu.edu/pest-management-recommendations-for-poultry>

13. Utilize Pest Control Chemicals Sparingly

Insecticide chemicals should be used only as an adjunct option to a comprehensive fly control plan that includes sanitation and environmental management. Chemical control methods will assist in temporarily minimizing populations of adult flies; however, resistance to these compounds can develop quickly, making them ineffective against future generations of flies. Selective use of pest control chemicals should be used to reduce insect populations only as a last resort.

Resources:

1. Cornell and Penn State article describes the biology of common agricultural pest flies and how to use chemical control for each species in combination with sanitation and environmental management practices: Pest Management Recommendations for Horses
https://extension.psu.edu/downloadable/download/sample/sample_id/979/

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2. "Insecticide Resistance: Causes and Actions." A short article from the Southern IPM Center explaining the development of insect resistance to chemical treatments, and how applicators can modify their use of these chemicals to prevent resistance and to get the most out of an insecticide application: <http://www.sripmc.org/IRACMOA/IRMFactSheet.pdf>

3. Washington State University- Managing Pesticide Resistance. This page presents a discussion of the factors that drive the development of insect resistance to chemical pesticides, and the strategies for chemical use that will prevent or slow this phenomenon:

<http://jenny.tfrec.wsu.edu/opm/displayspecies.php?pn=-70>. Great article

4. "60 Ways Farmers Can Protect Surface Water"- Article from the University of Illinois Extension service. See links on left hand side titled "Reducing Insecticide Use," "Selecting Pesticides," and "Handling Pesticides Safely and Effectively."

<http://www.thisland.illinois.edu/60ways/60ways.html>

14. Use Pesticides Properly

For effective and responsible use of chemical pesticides, you must adhere to the product label instructions. Online resources for searching current product labels and Cooperative Extension recommendations are listed below. These recommendations will provide information about the safe and effective preparation, use and disposal of pesticide products.

Resources:

1. UMaine Cooperative Extension- Insect Pests, Ticks and Plant Diseases Maine IPM Programs
Page: <https://extension.umaine.edu/ipm/programs/>

2. Maine Board of Pesticide Control-Pesticide Laws, Regulations and Policies:

<https://www.maine.gov/dacf/php/pesticides/laws.shtml>

3. Environmental Protection Agency information about Pesticide Labeling:

<https://www.epa.gov/pesticide-labels>

4. Pesticide Environmental Stewardship- How to Read the Label. This is an excellent resource (supported by NC State Cooperative Extension) with color pictures and links to many other basic topics relating to safe pesticide use: <https://pesticidestewardship.org/homeowner/how-to-read-the-label/>

5. NRCS Field Office Technical Guide Conservation Practice Standard- Pest Management.

Established standards for pest management practices in Maine:

<https://efotg.sc.egov.usda.gov/references/public/WI/595.pdf>.

6. Crop Data Management Systems (CDMS) Pesticide Label Lookup Tool:

<http://www.cdms.net/Label-Database>

7. USDA Pesticide Record Keeping Requirements- This article will describe the "why" and "what" of pesticide use record keeping, with a specific focus on federally regulated products. You will need to reference the Maine pesticide use restrictions in addition to those mentioned here, to be sure that your pesticide use is in full compliance. You can find this information online through *Resource 2* listed above:

https://extensiondata.missouri.edu/pub/pdf/miscpubs/mp0692.pdf?_ga=2.34853729.1515671366.1550103298-254498180.1538353883.

8. University of Kentucky Entomology- Fly control on Poultry. This article focuses on chemical options for fly control in the poultry house and manure piles. Be sure to follow local regulations

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and current animal medication regulations before implementing any of the practices described here: <http://www.uky.edu/Ag/PAT/recs/livestk/recpou/poufly.htm>

15. Use Proper Pesticide Application Techniques

Pesticides are a frequently used tool in agricultural production; however, the chemicals can pose significant risks to those who apply them, the environment where they are used, or to someone who may encounter improperly stored product. Pesticide applicators must be appropriately licensed (when applicable), use personal protective equipment, calibrate all application equipment, and store all materials properly.

Resources:

1. UMaine Pesticide Safety Education Program- Explanation of pesticide applicator licensing categories and electronic or print training manuals: <https://extension.umaine.edu/ipm/pesticide-safety/pesticide-applicator-license-categories-training-manuals/>.
2. UMaine Cooperative Extension IPM Programs Page- Pesticide Safety Education Program: <https://extension.umaine.edu/ipm/pesticide-safety/>
3. University of California IPM Program- a link to Free Publications page with several resources available including information for pesticide use safety training and various topics in Agricultural IPM strategies: <http://ipm.ucanr.edu/IPMPROJECT/freepublications.html>
4. Water Source Protection Practices Bulletin- Managing Large Scale Application of Pesticides to Prevent Contamination of Drinking Water. Published by the United States Environmental Protection Agency: https://www.oregon.gov/deq/FilterDocs/EPASWPPacticesBulletin_PesticidesLargeScale.pdf.
5. Agricultural Respiratory Protective Equipment Fact Sheet from the University of Colorado. This article focuses on airway protection options in overall category of personal protective equipment that should be worn when working with agricultural chemicals: <https://extension.colostate.edu/docs/pubs/farmmgmt/05020.pdf>
6. Maine Board of Pesticide Control Worker Protection Standard- Information for worker protection best management recommendations and training resources: https://www.maine.gov/dacf/php/pesticides/applicators/worker_protection.shtml#ppe

16. Pesticide Feed Additives

Pesticide feed additives are chemicals that are incorporated into livestock feeds which pass through the animal and into the manure. The presence of the chemical in the manure interferes with the lifecycle of the pest fly by preventing larval development (insect growth regulators) or killing larvae (larvicides). Use of these products must be part of a whole-farm insect management plan, as these chemicals will only affect larvae in treated manure. Other sources of larval development, such as compost piles, waste feed piles or other rotting organic material will continue to serve as an environment for pest fly larvae development. Pesticide feed additives should be used sparingly, in combination with other methods of biological and environmental pest control, and in accordance with label and Cooperative Extension recommendations. This is necessary to achieve maximum effectiveness of the product, and to preserve food safety and environmental health.

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Resources:

1. Nebraska Institute for Agriculture and Natural Resources- “Low Toxic Fly Control for Horses.” This is a short article that provides some information on how feed through pesticide products work, and how to use IGR pesticides as part of an overall fly-control program. The article is focused on the horse farm, however the concepts presented here are broadly applicable: <https://lancaster.unl.edu/pest/resources/flycontrolhorses%28332%29.shtml>
2. Larvicide Technical Brochure- Diflubenzuron Fly Control. This research and brochure was produced by a private company called Central Life Sciences for a product called ClariFly (Diflubenzuron). This compound is approved for use in multiple species and is available in other fly control products for livestock. This product brochure provides information about the use of this chemical. This citation is not an endorsement of this particular product: <https://pdpw.org/library/exhibitors/ClarifyTechBroch.pdf>

17. Cover Manure Piles

Manure piles must be contained and covered using plastic or other appropriate impermeable materials. Covering the manure pile will prevent moisture build up or nutrient runoff due to precipitation, and will prevent animals and insects from accessing the pile. Adult insects are attracted to the moist, outer layers of the manure pile where they will lay their eggs. Covering the pile will exclude these flies from accessing the decomposing organic material, and will prevent any hatching flies from being released.

Commented [HM6]: Is okay for very small operations, but for operations of any size, covering is not practical, and if the goal is to make good compost, it needs lots of air flow.

Resources:

1. Iowa State University Midwest Plan Service- This is a link to an online dashboard where you can view multiple electronic publications available for purchase. These publications are from the ISU Manure Management Catalogue and range from basic overview to operation specific and very detailed: <https://www-mwps.sws.iastate.edu/catalog/manure-management>
2. Virginia Cooperative Extension- Horse Manure Management. This is an excellent article addressing manure stockpiling, management, application and composting. While focused on the horse farm, these concepts are broadly applicable and describe the conditions of stockpiled manure that lead to problems with insects: http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/406/406-208/406-208_pdf.pdf
3. NRCS- Composting Manure. This article describes the rationale for composting animal manures and bedding to prevent insect and odor problems: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1167345.pdf

Commented [HM7]: There's a couple of statements in this reference that I would word differently, but overall I think it's worth keeping.

18. Compost

Composting can be used as a means of controlling insect populations in manure. Managing manure piles by composting requires attention to the carbon:nitrogen ratio of the contents, internal temperature of the pile as well as moisture and oxygen content. High temperatures achieved by proper composting can kill immature stages of flies as well as other pathogens such as parasites and bacteria.

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Resources:

1. Northeast Regional Agricultural Engineering Service (NRAES)- “On-Farm Composting Handbook.” This resource is a comprehensive guide to establishing an on-farm composting program:
<https://campus.extension.org/pluginfile.php/48384/course/section/7167/NRAES%20FarmCompost%20manual%201992.pdf>
2. Cornell University- Waste Management Institute. This website provides a menu of links related to specific composting subjects. Scroll down through the links to find detailed information about many steps of the composting process: <http://cwmi.css.cornell.edu/composting.htm>

19. Transporting Manure

If insect populations have become established in stockpiled manure, it should not be transported to another site or spread on fields. Insect infestation may be a result of failure to properly cover the manure pile, or if conditions for composting have not been achieved. This manure should be treated to eliminate fly populations before moving the infected material to a new location.

Resources:

1. University of Nebraska- Manure Entomology. This series of videos explains the insects involved in manure management, including both beneficial and pest insects:
<https://articles.extension.org/pages/73664/manure-entomology:-manure-management-that-wont-bug-you>
2. North Carolina State University Department of Entomology- “House Fly Survival After Mechanical Incorporation of Poultry Manure into Field Soil.” This article studies and explains the negative impacts of transporting and spreading animal manures containing pest fly eggs:
<https://academic.oup.com/japr/article/7/3/302/835792>