Best Practices for

Environmental Protection

in the

Mushroom Farm Community

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POLICY: It is the Department's policy to provide a person or municipality with the information necessary for the proper use or disposal of spent mushroom substrate.

PURPOSE: The purpose of this document is to provide uniform instructions and operating procedures for the use or disposal of spent mushroom substrate.

APPLICABILITY: This guidance will apply to all persons or municipalities that own or operate a mushroom growing operation.

DISCLAIMER: The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures, herein, are not an adjunction or a regulation. There is no intent on the part or DEP to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

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Best Practices for Environmental Protection in the Mushroom Farm Community (1997) was developed as a result of the realization among mushroom farmers and regulators that the changes in environmental regulations necessitated a complete revision of the earlier (1984) manual. The current document represents the cooperative efforts of the Pennsylvania mushroom farm community representatives and environmental regulators on state and local levels.

Members of the work group drafting this version of the "mushroom manual" are listed below. They are recognized for their commitment to facilitate understanding among the mushroom farm community, the Pennsylvania Department of Environmental Protection, other regulatory agencies, and the community at large. The work group members' knowledge, experience, and patience were critical in establishing these practices as workable and rational means to meet the goals of environmental protection and sound agricultural operation. Editing services for the manual were financed by the American Mushroom Institute and performed by Merry L. Morris, Ph.D.

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CHAPTER 1

INTRODUCTION TO THIS MANUAL

Mushroom growers, like many other farmers, are finding that being successful requires much more than merely applying their knowledge of agriculture to their crop of choice. Many aspects of farming are coming under the scrutiny of neighbors and evaluation by regulatory agencies. Especially in the environmental area, requirements are becoming more widely and more stringently applied to those activities once considered "just part of growing mushrooms."

While growers are not interested in spending money or time unnecessarily, there is widespread agreement that now is the time to reevaluate mushroom growing practices in light of current environmental laws, regulations, and policies, and begin the process of making needed upgrades. The first step for every grower is to review normal farm practices for potential sources of water pollution or odors. With heightened interest in the proper reuse and management of residual (usually solid) wastes, these materials also need to be inventoried and evaluated.

This manual is intended for both mushrooms farmers and non- farmers. It should be an educational document for those individuals needing to understand mushroom farming, e.g., field inspectors or interested citizens, and presents the basics of mushroom farming in Chapter 2. **The manual is limited to the cultivation of the Agaricus (white and crimini) mushroom.**

For the grower, this manual functions like a yardstick against which farm practices can be compared. Chapters 3 and 4 take the reader step by step through the mushroom growing process and present for each operation the suggested practices to reduce pollution potential. While they may be regarded as ideal, many of these practices are quite attainable for both large and small mushroom farms. Chapter 3 also discusses opportunities that growers can explore to reduce a farm's potential for odor problems. In Chapter 5, two aspects of mushroom farming, making mushroom substrate and spent substrate management, are evaluated under the recent Pennsylvania residual waste regulations. The Best Management Practices discussed in this chapter not only reduce the potential for pollution, but also the regulatory burden that a grower could face. When these Best Management Practices are followed, individual farm residual waste permits can be avoided. Chapter 6 introduces practices of another sort, the technical Best Management Practices based on Pennsylvania Technical Guide for Soil and Water Conservation (PATG) specifications that can be used at individual farms depending on their specific needs.

Current mushroom farm operations may fall short of best practices. Certain farm practices may present potential sources of pollutional discharge. If so, farmers need to change operations or upgrade their physical facilities to eliminate these problems. Chapter 6 introduces a mechanism whereby this process can be carried out in an efficient and effective way. A Mushroom Farm Environmental Management Plan (MFEMP) and the planning process necessary for the development of the plan can be used as the vehicle to get from current farm status to a point of greater compliance. In doing so, the farmer may find, as an added incentive, a reduction in the number of specific permits required by the PA DEP.

This manual was finalized in 1997 and is based on scientific understanding as of that time. Due to changing regulatory and environmental demands on mushrooms growers, more up-to-date guidance will become necessary. This manual will be revised periodically. Growers and other readers of this manual are urged to become acquainted with current regulations and to follow proposed changes in laws and regulations. An active and responsible community can assist agencies in developing the most effective regulations to accomplish environmental protection for the common good.

CHAPTER 2

AN OVERVIEW OF MUSHROOM FARMING

2.1. Introduction

Cultivation of the Agaricus (white or crimini) mushroom consists of six steps: Phase I composting, Phase II composting, spawning, casing, pinning, and cropping. These steps are described in their naturally occurring sequence. Of course, there are other related activities necessary to support these basic steps. Overall, it takes approximately 10-15 weeks to complete an entire growing cycle from the start of composting to the final clean up after harvesting has ended.

2.2. Phase I: Making Mushroom Substrate

Substrate is the growing medium that provides the nutrients needed for mushrooms to grow. Mushroom composting is designed to change the nutrients found in the initial ingredients into forms that are available to and selective for mushrooms. Composting produces a food source most suited for the growth of the mushroom to the exclusion of competing fungi and bacteria. There must be correct moisture, oxygen, nitrogen, and carbohydrates present throughout the process or the nutrients will be inadequate to support the future mushroom crop. Mushroom farmers use various recipes when formulating mushroom compost. Their choices are based on the availability and cost of the ingredients and the individual characteristics of their own farming practices. Generally speaking, however, two slightly different types of composts are made by mushroom farmers with different starting materials: 1) straw based stable bedding containing horse manure or 2) a mixture of hay and corn cobs or straw. A variety of other ingredients are added in order to improve the nutrition and structure of the developing compost. These other ingredients, their purpose, and typical sources are shown in Table 1. Preparation of mushroom substrate recycles vast quantities of agricultural nutrients, especially stable bedding from horse farms and race tracks and poultry manure. By utilizing these nutrient-rich materials productively, the mushroom farming community performs a service to those enterprises as well.

The preparation of mushroom compost occurs in two steps referred to as Phase I and Phase II composting. Phase I compost preparation usually occurs outdoors, although an enclosed building or a roofed structure may be used. A concrete, asphalt or low permeability compacted earthen material area, referred to as a wharf or compost turning yard, is required for composting. Compost turning machines are used to mix and water the ingredients, and a bucket-loader is necessary to move the ingredients on the turning yard.

Phase I composting begins on many mushroom farms with a preliminary or “pre-wet” step. Large heaps of the stable bedding or hay- or straw-mixture are wetted down by pumping water on them or dipping them into specially constructed dip pits. This wetting step initiates the heating process as a result of the growth and reproduction of microorganisms naturally present in the materials. This serves to soften the hay or straw and makes it more water absorbent. These heaps may be mixed together to produce a uniform starting compost. The pre-wet stage may last 3-4 days to 12-15 days.

Following the pre-wet stage, the materials are arranged in a long pile over which are spread nitrogen supplements and gypsum, and the pile or rick is thoroughly mixed with a turning machine. Aerobic composting continues after the pile is wetted and formed.

The compost pile must be carefully erected and managed. Most compost piles are roughly 5 to 7 feet wide, 5 to 10 feet high, and as long as necessary or practical. The pile or rick must hold its shape, but be loose enough to allow for aerobic conditions throughout. Turning and watering are done at approximately 2-day intervals. Turning provides the opportunity to water and mix the ingredients, as well as to relocate the compost from the cooler exterior to the warmer interior and vice versa. The aeration accomplished by turning is short-lived, so pile construction, structure, and contents are critical in promoting aerobic degradation. The number of turnings and the time between turnings depend on the condition of the starting material and the time necessary for the compost to heat up.

Table 1: Mushroom Substrate Ingredients

INGREDIENT	RATIONALE*				TYPICAL SOURCE	
	N[1]	C[2]	B[3]	O[4]		L[5]
MAIN INGREDIENTS						
Corncobs (whole, ground, crushed, pelletized)	X	X	X		Corn farm, corn sheller	
Hay	X	X	X		Hay farm	
Horse manure—straw bedded	X	X	X		Horse farm	
Poultry litter/manure	X				Poultry farm	X
Straw		X	X		Grain farm	
OTHER INGREDIENTS						
Adco	X				Fertilizer plant	X
Ammonium nitrate	X				Fertilizer plant	X
Animal fat	X				Meat processor	X
Brewers grains (wet or dry)	X				Brewery	X
Corn fodder		X	X		Corn farm	
Dried blood	X				Poultry or meat processor	X
Feathers or feather meal	X				Poultry processor	
Fish solubles	X				Fish processor	X
Grape pumice		X			Grape processor	
Ground wallboard				X	Construction industry	
Gypsum				X	Gypsum rock	
Gypsum, synthetic				X	Soil conditioner supplier	
Hardwood bark		X	X		Sawmill	
Hardwood tree leaves		X			Municipal leaf collection	
Licorice root	X					?
Lime				X	Soil conditioner supplier	
Livestock manures	X				Livestock farm	
Mushroom stumps and culls					Mushroom farm	
Paunch		X			Meat processor	X
Peat moss					Peat bog	
Potash, potassium					Fertilizer plant	X
Potato waste		X			Food processor	?
Seed—hulls		X			Seed processor	
Seed—meal	X				Seed processor	X
Seed—oil	X	X			Seed processor	
Shredded newspaper		X			Newspaper recycler	
Spent lime				X	Sugar processor	?
Sugar cane (bagasse)		X	X		Sugar processor	?
Sugar cane (pulp)		X			Sugar processor	?
Urea	X				Fertilizer plant	X
Other						

* The above materials represent common ingredients used for the preparation of mushroom substrate, their function(s) in the substrate, potential for leaching, and typical sources. 1 = nitrogen, 2 = carbon, 3 - bulk, 4 = flocculent or pH control, 5 = leachable.

Water addition is critical. Too much water will exclude oxygen by occupying the pore space and may lead to unnecessary loss of nutrients due to leaching. Too little water can limit the growth of bacteria and fungi. As a general rule, most of the water is added when the pile is formed and at the time of first turning, and thereafter water is added only to adjust the moisture content. On the last turning of Phase I composting, water may be applied generously to carry sufficient water into Phase II. Water, nutritive value, microbial activity and temperature are like links in a chain. When one condition is limiting, the whole chain may be affected.

Phase I composting lasts from 7 to 16 days, depending on the nature of the material at the start, its characteristics at each turn, the season, and the particular practices at a given farm. At the end of Phase I, the compost should have: a) a brown color; b) short, pliable straws; c) a moisture content from 68 to 74 percent; and d) an odor of ammonia. When these conditions have been reached, Phase I composting is completed.

2.3. Phase II: Finishing the Compost

Phase II continues the conversion of nutrients into a selective food supply for the mushroom. First, pasteurization is performed to kill any insects, nematodes, competing fungi, or other pests that may be present in the compost. Second, ammonia levels which formed during Phase I composting are reduced. At the levels present at the end of Phase I, ammonia can be lethal to mushroom spawn growth. Phase II composting can be viewed as a controlled, temperature dependent, ecological process using air to maintain the compost in a temperature range best suited for the deammonifying organisms to grow and reproduce. The growth of these thermophilic (heat-loving) organisms depends on the availability of carbohydrates in a usable form and the presence of nitrogen, some of which is in the form of ammonia.

Phase II can be managed in three different ways, depending on the type of growing system used. For the multiple zone growing system, compost is packed into wooden trays, the trays are stacked six to twelve high, and the trays are moved into an environmentally controlled Phase II room. Thereafter, the trays are moved to other special rooms, each designed to provide the optimum environment for each step of the mushroom growing process. At a mushroom farm using the single zone bed or shelf growing system, the compost is placed directly in the stationary beds which are in a room used for all steps of crop culture. The most recently introduced multiple zone system, the environmentally controlled "tunnel", is an enclosed system which allows compost to experience Phase II conditioning in a bulk form rather than in individual trays or beds.

Spawning

Spawning is the mushroom culture equivalent of planting seeds for a field crop. However, mushrooms are "planted" using fungal mycelia rather than seeds. Fungal mycelium propagated vegetatively is known as spawn (Latin expandere = to spread out). Spawn making requires laboratory facilities to propagate mycelia, so the mushroom mycelia do not get mixed with the mycelia of other fungi. Spawn making starts by sterilizing a mixture of cereal grain plus water and chalk; rye, wheat, millet, and other small grains are used. Once the sterilized grain has bits of mycelia added to it, it is incubated to promote its full colonization. Mushroom farmers purchase spawn from commercial laboratories.

At the mushroom farm, spawn is thoroughly mixed into the compost using a special spawning machine. Once the spawn has been mixed throughout the compost, the compost temperature and the relative humidity in the growing room are managed to optimize mycelial growth. The spawn grows out in all directions from a spawn grain. The time needed for spawn to fully colonize the compost depends on the amount of spawn added and its distribution, the compost moisture and temperature, and the nature or quality of the compost. A complete spawn run usually requires 10 to 21 days.

Casing

Casing is a top-dressing applied to the spawn-run compost and is necessary for mushrooms to grow from the mycelia which have grown throughout the compost. Clay-loam field soil, a mixture of peat moss with ground limestone, or weathered reclaimed spent mushroom substrate (SMS) can be used as casing. Casing is not used to supply nutrients; rather, it acts as a water reservoir and provides a place where rhizomorphs form. Rhizomorphs look like thick strings and form when the very fine mycelia grow together. Casing should be able to hold moisture since moisture is essential

for the development of a firm mushroom. During the period following casing, water must be applied intermittently to raise the moisture level to maximum water holding capacity before the mushroom pins form.

Pinning

Mushroom fruiting bodies (initials, primordia or pins) are small outgrowths from the rhizomorphs which form in the casing layer. These fruiting bodies continue to grow larger through a button stage, and ultimately enlarge into a mushroom. Harvestable mushrooms appear 16 to 28 days after casing. Pinning affects both the potential yield and quality of a crop. The management of water content of the casing, relative humidity, and carbon dioxide content of the air are all essential in determining crop yield and quality.

Cropping

The terms flush, break, or bloom are names given to the repeated 3- to 5-day harvest periods during the cropping cycle. They are followed by a few days when no mushrooms are available to harvest. Once mature mushrooms are picked, an inhibitor to mushroom development is removed, and the next flush moves toward maturity. This regrowth repeats itself in a 7- to 10-day cycle, and harvesting can be repeated as long as mushrooms continue to mature, though the yield decreases with each picking cycle. Most mushroom farmers harvest for 25 to 35 days, but harvest can continue for as long as 150 days. Temperature, water management, and ventilation continue to be critical parameters throughout the growing period.

One deciding factor related to the length of harvesting time is the necessity to maintain low levels of disease pathogens and insect pests. Mushroom pests can cause total crop failure. These pathogens and insects can be controlled by cultural practices coupled with the use of pesticides, but it is most desirable to exclude these organisms from the growing rooms. Shorter harvesting periods reduce the time for pests to become established and proliferate in the crop or growing room. After the last flush of mushrooms has been picked, the growing room should be closed off and a clean up performed. The room may be pasteurized with steam or treated with sanitizing agents. This final step is designed to destroy any pests which may be present in the crop or the growing room, thus minimizing the likelihood of infesting the next crop.

(Adapted from Wuest, Paul J.; Duffy, Michael D.; and Royse, Daniel J. Six steps to mushroom farming. Special Circular 268. The Pennsylvania State University. College of Agriculture, Extension Service, University Park, PA.)

CHAPTER 3

MANAGEMENT OF RAW MATERIALS AND MUSHROOM SUBSTRATE

3.1. Introduction

As discussed in Chapter 2, generating a substrate for the growth of the mushroom crop is a critical first step in mushroom culture for most cultivated commercial mushrooms. A poorly produced compost will invariably mean disappointing yields for the farmer.

Because some materials used in this substrate are high in nutrients, the mushroom farmer must take care at the farm to keep these nutrients separated from the natural water resources. This chapter reviews the composting process in the context of Best Management Practices (BMPs)[1] which help protect these resources from degradation.

A well-run operation for preparing substrate should evidence an efficiency of design and orderliness of operation which, in concert with good housekeeping and water management, will go a long way to protect water and air resources.

3.2. Watering Raw Materials and Ricks

As noted in Chapter 2, watering the raw materials and the ricks of substrate is an essential operation. If watering is optimal, bacteria and fungi cause changes in the raw materials in the rick (windrow), changing the mix of raw materials into a substrate that is selective for the Agaricus mushroom. Bacteria and fungi also metabolize nutrients and convert them into microbial protein. Excess water, however, can lead to anaerobic activity within the ricks and produce a sour product with the risk of malodors. Excess water can also lead to the loss of nutrients, which can become pollutants if not properly controlled.

A recommended practice is to add sufficient water, but not cause wash-out of ingredients and generation of large quantities of leachate. To find the balance point, wetting of the initial piles of substrate ingredients in the preliminary or "pre-wet" step, the watering volumes and schedules for the substrate ricks, rick turning schedules, and composting period can all be modified. Since loss of some water from the ricks is normal and unavoidable, the design and operations on the compost wharf must be adequate to control the highly nutritious water. Initial design of the wharf can be helpful in this regard, but wharves can be upgraded to meet the same objective. This objective, simply stated, is to keep all leachate, whether from raw ingredients or from the ricks, on the wharf surface unless it is being discharged to an approved wastewater collection unit or recycling system.

3.3. Wharf/Turning Yard Operations

Wastewater can be associated with the production of mushroom substrate, from storage of spent mushroom substrate (SMS) and from composting of SMS for later uses. However, the mushroom farmer has opportunities to reduce the potential for mushroom substrate ingredients or leachates to come in contact with water resources. The wharf should be of sufficient size to accommodate the ricks and also the movement of raw materials. Storage locations should be chosen taking into account the concentrations of soluble nutrients in the raw materials and the nutrients' potential to generate leachate of environmental concern. Placement of raw materials and ricks should be optimized to reduce unnecessary traffic and tracking of materials on the wharf. It is critical to provide sufficient room for operations and high quality storage areas for raw materials.

The wharf area must be paved or covered with an impervious material and sloped toward impervious collection areas. Ideally, this paved wharf area may be under roof, but this is not practical for most farms. Though roofing is expensive, it is advisable for storing high nutrient, leachable raw materials like chicken manure. Roofing will minimize the potential for contact of manure nutrients to contact with

[1]This manual contains Best Management Practices (BMPs) of two types: preferred ways of performing normal mushroom growing activities and technical Best Management Practices as described by the Natural Resources Conservation Service (NRCS). The operational BMPs may originate from common knowledge of good practice or from the requirements imposed under regulations. The operational BMPs are described in chapters 3, 4 and 5. Chapter 6 and Appendix B contain references to the NRCS BMPs. Appendix B contains a list of BMPs being used by the county conservation districts based on NRCS' best management practices.

groundwater and surface water and thus minimize the leaching of nutrients into the collection basin.

While storage of raw materials on paved wharf areas is the preferred management practice, alternatives can be considered for certain raw materials that have minimal or no potential to leach nutrients or other constituents. For these materials which do not generate leachates, bare ground storage is acceptable. (See Table 1 for examples of materials.) For added protection, the raw materials should be covered securely with waterproof tarps. In some cases, inventory quantities can be reduced to accommodate the size of the storage area.

Wharf runoff generated by storm events differs from normal leachate production because the mushroom farmer has less opportunity to control its rate, volume and frequency. Nonetheless, good practice and environmental laws dictate that there be no discharge of untreated stormwater from the wharf to the surface or groundwaters of the Commonwealth. Provisions must be made for control of stormwater. The wharf must be designed and operated to minimize run on of stormwater, and drainage channels must be adequately sized and constructed to carry stormwater away prior to any contamination with wharf material. Care must be taken to size stormwater units to accommodate higher volumes of water from storm events. Critical in this regard are the design and construction of collection basins. The code numbers for these management practices are listed in Appendix B. Once constructed, these stormwater management structures must be maintained to be serviceable at all times to control storm waters. Any stormwater generated on the wharf must be collected and treated as wastewater. The wastewater may be stored in tanks or impoundments as discussed in Chapter 5.

Care taken in daily operations can also reduce the likelihood of pollution. "Good housekeeping," such as cleaning up clumps of compost and raw materials scattered about the wharf and replacing them in ricks or storage areas can reduce the strength of runoff and potential for odor production. The collection of these stray materials in dry weather can control dust and the dispersal of pollution generating materials. Dry, dusty areas can be lightly moistened with a fine spray of water to reduce dust. Keeping drainage channels ditches which lead to collection basins free of wharf solids allows them to serve their purpose better. It also reduces the extent to which the solids will dissolve into the water being carried in the ditch, thus reducing the pollution load on the collection and treatment system. Stormwater and drainage channels should likewise be kept free of obstructing materials. As suggested earlier, using as little water as necessary to make a good compost can also be a way of reducing leachate generation.

Collected wastewater can be reused on some wharves in the substrate preparation process. Leachate and wastewater from the wharf can be added judiciously to the mix of raw materials in the early "pre-wet" heaps or later to the ricks themselves up to the second turning. This practice adds moisture to the mix and also reduces the accumulation and storage of high strength wastewater in collection basins. This recycled liquid should be kept aerated or agitated to reduce anaerobic activity, odors, and settlement of solids into the collection basins. Screens and filters are a wise investment to keep solids out of the water entering the collection basins, thus keeping solids out of the waste stream and facilitating the replacement of these solids into the ricks.

Wastewater can also be applied to SMS storage piles or spread on crop fields in accordance with the land application procedures identified in Chapter 5. The Department of Environmental Protection does not consider these liquids to be a "waste" if they are directly recycled onsite without treatment, processing or release into the environment as part of an ongoing normal farming operation by the grower. The wastewater may be stored in tanks or impoundments as discussed in Chapter 5.

3.4. Regulatory Best Management Practices for Normal Farming Operations

The practices that will be discussed below apply to normal farming operations, which include most mushroom farms. Normal farming operations are defined in the residual waste regulations as the customary and generally accepted practices engaged in by farms for agricultural production provided such practice does not cause pollution to the air, water, or other natural resources. It also applies to management, collection, storage, transportation, use and disposal of agricultural wastes on land where such materials will improve the condition of the soil, growth of crops or restoration of land for the same purpose.

Three aspects of the mushroom substrate composting operation should be reviewed by the mushroom farmer to make certain his farm operations meet the residual waste requirements: the composting operation, the substrate ingredients, and any wastes generated by the

composting operation. See Figure 1 for the relationship among substrate ingredients, substrate preparation, normal farming operations, and permitting requirements.

a. Normal Farming Operations:

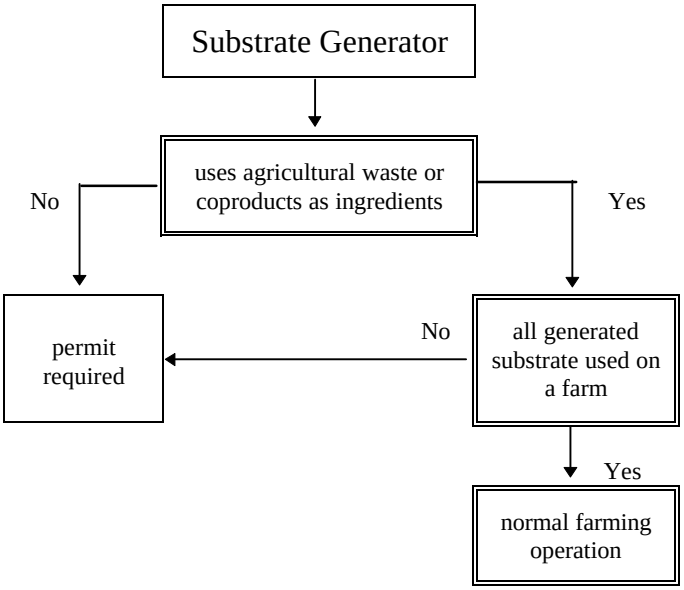
A permit is not required for a mushroom composting operation solely engaged in preparing mushroom substrate if it is part of a normal farming operation. In this case, to be considered part of a normal farming operation, the composting operation must comply with the following:

1. The composting must be conducted on a farm or other facility that complies with this manual and has an approved and implemented Mushroom Farm Environmental Management Plan (MFEMP). (See Chapter 6.)
2. The compost must be made using only agricultural wastes or agricultural wastes mixed with "products" or "coproducts."[2] See also Appendix A.
3. All of the finished substrate must be used on a farm for the production of mushrooms.

However, if the composting operation does not meet the definition of normal farming operations, it must obtain a residual waste processing permit from the Department of Environmental Protection. See Chapter 5 and Appendix A.

Table 1 identified common ingredients used in the preparation of mushroom substrate. Both for the generator of these ingredients and for the mushroom farmer making substrate, these ingredients can be considered as "coproducts". Using corn cobs as an example, both the farmer or sheller producing corn cobs and the mushroom farmer using corn cobs in his mushroom substrate can consider the cobs to be a coproduct. Storage of these materials should be practiced as discussed in this manual to avoid the potential for pollution and loss of coproduct status.

Figure 3.1: Regulatory Relationship Among Substrate Ingredients, SMS Use, Normal Farming Operations and Permit Requirement



b. Management of Waste:

Although the farmer's goal may be to generate zero waste material, a small amount of waste may be unavoidable. Wastes generated in the mushroom substrate production process, for example, wastewater, excess substrate or off-spec substrate must be collected and stored as indicated in this manual and an approved MFEMP. These wastes must be:

1. reused in the substrate production process,
2. land applied according to the application rates included in this Manual or in the Penn State Agronomy Guide,
3. qualified as coproducts, or
4. managed as waste under the residual waste regulations.

If these wastes are not directly reused, they must be stored in accordance with the residual waste regulations. (See Appendix A. See Chapter 5 for more details regarding wastewater use and storage.)

Records must be maintained by the mushroom farmer on an annual basis of the amount of waste generated from the substrate production activities and the disposition of the waste.

[2] *Product* and *coproduct* are terms used in the residual waste regulations. A *product* refers to an intentional result of a production process. In this case, the mushroom crop is the intentional result of a production process. A *coproduct* is a material generated by a process which is not the intentional product, but which can, nonetheless, be used in lieu of a raw material in a production process. For example, composted SMS may be able to be used in place of peat moss in the manufacturing of potting soils or in the growing of potted plants.

3.5. Odor Reduction Opportunities

Odors are sometimes associated with compost operations. They are a natural occurrence, but need to be minimized. There are some ways the mushroom farmer can reduce the odor potential of the wharf area. Many of these Best Management Practices have been mentioned above in connection with water quality control. Listed below are several practices that will aid in controlling and reducing odors:

1. Do not use more nitrogen-rich raw ingredients than necessary to produce a nutritious compost for the future mushroom crop.
2. Maintain aerobic composting operations.
    - Do not overwater and thereby create anaerobic conditions and nutrient wash out.
    - Make sure the initial mix of ingredients is thorough, especially with manures, to avoid producing anaerobic clumps in the compost.
3. Prevent standing water and poor drainage areas in the wharf, including around raw material storage areas.
4. Trap solids before they enter the collection basin. If solids are already present in the basin, remove them regularly.
5. Aerate and agitate stormwater runoff water that is in collection basins or impoundments.
6. Maintain maximum available isolation distances from where the composting operation is carried out and other potential land uses.
7. Screening (fences, trees, landscaping, berms) may be helpful in shielding the composting operation from the view of adjoining property owners. (See the "Manure Management Manual for Environmental Protection"[3] published by PA DEP for examples.)

[3]The Manure Management Manual for Environmental Protection is available through PA DEP, Bureau of Water Quality Protection, Division of Conservation Districts and Nutrient Management, P.O. Box 8465, Harrisburg, PA 17105-8465, 717-783-7577.

CHAPTER 4

GROWING THE MUSHROOM SPAWNING THROUGH HARVEST

4.1. Introduction

This chapter continues the presentation of practices for minimizing negative environmental effects from mushroom farming. The sub-headings are given in chronological sequence for producing mushrooms. This chapter contains some reference to pesticide application practices, but additional related information can be found in Appendix C - Pesticide Regulations and Appendix H - Pest Management for Mushroom Farms. The Pennsylvania Department of Agriculture can provide fact sheets covering all aspects of pesticide safety and current worker protection standards. As noted elsewhere in this manual, the emphasis is on producing Agaricus (white or crimini) mushrooms.

4.2. Spawning

As indicated in Chapter 2, the process of spawning is equivalent to the planting of seeds for a field crop. The spawn arrives on the farm in sealed containers that exclude other microorganisms. While spawn is being mixed with mushroom substrate, it is considered good practice to keep the area clean and to close the doors where possible. Cleanliness keeps undesirable fungal spores and bacteria from entering during the mixing procedure.

Good practices during spawning involve proper handling of solids rather than water. The packaging for the spawn should be either recycled or placed in refuse containers. Substrate and spawn mixture spilled during the mixing operation should be squeegeed from the floor and placed with SMS or stumps for utilization or disposal.

Immediately after spawning, a grower may choose to place a thin film of polyethylene over the spawned substrate to increase CO_2 concentrations in the tray or bed, help preserve water in the compost, and protect the surface from pests and mushroom pathogens. The film is not generally reusable and should be properly discarded once removed. Good practices call for the film to be placed without delay in the refuse for removal by a properly licensed solid waste disposal company. While awaiting removal, the plastic should be protected from rain to eliminate the potential for runoff of low level pesticide residues from the plastic surface.

4.3. Casing

As indicated in Chapter 2, the fully colonized substrate is covered with a layer of casing material to induce the formation of the mushrooms. This step involves a major input of solid material (peat and limestone, organic soil recycled from SMS, or virgin soil) to the mushroom farming operation.

Recommended practices include the reasonable activities related to good housekeeping. If casing material is stored outside in bulk, it should be treated as other raw materials, and erosion into streams or storm sewers should be prevented. Inside, good housekeeping dictates that any spilled casing material should be squeegeed and picked up. These sweepings can be placed with SMS generated after harvest is complete. The squeegeed materials are not to be placed with new casing for use on beds or trays because contact with the floor may add impurities to the material. The squeegeed materials may be managed in the same manner as the SMS.

The water used to moisten the cased substrate may also be used as a means for the application of low levels of minerals or pesticides. In these cases, especially, water should be applied at a rate low enough that the casing will absorb it all. Multiple small waterings should be used rather than a single large watering to avoid exceeding the absorption rate of the casing. Thus, there should be essentially no water or pesticide runoff from the casing to the next lower level or onto the floor.

A recommended practice on mushroom farms is to use a dedicated tank and pump system for watering. This system works as follows: the tank is filled only to the volume needed for a specific water application. If there are to be additives for that water application, those powders or solutions are placed in the tank and mixed. All pesticides mixed in the tank must be used according to the pesticide label directions. Mixing must continue during the pumping. It is a

recommended practice also that only sufficient mixture be prepared in the tank for a specific room or house, so that there is no leftover chemical requiring storage or disposal. The tank and pump system are useful for plain water application as well as for water with additives because the pump assures a constant pressure at the sprinkler head. In contrast, the well pump connected to a pressure-tank provides a varying pressure, particularly as other valves are opened and closed. Good water quality practices do not allow the use of a pesticide injection system that will place chemicals or pesticides directly into fresh water supply pipes.

4.4. Fruiting and Crop Care

Pinning is initiated by shocking the mycelia with an introduction of fresh air to lower temperatures and carbon dioxide concentration. Therefore, pinning does not have any environmental effects in terms of odors, water and solids management.

Once the pins are formed and begin to grow larger, the casing needs more water. As described above under casing, the applied water may have additives for controlling undesirable bacteria or fungi. Again, the amount of water should not be too much for the casing to absorb, thus preventing any runoff to the floor.

4.5. Harvesting Operations

Mushrooms are harvested by hand (in 1996). After picking the mushroom, the harvester trims off the ends of the mushroom, often called stumps, and accumulates them in a container for removal from the room or house. Harvesting also generates some over-ripe and misshapen mushrooms that have no commercial value (culls) and a small amount of dislodged casing material. Fallen harvesting debris should be swept from the floor and placed together in the container specifically designated for stumps. Stumps may be placed into the ricks to become part of future substrate or may be spread thinly on crop land. Land application practices such as are recommended for SMS in Chapter 5 should be used for application of stump material. Stump material should not be left in piles near mushroom houses or elsewhere because it rapidly degrades, attracting flies, sustaining their life cycles, and generating odors.

Workers move from house-to-house or room-to-room according to the harvest schedule. To reduce the transport of mushroom diseases, the workers may wet the bottoms of their footwear on a mat saturated with disinfectant. These mats can be located at the door(s) to each room or house. Also, the workers' tools may be brushed clean and dipped in disinfectant. As with pesticides, spills of these disinfectants must be avoided, and spill control and clean up measures must be in place.

As noted in Chapter 2, mushrooms grow in cycles (flushes, breaks, blooms). Between flushes, water is applied to the casing to supply the next mushrooms. This water application should be performed in the same careful manner as mentioned above under casing.

4.6. Post-Harvest Clean-Out

After the last picking, the room or house may be prepared for a heat treatment. It is good practice to add live steam to the room or house for the purpose of pasteurizing the substrate and interior surfaces. This practice reduces the spread of disease prior to moving all of the substrate and casing material from that location. SMS should be removed from the trays or beds and handled in an environmentally safe manner as described in Chapter 5 of this manual.

The room or house may be further disinfected or sanitized after the SMS is removed. Particularly during the outbreak of a mushroom disease, scrubbing the walls and remaining wood in the room and another application of heat may be used as a guard against future infection.

4.7. Insect Monitoring and Control

In Pennsylvania, there are two fly species (Phorid and Sciarid) that feed on mushroom tissue and have the potential to cause economic damage to the mushroom farm. These must be controlled to numbers below the economic threshold level. Integrated Pest Management (IPM) techniques aid the farmers in minimizing the quantity of chemical insecticide needed for fly control. IPM requires that the farmer know the level or number of flies in the room, so a monitoring device is essential. By observing the number of flies at the monitor, the experienced mushroom farmer can determine the flies' time of entry, life cycle, and potential for infestation. This is critical information for the farmer to judge the potential economic impact. Using the observations at the monitor, the farmer can schedule the timing and dose of insecticides. The IPM technique helps make most efficient use of expensive chemicals. Good housekeeping and farm sanitation practices help to eliminate breeding locations for all species of flies. As mentioned earlier, the stumps and overripe mushrooms

should be removed from the harvest areas to reduce that source of growth media for flies. See Appendix H for more information on pest management for mushroom farms.

4.8. Pathogen Control

Mushrooms have pathogens, too. Various species of bacteria, other fungi, and viruses can attack mushrooms. The farmer should use good sanitation practices as the first line of defense against these pathogens. In the event that an infestation occurs, and economic impact will be felt if the disease were to go unchecked, i.e., the economic threshold is exceeded, then chemical or biological control methods would be needed.

It is important to have as much information about the disease as possible so that pesticide use is most effective, not excessive. Some diseases can be spot treated, while others need whole-house treatment. From both an environmental and economic viewpoint, minimal use of pesticides is best. The farmer must apply pesticides according to label directions when needed to control a specific problem.

4.9. Pesticide Handling and Regulations

The U.S. Environmental Protection Agency (EPA) sets rules and regulations for pesticides that apply across the nation. Each state may establish additional rules for the handling and application of pesticides. The Occupational Safety and Health Administration (OSHA) has regulations that apply to pesticides and other hazardous materials. Each mushroom farmer must comply with regulations that are intended to protect the environment as well as people at the farm and nearby residents. This manual does not list all of the regulations for the use of pesticides, including limitations on SMS use, but the farmer is expected to abide by the current rules and the instructions on the pesticide label. (See Appendix C for the Pennsylvania pesticide regulations.) The county extension service is a good source of information regarding pesticide use, as is the Pennsylvania Department of Agriculture.

4.10. Trash Disposal

General trash and refuse items on a mushroom farm include typical household items such as newspaper, magazines, printout paper, lunch containers, beverage cans, etc. Unique to mushroom farms are: the plastic film used to cover the substrate during spawning; wood (lumber) not strong enough to stay in service for trays, beds, or shelves; pesticide containers; and broken harvest containers. Spawn and casing packaging should be recycled or added to the general trash. The mushroom farmer should check that a properly licensed waste disposal company removes the waste materials and should assure that the wastes are properly disposed of at an appropriate disposal site. If municipal waste is generated at seasonal farm labor camps the regulations for proper management of refuse must be instituted. (7 Pa. Code Section 177.13)

In anticipation of refuse removal, it is good practice for the discarded items to be covered. In general, a dumpster or other covered container is provided by the contract hauler. The farmer should be sure to place items in the container so that precipitation does not wash off chemicals, such as pesticides or nutrients. The recommended method to dispose of discarded lumber is to cut it to short lengths and place in the container. Containers for liquid pesticides should be triple-rinsed and punctured prior to disposal. Emptied bags for powdered pesticides may be discarded as municipal waste. Protective clothing, disinfectant mats, footwear, filters, etc. that are discarded must be managed in accordance with the pesticide or disinfectant label and the existing state regulations.

CHAPTER 5

MANAGEMENT OF WASTES FROM MUSHROOM GROWING OPERATIONS SPENT SUBSTRATE AND WASTEWATER

5.1. Introduction

In Chapter 3, the Pennsylvania residual waste regulations were introduced. In this chapter, the residual waste management requirements for spent mushroom substrate (SMS), wastewater or other potential wastes from mushroom growing operations are discussed. By managing these materials as outlined in this chapter, the farmer can reduce his responsibility for obtaining permits and still minimize the potential for pollution. This chapter also describes how these management practices and a Mushroom Farm Environmental Management Plan (described in more detail in Chapter 6) can work together to the advantage of the farmer.

5.2. Normal Farming Operations and Permit Requirements

Figure 5.1 illustrates residual waste management requirements and their implications for the mushroom farmer. These requirements would also apply to a person who has purchased SMS or wastewater from the farmer. The flow charts show that there are several pathways that can be followed. The farmer can follow the pathway which does not require permits if he uses the best management practices consistent with this manual. Both Figures 3.1 and 5.1 highlight the advisability for the mushroom farmer's activities to be consistent with normal farming operations as defined in Chapter 3 and in the regulations. As Figure 3.1 shows, making mushroom substrate using materials considered agricultural wastes or coproducts and then using all the substrate on a mushroom farm would be in line with normal farming operations and thus eliminate the requirement for a permit.

Figure 5.1 focuses on SMS and shows that location, storage, and utilization each play a part in keeping regulatory requirements to a minimum. Using the SMS for the growth of crops, the establishment of lawns, turf grass production, landfill revegetation, and other horticultural uses can all be performed as normal farming operations when done in accordance with this manual. In certain circumstances, SMS could also be considered a valuable coproduct. (See Appendix A for an explanation of criteria for determining a material to be a coproduct.) However, coproduct status will be lost if pollution is generated from improper storage or use of the material. Again, use of the best management practices in this manual benefits the farmer or subsequent owner of the SMS.

When not used as part of a normal farming operation or qualified as a coproduct, the SMS is considered a regulated waste which requires permits for utilization or disposal.

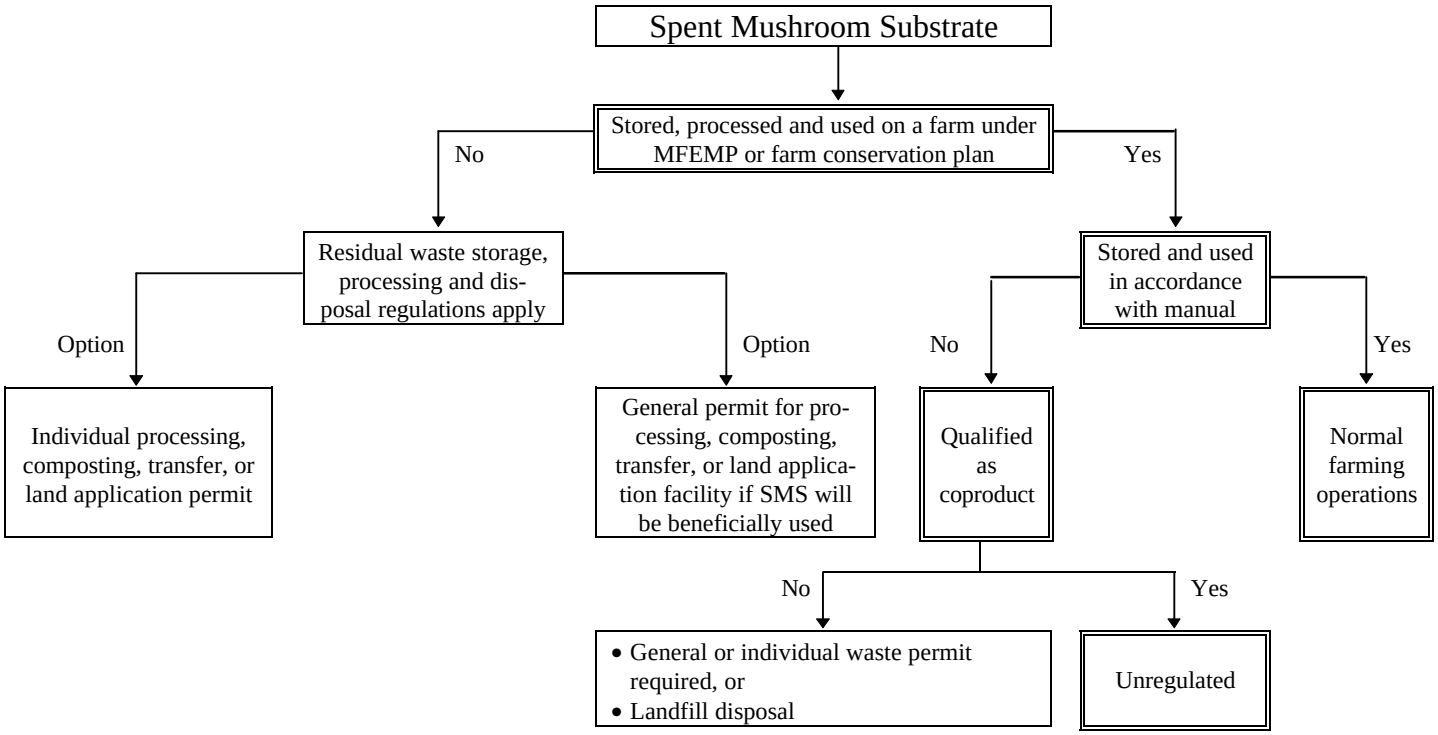
Figure 5.1 indicates that a number of general or individual permits will be required if the storage, processing or use of SMS does not conform to the best management practices outlined here. Several examples of acceptable storage, processing or use arrangements are discussed later in this chapter.

5.3. Recordkeeping

Recordkeeping represents an important and inexpensive management practice which can be used by the grower to verify the proper use and disposal of SMS and wastewater. When the grower maintains records consistent with this section, he can also fulfill his obligations under the residual waste regulations.

The amount of recommended recordkeeping is related to the type and scale of SMS and wastewater management programs. Substantial recordkeeping requirements are only triggered for large scale SMS uses or when these materials leave the farm.

Figure 5.1: Permitting Situations for Spent Mushroom Substrate Under Residual Waste Regulations



When large volumes of SMS are given away, sold, or taken away, the grower must maintain records of the date, volume, and identity of the person taking the waste, a brief description of the proposed use and a description of the coproduct determination. This can be recorded directly on the sales agreement, copies of which are available to the grower and the user of the SMS.

Small scale programs require very little in the way of recordkeeping. For giveaway programs in which SMS is picked up by homeowners or other small volume operations, such as when SMS is sold on a dump truck load basis for landscaping, the grower needs only to estimate the annual total volume of materials given away or sold.

Where passive composting (as described later in this chapter) is being carried out, the grower must maintain records of the length of SMS storage and when the SMS was removed. For example, a grower has four fields approved for passive composting which are included in his MFEMP. For each field he must record the dates when SMS is laid down and dates when it was removed for its subsequent use, along with a rough estimate of volume.

Wastewater resulting from making substrate can be utilized as part of make up water in substrate preparation. It can also be applied for its irrigation and nutritive value to farm fields and be conducted as a normal farming operation, if done in accordance with this manual. In the first case, the wastewater remains in the process, and no requirement for recordkeeping is triggered. In the case where wastewater is applied to farm fields, no additional recordkeeping is necessary as long as the water is applied as outlined in an approved nutrient management plan.

However, more recordkeeping is required if, for example, a mushroom grower gives away 10,000 gallons of wastewater from his substrate preparation operation ten times during one year to Farmer Jones, a grain farmer. Jones welcomes the wastewater and uses it as part of his normal farming operations for both the water and the nutrients. In this case, the mushroom grower should keep records on the transactions including the dates, volumes of

wastewater, name of recipient (Jones), and use of wastewater.

If the wastewater and SMS are managed as suggested in this section, the grower can minimize his recordkeeping needs and be in compliance with the residual waste regulations.

5.4. Isolation Distances and Existing Facilities

The following two sections deal with storage and composting of SMS. Certain aspects of the physical locations of these facilities may either increase or reduce their environmental impact. Distances have been established, known as isolation distances, that separate these facilities from sensitive areas (wetlands, streams, drinking water sources, occupied residences, etc.).

However, some flexibility may be available (for example, in the development or updating of the MFEMP) where existing facilities do not meet all the distance restrictions noted here. This flexibility is most likely to be applicable to stationary facilities that have been in operation for several years prior to the publication of this manual, are already covered by a MFEMP or other farm plan, or are located at the farm where the SMS was generated. For example, where a low permeability pad or roof effectively reduces the threat of groundwater contamination, these isolation distances may not apply.

It is, nonetheless, highly recommended that these isolation distances be observed wherever possible. Farmers or other operators are strongly encouraged to design new facilities or modify existing facilities to be consistent with these restrictions in order to assure pollution prevention in the future.

5.5. Storage of Solids Prior to Reuse on Farms

All mushroom farms have SMS after the harvesting of mushrooms is complete. While there are a variety of uses for this material, the farmer must be cautious about how and for how long the SMS is stored prior to its final use. The storage of SMS must be in accordance with a Mushroom Farm Environmental Management Plan (MFEMP) if the SMS is stored at the farm where it was generated or in accordance with the farm nutrient management plan where the SMS will be used. (See Chapter 6 for more information on MFEMPs and farm nutrient management plans.) In either case, the storage must be conducted in a manner that prevents groundwater degradation and surface water pollution.

Length of storage is critical as well. Current law (Solid Waste Management Act) considers storage of wastes for greater than one year to be disposal. If SMS is stored for more than one year, a permit will be required unless the PA DEP approves a longer storage period prior to the end of the first year of storage. The PA DEP will consider removal of SMS in relation to its rate of accumulation when deciding whether to grant storage for a period greater than one year. Any approval will be given as part of an approved MFEMP or farm nutrient management plan.

If SMS is stored in areas that are not farms, the storage must be done in accordance with the residual waste regulations (see Appendix A), and a general or individual permit for the transfer operation will be necessary. Fortunately, a general permit has been developed that may be used for SMS transfer operations that require a permit.

This general permit requires that the resulting materials be beneficially used or used in normal farming operations in accordance with this manual. If a mushroom grower sends SMS to a transfer facility operating under the SMS general permit, the grower will not have to comply with the generator requirements identified in the residual waste regulations.

5.6. Options for Storage of SMS

There are several options for the storage of SMS:

Case 1

Storage of SMS at the farm where it was produced prior to land application on a different farm or prior to use as a coproduct:

For areas where SMS is not continuously stored and is stored for a duration less than 120 days, the SMS must be stored in a location where it will be separated from the seasonal high water table by at least 20 inches of soil during all periods of the year. Surface run-on and stormwater runoff must be prevented.

For areas where the SMS is stored for greater than 120 days but less than one year prior to use, the SMS must be stored on a pad or under a roof or other structure capable of preventing contact with precipitation. If the SMS is stored on a pad, the pad must be concrete, asphalt, or a low permeability, compacted, earthen material capable of containing all

solids and collecting and diverting all wastewater to storage or treatment facilities. Storage on a pad is not necessary if the SMS is stored under a roof or other structure that prevents contact with precipitation and surface water run-on, and if the SMS is separated from the seasonal high water table by at least 20 inches of soil during all periods of the year.

The maximum volume of SMS that may be stored at the location where the SMS is generated during the course of one year cannot exceed the annual volume of SMS generated by that mushroom farm.

Case 2

Storage of SMS at the farm where land application will occur:

When SMS is stored at the farm where land application will occur, all of the material must be stored and spread consistent with a plan to manage nutrients. Storage may be in the fields in which the SMS is to be used or at a central location at that farm.

Case 2a

Storage in the fields where land application will take place:

For land application areas where SMS is not stored continuously in the same location, SMS may be stored until the next cropping cycle but in no case longer than 180 days. The storage must be part of an approved and implemented farm nutrient management plan (unless an MFEMP has been prepared for the location). The stored SMS must be separated from the seasonal high water table by at least 20 inches of soil. The storage must be at least 300 feet from a drinking water source; at least 300 feet from an occupied dwelling, unless the owner agrees to a reduced distance; and must be no less than 100 feet from a stream, wetland, spring or sinkhole.

The maximum volume to be stored in a field cannot exceed the volume that will be land applied in that field, in accordance with this manual and the Penn State Agronomy Guide, during the next growing season.

Case 2b

Storage at a central location at the farm where land application will take place:

Where storage will be less than one year but greater than 180 days or on a continuous basis, the SMS must be stored on a pad or under a roof or other structure capable of preventing contact with precipitation. If the SMS is stored on a pad, the pad must be concrete, asphalt, or a low permeability, compacted, earthen material capable of containing all solids and collecting and diverting all wastewater to storage or treatment facilities. Storage on a pad is not necessary if the SMS is stored under a roof or other structure that prevents contact with precipitation and surface water run-on, and if the SMS is separated from the seasonal high water table by at least 20 inches of soil during all periods of the year. The storage area must be at least 300 feet from a drinking water source; at least 300 feet from an occupied dwelling, unless the owner agrees to a reduced distance; and must be at least 100 feet from streams, springs or sinkholes.

The maximum volume of SMS in storage cannot exceed the volume that will be land applied on that farm during the year.

Case 3

Storage of SMS at other farms where land application will not occur:

Where farms are used for storage without land application, the SMS can be stored up to one year. The SMS must be stored on a pad or under a roof or other structure capable of preventing contact with precipitation. If the SMS is stored on a pad, the pad must be concrete, asphalt, or low permeability, compacted, earthen material capable of containing all solids and collecting and diverting all wastewater to storage or treatment facilities. Storage on a pad is not necessary if the SMS is stored under a roof or other structure that prevents contact with precipitation and surface water run-on, and if the SMS is separated from the seasonal high water table by at least 20 inches of soil during all periods of the year. The storage area must be at least 300 feet from a drinking water source; at least 300 feet from an occupied dwelling, unless the owner agrees to a reduced distance; and must be at least 100 feet from streams, springs or sinkholes.

Additional requirements apply to this storage arrangement. The maximum volume of storage for one year cannot exceed 20,000 cubic yards or 2 acres in size. The operation must be in compliance with Chapter 102 (relating to erosion control), and cannot pollute the air, water, or other natural resources of the Commonwealth. The storage farm owner must maintain records of the date and volume of all SMS that is received and the date and volume of all SMS that is removed from the facility. In addition, the

records must include the name of the mushroom grower bringing SMS to the farm, the name of the person removing the SMS, and a brief description of the use of the SMS.

5.7. Composting of Spent Mushroom Substrate

a. Passive composting or curing of SMS on a farm

Passive composting or curing involves creating shallow piles of SMS from a farm and allowing it to decompose naturally into a more stable, humus-like product that can be used as casing in mushroom growing operations or for other agronomic uses. This system cannot maintain the same high temperature conditions necessary for rapid composting and therefore results in slower decomposition.

According to these best management practices, the cured SMS must be used in a manner consistent with the land application procedures identified in this chapter and the Penn State Agronomy Guide to qualify as a normal farming operation or may be used as a coproduct if a determination is made. Otherwise, an individual or general permit is required for the composting and subsequent use of the materials. The composting of SMS must be conducted in a manner that prevents groundwater degradation and surface water pollution.

The best management practices of a passive composting operation must be carried out in the following ways:

1. The SMS must be processed in a layer not to exceed three feet in depth. Since SMS self-compacts during the early days of its placement, the depth should be measured 30 days after placement.
2. The passive composting process must be managed in accordance with an approved MFEMP.
3. The passive composting process must be completed in three years or less, unless a longer period is needed to prepare the SMS for a particular use. If this is the case, the specific alternate practice must be included in the MFEMP.
4. The same field cannot be used for additional passive composting until the field has undergone two resting years (years of no application).
5. The operation must assure prevention of stormwater runoff to the greatest possible extent.
6. To reduce the potential for air dispersion, surface water runoff, and groundwater contamination, a fast-growing vegetative cover must be established on the surface of the SMS within six months after placement
7. Passive composting is prohibited in the following locations: within the 100-year floodplain, within 100 feet of a wetland, within 100 feet of a sinkhole, within 100 feet of a perennial stream or other waters of the Commonwealth; within 300 feet of a drinking water source, within 100 feet of the property boundary, and in areas where the seasonal high water table is less than 20 inches from the surface during any season of the year.

If passive composting is carried out using the practices noted above, groundwater monitoring will not be required. However, if the practices are modified in any way which results in more SMS being applied per acre, groundwater monitoring may be required. Monitoring should be conducted in a manner that demonstrates groundwater degradation is not occurring. This monitoring may include, but not be limited to underdrain monitoring, lysimeter monitoring or groundwater monitoring. The monitoring should be done on a quarterly basis and must be approved as part of the MFEMP. The parameters tested on a quarterly basis must include, at a minimum, specific conductance. If the specific conductance level exceeds 200 µmhos above the background level, the following additional parameters must be added beginning the next quarterly sampling: sulfate, DOC, chlorides and nitrates. (Though nitrates can enter groundwater from a variety of sources, many of which are not related to SMS placement, nitrates can serve as an indication of the effect of poorly managed SMS on groundwater.)

If the monitoring indicates that groundwater degradation has occurred or is occurring that exceeds a remediation standard as defined in the Administration of Land Recycling Regulations (25 Pa. Code Chapter 250) for any constituent, a schedule must be developed within one month which indicates the steps to be taken to further investigate the groundwater degradation or to initiate mitigating measures, which may include

removal. The removed SMS must be properly managed using the practices noted in this manual or properly disposed. The groundwater remediation must meet a cleanup standard under the Land Recycling and Environmental Remediation Standard Act (Act 2). In the future, the same area should not be used for passive composting unless a revised design which will not cause groundwater degradation is approved and made part of the MFEMP or farm plan.

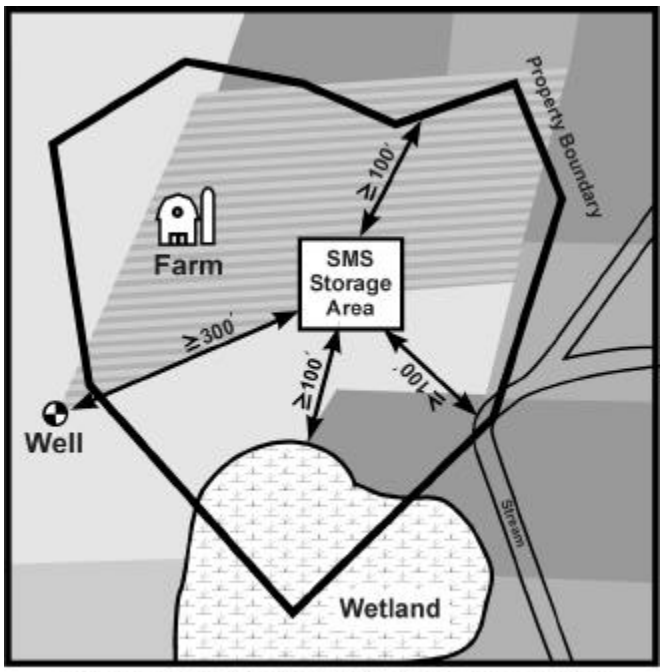


Figure 5.2: Passive Composting of Spent Mushroom Substrates on a Farm.

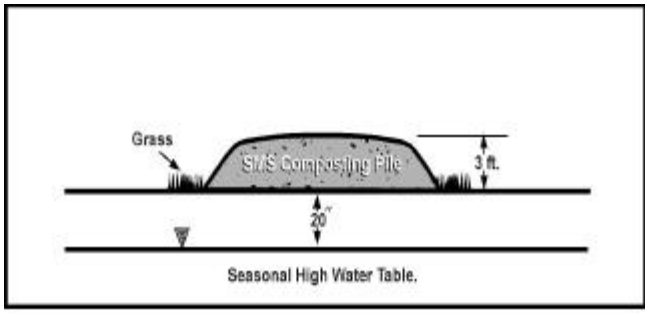


Figure 5.3: Passive SMS Composting

b. Active composting of spent mushroom substrate on a farm

Active composting involves mixing the SMS and forming it into elongated piles commonly called windrows. These windrows are periodically turned or agitated. This process provides faster decomposition due to the attainment of high temperatures and the trapping of the heat within the mass of the pile. Turning the pile provides temporary cooling to the hot pile interior, rotates cool outer material to the pile interior, replenishes pile porosity, and disperses decomposition gases and water vapor.

After composting, the cured SMS must be used in normal farming operations, or may be used as a coproduct if a determination is made. If used as part of normal farming operations, the cured SMS must be used in accordance with the land application procedures identified in this chapter and the Penn State Agronomy Guide. Otherwise, an individual or general permit is required for composting and subsequent use of the material.

The best management practices of an active composting operation must be completed within one year and must be carried out as described below.

1. The composting and storage of any SMS or composted SMS must be conducted on a concrete, asphalt, or low permeability compacted earthen pad that is capable of containing and collecting all liquids generated from the composting process, or it must be conducted in a vessel or under a roof.
2. Any liquids collected from the process must be directly reused in the composting process or stored and land applied in accordance with this chapter.
3. Composting must be maintained by means designed to promote largely aerobic conditions.
4. The compost windrows must be constructed promptly, in no case longer than two (2) weeks following receipt of the SMS at the farm.
5. No more than 6000 cubic yards per acre of the sum of the SMS, composting SMS and finished product, excluding bagged finished product and bulk finished product stored under cover, can exist at any one time at the site.
6. The SMS composting facility, excluding any areas used for storage of bagged product or bulk product under cover, cannot exceed 5 acres in size. (Facilities of greater than 5 acres are not prohibited, but will be subject to additional requirements and review.)
7. Composting is prohibited in the following locations unless conducted within a vessel: within 20 inches of the seasonal high water table; within the 100 year floodplain; within

100 feet of a wetland; within 300 feet of an occupied dwelling, unless the owner agrees in writing to a lesser distance; within 100 feet of a sinkhole; and within 100 feet of a perennial stream or other waters of the Commonwealth.

8. All stormwater should be diverted around the pad. A berm around the pad should be established to prevent run-on and collect runoff.

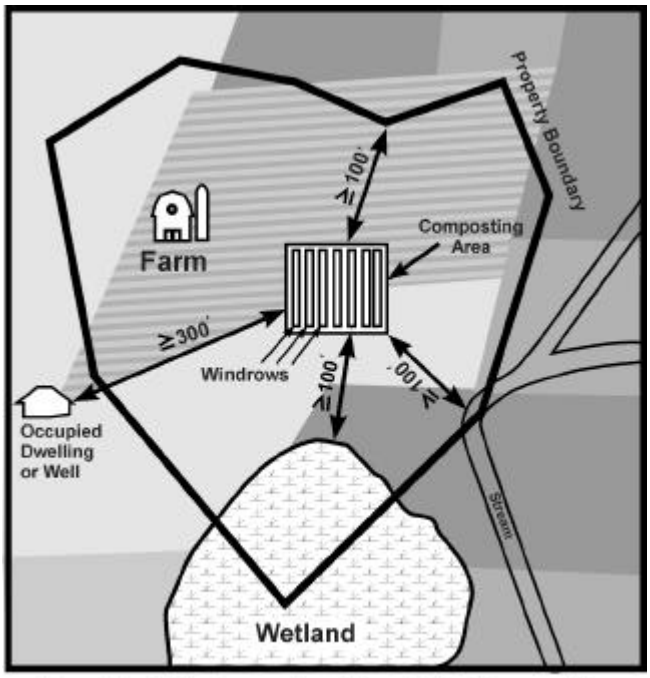


Figure 5.4: Active Composting of Spent Substrates on a Farm

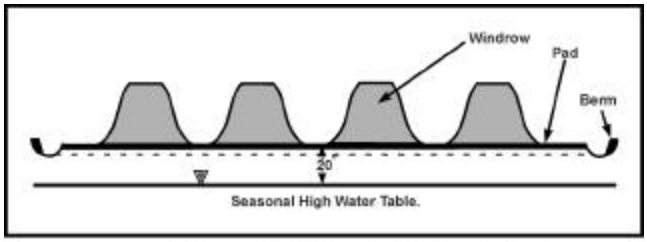


Figure 5.5: Active SMS Composting

5.8. Reuses and Storage of Wastewater from a SMS Composting Operation Prior to Reuse on Farms

As noted earlier, wastewater also can result from the production of SMS and from its storage. To a much lesser extent, it can result from composting of the SMS for later uses. The PA DEP does not consider these liquids to be "wastes" if they are reused directly. The collected wastewater can be reused in the substrate generation process, reapplied to SMS storage piles, or spread on crop fields as a normal farming operation if performed in accordance with the land application procedures identified in this chapter. The wastewater may be stored in tanks or impoundments as discussed below.

a. Storage of wastewater in tanks

To avoid the detailed design and operating requirements necessary for storage impoundments, such as liners and groundwater monitoring, it is recommended by the PA DEP that tanks be used for wastewater storage. The following are requirements for storage tanks used as part of normal farming operations.

1. The tanks must have sufficient shell strength to ensure that they do not collapse or rupture. No wastewater can be placed in a tank if it would cause the tank to rupture, leak, corrode or otherwise fail. Tanks must be constructed in accordance with the Pennsylvania Technical Guide Standard and Specification 313 criteria and all other local, state and federal requirements.
2. The tank must be inspected during construction or installation and annually during operation for uniformity, damage and imperfections.
3. Subsurface tanks used for wastewater storage must be hydrostatically tested annually and when there is evidence of a leak. This can be done by comparing measurements over a 48 hour period. Visual inspection can be used where subsurface tanks are constructed in vaults or other structures that provide sufficient space for physical observation. If a leak is detected, the PA DEP Regional Office must be contacted. A list of PA DEP contact numbers, including those for reporting leaks, can be found in Appendix G.

b. Storage of wastewater in impoundments

Storage in impoundments is more heavily regulated by PA DEP because of concerns for groundwater protection. Impoundments used for the storage of wastewater must have a valid permit from PA DEP for storage of wastewater under the Clean Streams Law. If a mushroom farmer has a storage impoundment that is not permitted, the appropriate PA DEP Regional Water Quality Program Manager should be contacted. (See Appendix G.) All storage impoundments existing on July 4, 1992 are required to have an installed groundwater monitoring system by July 4, 2002, unless

requested sooner by PA DEP. Storage impoundments constructed after July 4, 1992 are required to have a liner system, a leachate collection system, and groundwater monitoring. The PA DEP may waive or modify the liner and leachate collection system for impoundments permitted and constructed before July 4, 1992 if certain conditions are met. To determine if an existing impoundment qualifies for any waivers or modifications, the farmer should review Appendix A and contact the PA DEP Regional Waste Management Program Manager (Appendix G).

5.9. Land Application of Spent Mushroom Substrate and Wastewater

The SMS and wastewater generated from mushroom growing operations can be valuable agricultural by-products that should be put to use in normal farming operations. Applying the SMS to fields and lawns nourishes vegetation; improves the tilth, aeration, and water-holding capacity of soil; decreases soil erosion potential; and promotes the growth of beneficial soil organisms. As an alternative to diverting all wastewater to tanks or impoundments prior to its final use, wastewater can be diverted to a vegetated area or similar arrangement that is capable of filtering solids and using all nutrients without causing pollution. This practice must be approved as part of an MFEMP.

Unfortunately, many SMS or wastewater management systems do not fully utilize the nutrients in SMS. Applying SMS or wastewater in excess, at the wrong time, or improperly handling it in other ways, releases the nutrients into the air and water. Instead of nourishing crops, the nutrients may leach through the soil and into groundwater. One common misuse of agricultural waste, for example, is to apply it to a field and then to supply a crop's nutrient needs with commercial fertilizer without considering the nutrients contained in the waste. An efficient SMS or wastewater management and application system meets, but does not exceed, the needs of the crop and thereby minimizes pollution.

The following sections identify the best management practices for the land application of SMS and wastewater generated from the storage of SMS. For more information on the spray irrigation of wastewater, the farmer should review Appendix A and contact the PA DEP Regional Water Quality Program Manager (See Appendix G).

a. Site Considerations

The mushroom grower or other person who applies SMS or wastewater must follow certain soil conservation practices as outlined in the soil erosion and sediment control regulations (25 Pa. Code, Chapter 102 regulations). One such requirement is that a farm conservation plan must be developed for all fields where SMS or wastewater is land applied. The farm conservation plan outlines acceptable farming practices that minimize soil loss and runoff from the application site. In most cases the local field representative of the Natural Resources Conservation Service may, as time, resources and priorities permit, develop or assist in the development of the farm conservation plan. The county conservation district or a private consultant may also develop or assist in the development of the farm conservation plan.

The SMS or wastewater may not be applied on the soil surface within 100 feet of a drinking water source, springs, sinkholes, streams or lakes.

b. Nutrient content of spent mushroom substrate or wastewater from spent mushroom substrate

The amounts of nitrogen, phosphorous, and potassium or N-P-K in the SMS or wastewater vary depending upon the materials used to develop the substrate, as well as the methods of handling the SMS or wastewater prior to field application. Because the nutrients and other chemicals in the SMS or wastewater can vary due to the different substrate mixes, each mushroom farmer or other person who land applies SMS and wastewater must analyze the SMS and liquids to determine, at a minimum, their N-P-K nutrient content. After the baseline nutrient content is established, repeated analyses are not necessary unless the ingredients in the substrate mix are changed or the mushroom grower has reason to believe that changes in the SMS composition have occurred. If ingredients other than those identified in Table 1 are introduced into the substrate mix, additional chemical testing may be necessary to characterize the waste. Analyses are available through commercial laboratories or Pennsylvania State University Cooperative Extension Service.

c. Application methods and timing

Wastewater

The MFEMP or farm plan will specify the methods and timing of wastewater and SMS application. Wastewater can be used to irrigate and fertilize an existing perennial crop (for example, hay) or a seasonal field crop. It can be applied to the ground or vegetation surface, or it can be incorporated into the soil.

Seasonal application timing and site selection are important considerations for wastewater application. Spring application is best for conserving nutrients. At this time, wastewater application can be coordinated with crop germination or the end of the dormant period for an existing crop. Summer application of wastewater is suitable for small-grain stubble, non crop fields, or little used pastures. Fall application of wastewater generally results in greater nutrient loss than does spring application. However, if wastewater is incorporated or injected immediately, the soil will immobilize some nutrients, especially at soil temperatures below 50^0F. During this season, wastewater is best applied to fields to be planted in winter grains or cover crops. If winter crops are not to be planted, wastewater should be applied to the fields containing the most vegetation or crop residues.

Winter application of wastewater is the least desirable from both a nutrient use and pollution point of view. The frozen soil surface prevents rain and melting snow from carrying nutrients into the soil. The result is nutrient loss and pollution through runoff. Winter application of wastewater should be avoided by foresight and good planning. If occasional spreading is necessary, the wastewater should be applied to distant fields with the least runoff potential. Application should be in areas that are at least 100 feet from streams and that have slopes less than 3%, unless other provisions are made in the farm conservation plan or MFEMP. The wastewater should be applied to limited access fields in early winter, then to nearer fields later in the season when mud and snow make spreading more difficult. Winter application of wastewater must not cause surface water pollution. Measures to prevent surface water pollution must be addressed in the farm conservation plan or MFEMP.

Spent Mushroom Substrate

Spent mushroom substrate is a material of proven value for soil conditioning and long term fertilization. It provides a variety of plant macro and micronutrients, many of which are in the organic form and have slow release properties. SMS adds much needed organic matter to poor or impoverished soils.

SMS can be applied as a top dressing to an existing crop (for example, hay), as mulch or as a fertilizer. Due to the physical characteristics of SMS, its nutrients are in a more stable form than those in its raw ingredients or in manures. They pose less threat to surface water resources if reasonable care is taken to avoid application to areas where erosion is likely.

As noted above for wastewater, SMS can be applied during any season, but spring applications are most beneficial for seasonal field crops. Summer application is also suitable for small-grain stubble, non crop fields, or little used pastures. Spreading SMS following the removal of one hay cutting has logistical advantages and also provides nutrients for the growth of the next cutting. SMS application in the fall should be targeted for fields with winter grains, cover crops, significant vegetation or crop residues. As with wastewater, winter application of SMS requires careful choice of fields and must be performed according to any winter restrictions in the MFEMP or farm conservation plan. SMS may also be stored until the season of use as outlined earlier in this chapter.

Because of its solid form, SMS can be applied to more steeply sloped fields with less threat of nutrient loss and pollution than can wastewater. Slopes up to 12% can be used for SMS application in spring, summer or fall. During winter, slopes should be limited to 3%. Vegetated buffer areas located at the base of steep slopes can effectively take up nutrients that might be transported during heavy precipitation.

d. Application rate

The MFEMP or farm conservation plan will outline the application rates for the wastewater or SMS. In the preparation of the plan, a match will be made between the nutrient contents (N-P-K) of the wastewater or SMS and the needs of the vegetation in the application areas. A limit on the amount of

liquid to be applied over a specified time may also be a part of the plan design when wastewaters are applied.

At this time, only available nitrogen is being used to determine SMS application rates. The amount of available nitrogen in the material to be applied to the land is limited to the amount of nitrogen required by the crop to be grown. The organic nature of the SMS gives it slow-release properties and allows only a portion (approximately 20%) of its nitrogen to be available in the first year. If SMS is being applied as the only fertilizer, this fairly low rate of nitrogen availability will affect the amount of SMS to be applied. If SMS is used as a protective layer to reduce evaporation, prevent erosion, control weeds, or enrich the soil (as a mulch), up to a six inch application rate can be used unless the nitrogen requirement will be exceeded at that rate.

Under some circumstances, test results of soil fertility, wastewater or SMS could point to other constituents as the basis for application rates. For more information on calculating the annual application rate based on crop nutrient requirements and soil fertility management, consult with the county conservation district or NRCS representative or refer to the most current edition of the Penn State Agronomy Guide. Additional information on the land application of wastewater is available from the Department of Environmental Protection Regional Water Quality Management Program (Appendix G).

e. Spent mushroom substrate uses other than normal farming operations

There is an increasing potential for the use of SMS to reclaim mined land or assist in the establishment of wetlands. This use is not considered a normal farming operation, and, therefore, the permit exemption for its use does not exist. However, in many instances, the use of SMS can be done as part of another permit. For example, the use of SMS in revegetating a landfill or active mine site can be done as part of the operating permit issued to those facilities. In other instances, a general permit for beneficial use may be obtained from the PA DEP Bureau of Land Recycling and Waste Management for the use of the materials to reclaim active mines or establish wetlands, or a determination that the SMS is a coproduct for these purposes may be pursued. If the SMS is qualified as a coproduct for these uses, no residual waste permit is required. At these operations, the use of SMS that is covered by a general permit or qualified as a coproduct may also need to be approved as part of a permit or approval issued by the Department for the particular mine reclamation or wetland construction activity.

Since these uses are not considered normal farming operations, the grower must maintain records of the date, volume and identity of the person taking the waste, a brief description of the proposed use and a description of the coproduct determination.

f. Distribution and sale requirements

In addition to the requirements in this manual, SMS that is sold or distributed in bulk or bag as a fertilizer or soil conditioner in the Commonwealth must be registered with the Department of Agriculture. See Appendix D for more information.

CHAPTER 6

MUSHROOM FARM ENVIRONMENTAL MANAGEMENT PLANS

6.1. Introduction

Under state law, the Pennsylvania Department of Environmental Protection (PA DEP) has the responsibility to protect the quality of the waters of the Commonwealth and the authority to require a permit for the management of groundwater and surface water.

However, PA DEP has determined that those mushroom farms that operate in accordance with this manual and that have developed, filed, and implemented a Mushroom Farm Environmental Management Plan (MFEMP) may not be required to obtain a permit or permits. An MFEMP is a carefully planned program and documented record outlining how the mushroom farmer or landowner intends within practical limits to manage the farm to prevent pollution incidents and to maintain or improve the condition of the soil, water, and air resources.

To comply with applicable regulations, all operations listed below need MFEMPs:

1. farms which produce mushrooms,
2. farms which produce mushroom substrate, and
3. spent mushroom substrate processors.

6.2. The MFEMP Plan

The MFEMP plan may be developed for a specific operation in cooperation with the Natural Resource Conservation Service and the county conservation district, taking into account the particular characteristics of the operation. For many farms, in addition to improved operational measures, some new Best Management Practice structures will need to be installed. The agencies that assist in development of the farm conservation plan may also provide technical help for installation of the practices. With certain qualifications, there may be cost-share funds available to implement the MFEMP.

As the MFEMP is implemented, it serves as a documented record of the farmer's effort to comply with regulatory requirements. If the requirements in the plan are being met, the MFEMP will serve in the place of a PA DEP permit and will be kept on file with the PA DEP Regional Water Quality Management Office.

The MFEMP will focus on the detailed design requirements for structures and specific management activities that will prevent pollution during normal farm operations. The MFEMP will also provide the procedures to follow in the event of a pollution incident to minimize the impact of the pollution. It will need to be updated to reflect changes in technology, government regulation, and when the potential to cause pollution changes at the farm.

All farms that apply SMS or wastewater as a soil conditioner or fertilizer and that are not required to develop a full MFEMP must develop and implement a nutrient management plan and a soil conservation plan. A nutrient management plan incorporates the best management practices to control plant nutrients for crop production and water quality protection. A conservation plan identifies conservation practices and, at the very least, includes an erosion control plan.

6.3. Basic Components of an MFEMP

The MFEMP is designed to prevent pollution or the danger of pollution to the ground or surface waters of the Commonwealth. It identifies specifically the required Best Management Practices[1] (BMPs) to meet those objectives. These are normally covered in the following plan components. All components shown below may not be required for each farm.

a. Erosion and Sediment Control

This section of the plan looks at the soils, geology, topography, ground cover, and other natural features of the site. Depending on these natural features, BMPs may be required to prevent erosion and pollution from sediment. Some examples of BMPs are: contour strips, diversions, waterways,

[4]This manual contains Best Management Practices (BMPs) of two types: preferred ways of performing normal mushroom growing activities and technical BMPs as described by the Natural Resources Conservation Service (NRCS). The former are described in Chapters 3, 4 and 5. Appendix B contains a list of BMPs being used by the county conservation districts based on the NRCS' BMPs.

terraces, crop rotation, and critical area planting. The Clean Streams Law (Title 25, Chapter 102. Erosion Control) requires an erosion and sedimentation plan for all plowing or tillage activities.

b. Surface Water and Storm Water Management

Earlier chapters have presented operational practices that can reduce potential for pollution of surface waters. When properly implemented, a storm water management plan will assure that the quality of runoff during a storm event is protected. At most mushroom farm operations, storm water runoff can be divided into uncontaminated and contaminated water. The uncontaminated water must be directed away from possible sources of contamination or carried through the site using BMPs such as diversions, underground pipe systems, roof downspouts, gutters, drains, and waterways. BMPs must be in place to insure that contaminated stormwater is managed so that no discharge occurs to the surface or groundwater.

c. Groundwater Protection

The plan includes a section describing the BMPs to be instituted or constructed to prevent or minimize groundwater contamination. Some of the BMPs that could be utilized include storing raw materials and SMS on impervious surfaces or under roofs, installing monitoring wells around impoundment structures, and developing well head protection zones.

d. Nutrient Management for Substrate Utilization or Spray Irrigation Programs

A Nutrient Management Plan is site specific and includes the vegetable or field crop requirements for the management of nutrients (nitrogen, phosphorus and potassium) required for maximum crop yields while protecting water quality. The Plan includes the following:

1. Expected crop yield.
2. Existing nutrient levels in the soils.
3. The season, method of application, and the amount of nutrients applied to maintain optimum nutrient levels for a particular crop.
4. Normal farming practices including liming, pest control, crop rotation, and harvesting.
5. A description of farming practices such as spray irrigation of runoff water collected from the wharf or SMS storage areas, impoundments, and land application of SMS.
6. Limitations based on land slope, cover type, infiltration rates, soil moisture and proximity to water resources.

e. Integrated Pest Management

Use of chemical pesticides can be minimized when an effective Integrated Pest Management (IPM) Plan is in place. IPM involves developing and implementing a program to determine the threshold population size of a pest at which an economically meaningful level of crop damage occurs and minimizing pest damage in excess of that level. Pest control may be accomplished using the proper non-chemical or alternative controls. It is recommended that chemical control of pests should be used only as needed. An IPM Plan includes the proper use, handling, and storage of all pesticides. (See Appendix H for more information on pest management.)

f. Operations and Maintenance Requirements

Any BMP that is installed has normal required maintenance. No system, no matter how well it worked when it was installed, can function without maintenance. Operation and maintenance for individual practices are described in the Pennsylvania Technical Guide for Soil and Water Conservation used by NRCS and county conservation districts. The following are examples of items to address:

1. Grassed diversions, waterways, and impoundment embankments need to be mowed at least twice a year;
2. Structures must be inspected for cracks or structural failure;
3. Pumps need periodic inspection and greasing;
4. Schedules for the removal of solids from collection basins, screens or entrapments should be developed.

These items and others pertinent to the specific farm should be included in the operation and maintenance section of the MFEMP. Recordkeeping is an important part of the operations and maintenance component of the

MFEMP as it is being implemented. The BMPs should be listed and checked off as they are inspected. The inspection date and any corrective action taken should be recorded.

g. MFEMP Implementation Schedule

The implementation schedule must include a full listing of the farm's planned BMPs with the dates they are scheduled to be implemented. The detailed schedule must be included in the MFEMP, but can be revised by requesting and receiving approval from the county conservation district and sending a revised schedule to be placed in the file at the PA DEP Regional Water Quality Management Program.

h. Air Quality Management

Odors are a natural occurrence in mushroom composting operations. However, a farmer must minimize and control potential odors from his operation. Many of the odor reduction techniques and BMPs have already been described in Chapter 3, under Odor Reduction Opportunities. A description of the specific odor control methods that will be utilized at the farm should be included in the MFEMP.

i. Emergency Preparedness Plan

An Emergency Preparedness Plan outlines the types of emergencies which require notification of community and government agencies, the steps to minimize the damage in a pollution event, and the telephone numbers a farmer needs to have immediately available if an emergency occurs. A description of the Emergency Preparedness Plan must be included in the MFEMP.

j. Wastewater Management

The plan identifies the methods of collection, monitoring, and the reuse or disposal of all wastewater collected from the wharf area and the mushroom growing operation.

k**. Spent Substrate Management**

The plan must provide for the management, reuse or disposal of the SMS and any off-spec substrate.

6.4. Development of an MFEMP

A mushroom farmer has alternatives when deciding who will prepare and provide technical assistance in developing an MFEMP. The county conservation district and/or the NRCS will prepare the plan, usually at little or no cost, upon request of the farmer as time, resources and priorities permit. There are also many private consultants and engineering firms qualified to develop MFEMPs in consultation with the county conservation district or the NRCS. Regardless of who develops the MFEMP, all structural and management BMPs will be evaluated based on current and relevant technical standards and specifications. The MFEMP must be reviewed and approved by the local conservation district. For the name and address of the county conservation district and NRCS contacts, see Appendices E and F.

6.5. Funding Sources to Implement BMPs

The mushroom farmer has the basic responsibility to pay for the cost of implementing the MFEMP. However, some governmental sources of funding are available periodically. The United States Department of Agriculture (USDA) may have a cost share program to provide incentives to install BMPs. A local work group madeup of farm, goverment and community representatives sets the local priorities and allocates funds to selected projects. Farms in certain watersheds or within the Chesapeake Bay watershed may be eligible for other funding as well. There are also various state programs which provide grants or low interest loans for the installation of BMPs. A farmer interested in participating in any of these funding sources can get information and direction from either the county conservation district (Appendix E) or the Natural Resource Conservation Service (Appendix F).

6.6. Monitoring for Compliance

MFEMPs should be submitted to the PA DEP Regional Water Quality Management Program.

APPENDICES

APPENDIX A

SUMMARY OF SOLID WASTE RULES AND REGULATIONS

A.1. Solid Waste Management Act

The Solid Waste Management Act, Act 97 of 1980, defines three types of solid waste: municipal, residual, and hazardous. The definition of residual waste includes refuse, other discarded material or other waste resulting from industrial, mining or agricultural operations. Section 301 of Act 97 of 1980 requires a permit prior to owning or operating a residual waste processing or disposal facility. However, Section 501 of Act 97 indicates that a permit is not required for agricultural wastes produced in the course of normal farming operations, provided that the wastes are not classified as hazardous. A "normal farming operation," is the customary and generally accepted practice engaged in by farms for agricultural production provided that such practice does not cause pollution to the air, water or other natural resources of the Commonwealth. In addition, a normal farming operation includes the management, collection, storage, transportation, use, or disposal of agricultural waste on the land where such materials will improve the condition of the soil, the growth of crops, or in the restoration of the land for the same purposes.

Liquid and solid wastes resulting from mushroom substrate generating operations and from mushroom farming operations are considered residual waste and also agricultural waste if produced on a farm.

The permit exemption applies where agricultural waste is produced, stored, processed and used on a farm. If the operation does not qualify for the normal farming operation exemption, a permit is required for any processing or beneficial use of the wastes generated.

Figures 3.1 in Chapter 3 and 5.1 in Chapter 5 demonstrate how Act 97 applies to mushroom substrate generating operations and mushroom farming operations.

Chapter 5 identifies the normal farming operation standards necessary to prevent pollution to the air, water or other natural resources of the Commonwealth. If the standards in Chapter 5 are met, and no pollution is caused, the waste management activities will be considered part of normal farming operations and no residual waste permits will be required.

A.2. Residual Waste Regulations (25 Pa. Code Chapters 287-299)

Chapter 287, Subchapter C of the residual waste regulations indicates that a permit is not required for the application of agricultural waste produced in the course of normal farming operations, provided the waste is not hazardous. In addition, the residual waste generator requirements (biennial report, annual chemical analysis and source reduction strategy) do not apply to these normal farming operations.

The following is a summary of the residual waste regulations as they may apply to the compost or substrate generating process and the storage, processing, and land application of spent mushroom substrate (SMS) in operations other than normal farming operations.

The residual waste regulations provide many opportunities through the general permit and coproduct determination to easily and legitimately reuse waste. In some instances these options may provide more flexibility for the reuse of waste than the normal farming operations exemption.

Permits

Permits must be obtained for a compost processing facility, a land application operation, a transfer facility, or for the beneficial use of SMS if the activities are not part of a normal farming operation.

A general permit can be used for facilities processing mushroom compost for distribution off a farm. A general permit is a regional or statewide permit issued by the Department for a specific category of beneficial use, the terms of which allow an applicant to operate under the general permit if the terms and conditions of the general permit are met. For example, one permit can possibly cover all compost processing operations. In addition, one general permit could be used to land apply SMS for mine reclamation. All SMS generators that have a similar quality SMS and that plan to land apply the SMS in similar operations could qualify.

Coproducts

In some instances it will be possible for SMS to be qualified as a coproduct. A coproduct is a material generated by a manufacturing process that is not a product, but can be used in lieu of a raw material or other material in the production process. A coproduct must be physically and chemically equivalent to the material it is substituting for, must present no greater risk to the environment than the material it is substituting for, and must be used on a regular basis. (See 25 Pa. Code, Section 287.1) The coproduct determination can be done by the generator or person using the material. An example of a coproduct determination appears later in this Appendix.

Once qualified as a coproduct, the SMS would not be considered a waste and could be distributed and used in accordance with the coproduct determination.

Spent Mushroom Substrate Management Examples

The following are examples of possible mushroom farming operations, and a description of how the residual waste regulations apply or may be used to facilitate reuse.

1. A mushroom farmer pays another firm/company to haul the SMS away from the mushroom farm immediately as it comes from the mushroom house.

   Whether the farmer pays to have a firm take the SMS, has a firm purchase the SMS, or gives the SMS away free of charge is irrelevant. The monetary value is not a criterion when determining applicable reuse or disposal requirements. The company or firm that hauls the SMS can use it on another farm in accordance with Chapter 5 of this manual and a permit would not be required. If not used in normal farming operations in accordance with Chapter 5, the SMS could be qualified as a coproduct by the farmer or the hauler prior to land application or other reuse. To qualify as a coproduct, the SMS could possibly be compared to an organic fertilizer, peat moss or other soil conditioner and land applied or used as such. If not qualified as a coproduct, the SMS could possibly be land

applied or beneficially used by the hauler or landowner under a general permit or individual residual waste permit.

2. A mushroom farmer gives away or sells the SMS before or after curing to surrounding landowners, landscapers or potting soil manufacturers.

   The SMS must be cured or passively composted in accordance with Chapter 5 to be considered a normal farming operation, or if not, composted or cured under a general permit. The cured or uncured SMS can be qualified as a coproduct or distributed for off-farm use under a general permit. If the surrounding landowners are farmers and are applying the SMS in accordance with the normal farming land application requirements identified in Chapter 5, no permit is required for the beneficial use of the SMS.

3. A mushroom farmer or other person transports the SMS to another farm for storage prior to selling or moving the SMS to another field for land application.

   Chapter 5 indicates that to be considered a normal farming operation, the SMS must be stored at the point of generation or on the area where land application will take place. In this instance the operation would require a transfer facility permit.

4. The mushroom farmer or other farmer stores SMS in a field prior to spreading as a soil amendment.

   If the SMS is stored at the farm field where land application will occur, and the storage and land application is done in accordance with Chapter 5, the operation would not require a permit.

5. The mushroom farmer applies SMS to farm land as it comes out of the mushroom growing room or house.

   If the SMS is applied to farm field in accordance with Chapter 5 a permit is not required.

Coproduct Determination Example

The following illustrates how to prepare a coproduct determination for the use of composted SMS in lieu of peat moss in the production of potting soil. Under the definition of coproduct in the residual waste regulations, a material is a coproduct and not a waste if the following are met: the material is chemically and physically equivalent to and used in place of an intentionally manufactured product or produced raw material, the use of the proposed coproduct presents no greater risk to the public or the environment than the material it is substituting for, and the material is used on a regular basis.

If all of the conditions are not satisfied, the material is considered a waste, not a coproduct.

1. The first step in the coproduct determination is to ascertain if the material is physically or chemically equivalent to the intentionally produced raw material it is replacing. Depending on the chemical and physical analysis of composted SMS, it may be physically and chemically similar to peat moss, which is an intentionally produced raw material. In the

table below, data from analysis of specific samples of composted SMS are compared with peat humus and peat moss.

	Concentration (mg/kg)								
ANALYSIS	As	Cd	Cr	Cu	Hg	Pb	Ni	Zn	Mo
SMS A			0.4	8.0	21.9	0.1	18.5	14.0	75.7
SMS B			0.4	6.9	39.5	0.3	25.1	13.2	99.6
SMS C			0.1	14.1	52.6	0.3	21.6	17.5	126.0
Peat Humus	19.8	1.4	2.0	2.0	3.16	13.8	4.0	12.5	4.0
Peat Moss	4.5	1.0	17.8	19.4	0.10	16.4	18.9	80.5	2.0

Note: All SMS was weathered for 9 months

In this example, the chemical analysis of the composted SMS is within a range that is considered equivalent to peat humus and peat moss.

2. The second step in the coproduct determination is a two level evaluation to ascertain whether use of the proposed coproduct will present a greater threat or harm to human health and the environment than the use of the manufactured product or produced raw material (peat moss) it is replacing.

   Both the Level 1 and 2 evaluations focus on the potential for increased threat due to differences in the chemical composition. The Level 1 test is usually based on review of the chemical analysis of the proposed coproduct. The Level 2 test goes beyond the analysis and requires evaluation of the possible routes of exposure to humans and the environment. This threat usually results from:

   - the presence of hazardous or toxic constituents (free riders) not found in the material being replaced,
   - the presence of elevated levels of hazardous or toxic constituents, and
   - increased availability of hazardous or toxic constituents due in part to the material being placed directly into the environment.

   To pass the Level 1 test, all the following must be true.

   a. There are no hazardous or toxic constituents present in the proposed coproduct in levels that are in the common range as those found in the materials it is replacing.

   b. The coproduct will not be placed directly into the environment.

   c. It is feasible to accurately sample the coproduct and the material it is replacing.

   The composted SMS does not contain hazardous or toxic constituents based on the chemical analysis above, will not be placed directly into the environment because it is used as an ingredient in potting soil, and can be accurately sampled. Therefore, in this example,

the use of composted SMS in lieu of peat moss in the production of potting soil, this aspect of the coproduct demonstration has been met.

If a proposed coproduct does not pass Level 1 or if Level 1 is not applicable, the Level 2 evaluation would have to be pursued. Level 2 applies where:

a. It is not feasible to accurately sample the proposed coproduct.

b. The proposed coproduct will be placed directly into the environment.

c. The proposed coproduct fails Level 1.

d. Free riders are present in the proposed coproduct.

3. Step 3 in the coproduct determination is to evaluate whether the composted SMS will be used on a regular basis, without accumulating significant stockpiles. Market development is often necessary in advance of a finalized coproduct determination in order to assure that the material will actually be used on a regular basis. If the material is abandoned or disposed, it loses its designation as a coproduct and must be managed as waste.

Finally, it is important to retain documentation of a coproduct determination since it is the obligation of a person producing, selling, transferring, possessing or using a material as a coproduct to demonstrate that the material is not waste.

Impoundments

The wastewater that is generated by mushroom substrate producing operations or by mushroom farms would be residual waste unless qualified as a coproduct. The following is a summary of the requirements that apply to the storage of residual wastewater in impoundments.

The residual waste regulations require all storage impoundments to obtain a permit under the Clean Streams Law. See Sections 308 and 402 of the Clean Streams Law and Chapter 299, Section 299.142 of the residual waste regulations.

The residual waste regulations require that all operating storage impoundments (existing prior to July 4, 1992) install groundwater monitoring by July 4, 2002 unless requested sooner by the Department (See Section 287.112).

The design and operating requirements for all impoundments constructed after July 4, 1992 can be found in Sections 299.141-299.145 of the residual waste regulations.

A.3. Administration of the Land Recycling Program (25 Pa. Code Chapter 250)

The regulations were developed to implement Act 2, which became effective July 18, 1995. Act 2 establishes a framework for developing remediation standards that can be applied to any release of regulated substances. Regulated substances include hazardous substances and contaminants regulated under the SWMA (35 P.S. §§ 6018.101-6018.1003), the Hazardous Sites Cleanup Act (HSCA) (35 P.S. §§6020.101-6020.1305), the Air Pollution Control Act (APCA) (35 P.S. §§ 4001-4005), The Clean

Streams Law (CSL) (35 P.S. § 691.1-691.1001), the Storage Tank and Spill Prevention Act (STSPA) 35 P.S. §§ 6020.101-6020.2105) and the Infectious and Chemotherapeutic Waste Act (ICWA) (35 P.S. §§ 6019.1-6019.6). The Environmental remediation standards established under Act 2 must be used whenever a site remediation is voluntarily conducted or is required to be conducted under one of the laws stated in this paragraph, to qualify for a release of liability. The regulations encourage the recycling and redevelopment of industrial sites, preserving existing uses of land, and encourage persons to perform cleanups by providing the opportunity for a release of liability.

A person who intends to perform a remediation in accordance with Act 2 should consult the statute, these regulations and the *Land Recycling Technical Guidance Manual (Manual)* developed by the Department.

APPENDIX B

LIST OF BEST MANAGEMENT PRACTICES[5]
NATURAL RESOURCES CONSERVATION SERVICE
FOR MUSHROOM FARM ENVIRONMENTAL MANAGEMENT PLANS

BMP NO.	COMPONENT	PRACTICE CODE NO.
1	Fencing	382
	Pasture and Hayland Planting	512
	Use Exclusion	472
2	Waste Management System	312
	Waste Storage Pond	425
	Waste Storage Structure	313
	Waste Treatment Lagoon	359
	Barnyard Runoff Control	357
	Roof Runoff Management	558
	Subsurface Drainage	606
	Filter Strips	393
	Irrigation System, Sprinkler	442
	Fencing	382
	Nutrient Management	590
	Constructed Wetlands	Limited w/State Engineer approval
	Monitoring Well Systems (Not PATG)	
	Spent Substrate Storage (Not PATG)	313
3	Contour Farming	330
	Obstruction Removal	500
	Stripcropping, Contour	585
	Subsurface Drainage	606
4	Terraces	600
	Surface Drainage	606
	Obstruction Removal	500
	Underground Outlet	620
	Water and Sediment Control Basin	638

[5] Additions, deletions and revisions are updated periodically. Check regional contact for the most recent component and practice code number.

BMP NO.	COMPONENT	PRACTICE CODE NO.
5	Diversion	362
	Obstruction Removal	500
	Subsurface Drainage	606
6	Use Exclusion	472
	Fencing	382
	Pipeline	516
	Pond	378
	Pond Sealing or Lining	521
	Spring Development	574
	Trough or Tank	614
	Well	642
7	Grassed Waterway or Outlet	412
	Lined Waterway or Outlet	468
	Subsurface Drainage	606
	Structure for Water Control	587
8	Cropland Protective System (Not PATG)	
9	Conservation Crop Rotation	328
	Residue Management	329
	Contour Farming	330
	Residue Management, Seasonal	344
	Cover and Green Manure Crop	340
10	Channel Vegetation	322
	Fencing	382
	Filter Strip	393
	Streambank & Shoreline Protection	580
	Tree/Shrub Establishment	612
11	Critical Area Planting	342
	Fencing	382
	Field Borders	386
	Filter Strip	393
	Use Exclusion	472
	Mulching	484
	Roof Runoff Management	558
	Subsurface Drainage	606
	Tree/Shrub Establishment	612

BMP NO.	COMPONENT	PRACTICE CODE NO.
12	Grade Stabilization Structure	410
	Fencing	382
	Roof Runoff Management	558
	Sediment Basin	350
	Structure for Water Control	587
	Water and Sediment Control Basin	638
13	Fertilizer, Manure and Compost Recommendations (Not PATG)	
	Manure and Spent Compost Analysis (Not PATG)	
	Soil Analysis (Not PATG)	
	Waste Water Analysis (Not PATG)	
14	Excess Manure and Compost Transportation (Not PATG)	
15	Nutrient Management	510
	Pest Management	595

Standards and specifications for the above practices are found in the Pennsylvania Technical Guide Section IV “Standards and Specifications”. This is not an all inclusive list of Best Management Practices that can be used. For further information, contact your local NRCS or Conservation District office. A 25-year and 24-hour storm event should be used as the required design storm frequency, unless another frequency is approved by the Department for such things as very small drainage areas.

APPENDIX C

PESTICIDE REGULATIONS

C. 1. GENERAL PROVISIONS

§128.2. Definitions.

General use pesticide - A pesticide not classified for restricted use.

Restricted use pesticide - The term includes the following:

(i) A pesticide classified for restricted use under section 3(d) of the Federal Insecticide, Fungicide and Rodenticide Act of 1947 (7 U.S.C.A. §136a(d)).

(ii) A pesticide designated by the Secretary for restricted use under section 7(b)(6) of the act (3 P.S. §111.27(b)(6)).

§128.3. Fees.

(a) Pesticide dealer's license. The annual fee for a pesticide dealer's license is $10.
(b) Pesticide application business' license. The annual fee for a pesticide application business' license is $25.
(c) Commercial applicator's certificate. The annual fee for the commercial applicator's certificate is $30. When the initial certification requires examination, no fee will be charged. The fee for a duplicate commercial applicator's certificate is $10.
(d) Public applicator's certificate. The triennial fee for a public applicator's certificate is $10. No fee is required when the initial certification requires examination. The fee for a duplicate public applicator's certificate is $3.
(e) Examination fees. Examination fees are nonrefundable. The following examination fees, with payment made in advance, will be charged:

(1) Commercial/public applicator's core examination $50.
(2) Commercial/public applicator's category examination $10.
(3) Private applicator's examination-no charge.

(f) Private applicator's permit. The triennial fee for a private applicator's permit is $10. The fee for a duplicate private applicator's permit is $3. No fee will be charged for a special permit which may be issued in conjunction with the private applicator's permit.

C.2. PESTICIDE DEALERS

§128.11. Recordkeeping.

(a) A pesticide dealer shall keep for each sale of a restricted use pesticide a record containing the following information:
(1) The name and address of the customer and his applicator's certificate number or business or dealer's license number.
(2) The brand name and formulation of the restricted use pesticide that was purchased.
(3) The amount of the pesticide that was purchased.
(4) The date of the purchase.
(b) A record required to be kept under this section shall be maintained for at least 3 years and shall be made immediately available to the Department upon request or immediately available to medical personnel in an emergency.

C.3. PESTICIDE APPLICATION BUSINESSES

§128.31. Licensing requirements.

(a) The license period shall end on December 31 each year, except that the Department may issue a license for the following year when an initial license application is filed during the last 2 months of a licensing year.

(b) A pesticide application business shall prominently display on every vehicle involved in the pesticide application phase of its business the license number assigned by the Department. The number shall be in figures at least 3 inches high and shall be located on both sides of the vehicle at a readily visible location.
(c) A licensed business shall notify the Department in writing within 15 days of a change in information in its application for licensing, or if it is no longer engaged in the application of pesticides.

§128.32. Categories of business licenses.

A commercial or public business shall identify in its application those business categories in which it desires to operate. A business shall employ for each business category in which it makes a pesticide application at least one applicator who is certified in a specific applicator category recognized under the general business category and shall limit its applications to those applicator categories in which it employs at least one certified applicator. The business categories are listed in paragraphs (1)-(9). The applicator categories recognized under a particular business category are listed under that business category.

(1) Agricultural Plant Pest Control.
01 Agronomic Crops
02 Fruits and Nuts
03 Vegetable Crops

§128.33. Assignment of work.

A pesticide application business may not permit an individual to make a pesticide application in an applicator category in which the individual has not been certified as an applicator or trained and registered as a technician.

§128.34. Financial responsibility.

(a) The Department will consider a certificate of insurance from an insurer or surety to be evidence of financial responsibility if the insurer or surety is licensed to do business under section 7 of the act of January 24, 1966 (P.L. 1509, No. 531) (40 P.S. §1006.7), known as the Surplus Lines Insurance Law, or otherwise permitted by Federal law or the Insurance Department to do business in this Commonwealth, if the following conditions are met:

(1) The certificate of insurance includes the name of the insurance company, policy number, insurance amount, type of coverage afforded, and exclusions relating to damage arising from the use of pesticides and expiration date of the policy.
(2) The minimum comprehensive general liability insurance provided is $100,000 for each occurrence of bodily injury liability and $100,000 for each occurrence of property damage liability. A policy may be written with combined limits if the limits equal or exceed the sum of the individual limits.
(3) The certificate indicates coverage for completed operations and includes a statement indicating that the coverage applies to pesticide application.
(4) The maximum deductible amount does not exceed $1,000 of the combined policy limits. If a pesticide application business has not satisfied the deductible amount in a prior claim, the policy may not contain a deductible amount.
(5) A current certificate of insurance is forwarded to the Department at each insurance renewal date which sets forth the same information specified in paragraphs (1)-(4).

§128.35. Recordkeeping.

(a) A pesticide application business shall keep for every application of a pesticide a record containing the following information:

(1) The date of application. For a pesticide requiring a reentry time, the date of application shall include the hour completed.
(2) The name and address of the customer and the address and location of the application site if different from the address of the customer.
(3) The brand name and formulation of the pesticides used.
(4) The amount of every pesticide used.
(5) The dosage or rate of every pesticide used.
(6) The names and when applicable the certificate or technician's registration numbers of the persons making or supervising the application.

(b) A record required to be kept under this section shall be maintained for at least 3 years and shall be made immediately available to the Department upon request or to medical personnel in an emergency.

C.4. COMMERCIAL AND PUBLIC APPLICATORS

§128.41. Requirements for certification.

A person is deemed to be a commercial or public applicator and required to be certified if one or more of the following criteria are met:

(1) A person, whether or not he is a private applicator with respect to some uses, who applies or supervises the application of a pesticide on the property or premises of another, including an easement.
(2) A person who applies or supervises the use of a restricted use pesticide on property owned by him or his employer when not applied for the purpose of producing an agricultural product.
(3) A person who applies or supervises the application of a pesticide to the following types of application:
(i) Fumigation

§ 128.42. Categories of commercial and public applicators.

A commercial or public applicator applying or supervising the application of a pesticide shall be certified in one or more of the following applicator categories:

(1) Agronomic crops - The use of a pesticide in the production of an agricultural crop, including, but not limited to, tobacco, grain, soybeans and forages and the application of a pesticide to noncrop agricultural land.
(3) Vegetable crops - The use of a pesticide in the production of vegetables, including, but not limited to, tomatoes, cabbage and celery.

§128.43. Determination of competence.

(a) For each of the categories listed in §128.42 (relating to categories of commercial and public applicators), competence in the use and handling of pesticides shall be determined on the basis of a written examination. The examination will include the following:

(1) Areas of knowledge and competence set forth at section 16.1 of the act (3 P.S. §111.36a).
(2) Safety.
(3) Labeling and label comprehension.
(b) An examination for certification will consist of two parts:

(1) One part of the examination, the core area, will be based on general information required of commercial and public applicators.
(2) The second part of the examination will be based on information related to the specific categories of commercial and public applicators.

(c) An examination shall be proctored. A person may use approved reference sources during an examination. Successful completion of the core area, and successful completion of part two of the examination in a specific category will entitle a person to certification in that category. A person desiring certification for additional categories will be required to be examined for each additional category. An opportunity will be provided to retake an examination where a passing grade has not been achieved.

(d) If a person successfully completes only one part of the two-part examination, successful completion of the remaining part of the examination shall be obtained within 180 calendar days from the date the initial part of the examination was successfully completed.

§128.44. Eligibility.

(a) A person is eligible for certification upon fulfilling the requirements under §§128.41 - 128.43 (relating to requirements for certification; categories of commercial and public applicators; and determination of competence). In addition to the requirements for a commercial applicator's certification, an aerial applicator shall have a current commercial agricultural aircraft operator's certificate issued by the Federal Aviation Administration under

14 CFR 137.19(a) (relating to certification requirements).
(b) Within 12 months of becoming eligible to be certified as a commercial applicator, a person shall file with the Department an application for certification. A person who fails to file an application within this 12-month period will lose certification eligibility and shall again establish eligibility in accordance with §§128.41-128.43. An application for initial certification will be accepted from an eligible person throughout the year. A certificate shall expire on September 30 following the date of application, except that the Department may issue a certificate for an additional year when an application is initially filed during the last 2 months of the certification year.

§128.45. Recertification.

(a) At intervals of 3 years, a certified commercial or public applicator shall provide evidence of having received current update training in technology relating to pesticides in the specific categories in which he is certified to maintain certification. Training will be divided into core and category specific areas as follows:

(1) Core
(i) Safety and health.
(ii) Labeling and label comprehension
(iii) Environmental protection.
(iv) Equipment use, calibration and dosage calculations.
(v) Protective clothing and respirator equipment.
(vi) Cleaning and maintaining equipment.
(vii) Transportation, storage and disposal.
(viii) Applicable State and Federal Laws.
(2) Category specific
(i) Identification of pests
(ii) Appropriate control measures.
(iii) Integrated pest management.

(b) Recertification credits will be given on the basis of attendance at meetings or other appropriate training approved by the Department.
(1) Training shall be conducted or sponsored by an educational institution, and individual, an association, a business or a governmental agency.

C.5. PRIVATE APPLICATORS

§128.61. Determination of competence.

(a) Competency in the use and handling of restricted use pesticides by a private applicator will be determined on the basis of a written examination. The examination will include the following:

(1) Areas of knowledge described at section 17.2 of the act (3 P.S. §111.37b).
(2) Transportation, storage and disposal.

(b) An opportunity will be provided to retake an examination if a passing grade has not been achieved.

§128.62. Eligibility.

(a) A private applicator will be eligible for a permit upon fulfilling the requirements of §128.61 (relating to determination of competence) and subsection (b).
(b) Within 1 year of fulfilling the requirements of §128.61, a private applicator shall file with the Department an application for a permit accompanied by the appropriate fee. A person who fails to file within this 1 year period shall again establish eligibility under §128.61.
(c) A private applicator will be issued a numbered permit which shall be used by the applicator when purchasing a restricted use pesticide.

§128.63. Recertification.

(a) At intervals of 3 years, a private applicator shall have accumulated credits as a result of having received update training approved by the Department in technology relating to the proper and safe use of pesticides to continue as a permitted private pesticide applicator. Training will be divided into core and category specific areas as specified in §128.45(a) (relating to recertification).
(b) Recertification credits will be given on the basis of attendance at meetings or other appropriate training approved by the Department.
(c) If a private applicator fails to renew his permit by the date of expiration, renewal requires the following:

(1) Completion of due recertification credits as described in subsections (a) and (b).
(2) Completion of the examination requirements as described in §§128.3, 128.61 and 128.63 (relating to fees; determination of competence; and eligibility) by the applicator if the due recertification credits are not completed within 1 year from the expiration date of the permit.

§128.64. Fumigation by a private applicator.

(a) In addition to the requirements in §128.61 (relating to determination of competence), a private applicator using structural, commodity and space, or soil fumigant shall demonstrate competence in the proper and safe use of these pesticides. Competency shall be demonstrated by passing a written examination specifically relating to each type of fumigant the applicator intends to use.
(b) A special permit will be issued, relating to fumigation, and will be valid for a 3-year period. No fee will be charged for this special permit. No special permit will be issued for the use of a fumigant unless the applicant has a private applicator's permit.
(c) Recertification requirements shall be met through attendance at approved meetings and shall consist of at least two credits of category specific education relating to the appropriate area of fumigation in which the applicator is certified. The credits obtained by a private applicator to meet the requirements of this subsection may also be used to meet the requirements of §128.63 (relating to recertification).

§128.65. Recordkeeping.

(a) A private applicator shall keep for each application of a restricted use pesticide a record containing the following information:

(1) The date of application. For a pesticide requiring a reentry time, the date of application shall include the hour completed.
(2) The place of application including the name and address of the farm and the specific field or land area and the crop treated.
(3) The brand name and formulation of every pesticide used.
(4) The amount of every pesticide used.
(5) The dosage or rate of every pesticide used.
(6) The names and, when applicable, the permit numbers of the persons making or supervising the application.

(b) A record required to be kept under this section shall be maintained for at least 3 years and shall be made immediately available to the Department upon request or immediately available to medical personnel in an emergency.

§128.91. EPA registration required.

Only a pesticide with an approved EPA registration will be accepted for registration by the Department.

§128.92. Special local need registration.

(a) Special local need registrations are subject to approval by the Department for pesticides currently registered for use in this Commonwealth. A special local need label shall conform with 40 CFR 162.153
(e) (relating to state registration procedures).
(b) A copy of the proposed special local need use label, supporting data and a statement verifying the existence of a special local need shall be submitted with the completed form provided by the Department for special local need registration.
(c) A pesticide registered under this section may be canceled by the Department or by the EPA.

§128.101. Reporting of pesticide accidents.

(a) The Secretary has designated the Department as the State agency to which significant pesticide accidents or incidents shall be reported.
(b) An applicator, a pesticide application technician or another person who has knowledge of a significant pesticide accident or incident shall report it to the Department.
(c) As used in this section, the term "significant pesticide accident or incident" means an accident or incident involving a pesticide which creates a danger to human beings or results in damage to plant or animal life.
(d) This section does not supersede the reporting procedures of other statutes or the regulations promulgated thereunder.

§128.103. Handling, transportation, storage, use and disposal of pesticides.

(a) A person may not use, handle, transport, store, display or distribute a pesticide in a manner that endangers man or his environment or contaminates food, feed, feed supplements, medications, fertilizers, seed or other products that may be handled, transported, stored, displayed or distributed with the pesticides.

(b) A person may not use, or cause to be used, a pesticide inconsistent with its labeling. A pesticide label containing an advisory instruction concerning the use of the pesticide being an environmental hazard shall be considered by the Secretary as a further restriction on the pesticide's use.

(c) An application of a pesticide may not be made where weather conditions are such that it can be expected that the pesticide will move off of the proposed application site.

(d) A person may not dispose of, store or receive for disposal or storage a pesticide, pesticide container or pesticide container residue in a manner that does one or more of the following:

(1) Is inconsistent with its label or labeling.

(2) Causes or allows the open dumping of pesticides or pesticide containers. Open burning by the owner of small quantities of combustible containers that do not exceed 50 pounds is exempt if the pesticide residue does not contain organic mercury, chlorates, lead, cadmium or arsenic compounds and Commonwealth or local regulations permit the burning. When the burning takes place, regard shall be giving to wind direction in relation to the protection of crops, animals and people from pesticide vapors created through burning.

(3) Causes or allows dumping of pesticides in a stream, river, pond, sewer or lake, except in conformance with permits issued jointly by the Department of Environmental Resources and the Fish Commission, or other Commonwealth agencies having jurisdiction regarding water pollution.

(4) Violates an applicable State or Federal pollution control standard.

(e) A person shall dispose and store pesticides, pesticide containers and pesticide container residue in accordance with acts and regulations administered by the EPA and the Department of Environmental Resources.

APPENDIX D

THE PENNSYLVANIA FERTILIZER, SOIL CONDITIONER AND PLANT GROWTH SUBSTANCE LAW

The Pennsylvania Department of Agriculture, Bureau of Plant Industry, Division of Agronomic Services administers the Pennsylvania Fertilizer, Soil Conditioner and Plant Growth Substance Law. The Act regulates all products that are sold or distributed in the Commonwealth as a fertilizer, soil conditioner or plant growth substance.

Every person who owns or operates a manufacturing facility producing fertilizer, soil conditioners or plant growth substances and each guarantor of these products which are offered for sale or distributed in the Commonwealth shall obtain an annual license.

Products sold in the Commonwealth as a specialty fertilizer, soil conditioner or plant growth substance must be registered with the Department of Agriculture. The application for registration of specialty fertilizers shall include the following information in the following order:

(1) The net weight

(2) The brand and grade

(3) The guaranteed analysis

- a. Total Nitrogen %
- b. % Ammoniacal Nitrogen (if claimed or required)
- c. % Nitrate Nitrogen (if claimed or required)
- d. % Water Insoluble Nitrogen (if claimed or if the statement “organic” or “slow acting nitrogen” is used in the label)
- e. Available Phosphoric Acid (P_2O_5) %
- f. Soluble Potash (K_2O) %
- g. Additional Plant Nutrients as prescribed by regulation %

(4) The name and address of the person guaranteeing the fertilizer.

The application for soil conditioners or plant growth substances shall include the following information in the following order:

(1) The net weight or other measure prescribed by regulation

(2) The brand

(3) An accurate statement of composition and purpose

(4) The name and address of the person guaranteeing the soil conditioner

Different brand and grades of product, including different blends require separate registration. A current copy of label must be submitted with the registration.

For specific information on licenses or approvals that apply to your distribution or marketing operation, please contact:

Pennsylvania Department of Agriculture
Bureau of Plant Industry
Division of Agronomic Services
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APPENDIX E

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[6] This listing is subject to change. The most recent office and contact may be checked in the telephone book, blue page under Government, Federal or in a shared file folder maintained by the Bureau of Water Quality Protection.

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APPENDIX H

PEST MANAGEMENT FOR MUSHROOM FARMS

The Mushroom Integrated Pest Management (IPM) Program can be described in terms of the five steps involved:

1. Acquire pest information.

2. Monitor the farm environment, including climate, disease, immature insect and adult insect populations, and grower/growing practices.

3. Make decisions based on the actual or potential damage levels.

4. Use IPM techniques and tools to control pest populations.

5. Consider the mushroom farm Community.

H.1. ACQUIRING PEST INFORMATION

Effective pest management is based on accurate knowledge about the organisms to be managed. It is essential to know the biology and behavior of insects and the conditions which favor colonization and spread of disease pathogens.

Insect Pests.

Two insect pests of commercial mushrooms are considered: *Lycoriella mali* (Fitch), a Sciarid or darkwinged fungus gnat, and *Megaselia halterata* (Wood), a Phorid or humpbacked fly.

Lycoriella mali, commonly referred to as the Sciarid or "big fly," passes through four stages in its life cycle -- egg, larva, pupa, and adult. The latter three stages are easily seen without a handlens, but magnificent is required to see the eggs.

Sciarid eggs are smooth, oval, whitish and translucent; as they develop, the distinctive black head capsule of the larva becomes visible. Phorid eggs are also whitish, but oblong and concave. Eggs of both flies are deposited in compost.

Sciarid larvae are translucent white, segmented, and have a black-headed capsule. Four full-grown larvae laid end-to-end cover a span of 1 inch. Phorid larvae are also whitish and segmented, but do not have the external black head capsule. Phorid larvae resemble the house fly maggot --- blunt on the rear end and tapered on the front end, but considerably smaller. Six mature Phorid larvae laid end-to-end measure 1 inch. Sciarid larvae are often found inside the mushroom stem while Phorid larvae remain in the compost.

The pupae of the two flies differ considerably: Sciarid pupae have barely visible legs which hang loosely. Phorid pupae have a "cocoon-like" appearance. Both species pupate in the compost.

The adult -- or fly --- stage of the two species differ in several respects. Female Sciarid flies are larger and more rotund than the humpbacked adult Phorid and have antennae that are easily seen. Antennae on the Phorids are difficult to see. (A caution on identification by size alone; Sciarid males are about the same size as an adult Phorid.) Form of adult movement is also a clue to identification --- Phorids move with quick jerky movements, while Sciarid movement is less erratic.

Besides knowing what flies are present, growers should know something about the development time needed for an insect to evolve from one stage to another; this varies greatly with temperature for each insect. To review a few general characteristics of common insects in mushroom growing operations:

1) Egg-development time is longer for the Sciarid;

2) Larvae-development time is longer for the Sciarid;

3) Pupae-development time is longer for the Phorid; and

4) Total generation time is longer for the Phorid.

Both species exhibit behavioral patterns significant to a management program. Sciarids enter the mushroom house during Phase II cooldown as soon as the air temperature drops to below 110°F; they lay their eggs on the unspawned compost. Phorids infest the house only after the beds or trays have been spawned, the greater numbers entering 4 or 5 days after spawning and to a lesser extent after casing. Phorids lay eggs only on spawned compost. Lastly, adults of both species are attracted to light, especially fluorescent black light, with the exception of the Sciarid adult male which is not attracted by light.

Pathogens

Disease causing pathogens also have distinctive characteristics. The two diseases considered in this section are Verticillium spot and dry bubble caused by *Verticillium fungicola* Gams, and bacterial blotch caused by Pseudomonas fluorescens, biotype Va (*P. tolaasii*). There are other very significant diseases not included, well known to mushroom farmers as menaces. Information on them must come from another source.

Verticillium disease has several recognizable symptoms. An often-encountered symptom is dry bubble, the disrupted growth of a pin or button into a ball-like mass, generally the size of a grape or a bit longer. Another common symptom is stem (stipe) “blow-out” -- the stem shatters and the cap tilts slightly. Many times the fungus pathogen can be seen fruiting on infected tissue of the cap where it appears as a grayish hue in the infected area. A less recognized form of the disease is called fly speck or spot. Spots develop when the pathogen infects a single site on the cap which developed into a discrete spot. The pathogen arrives on the cap in splashed water or on hands or tools of a picker. The fungus usually enters a growing room via casing that is not adequately treated, on infested tools and picking instruments, and dust particles in the air; it can also be carried in by flies and on the clothing of workers. When present, the severity of disease may range from a trace to a yield loss of as much as 70 percent of the crop. Even if yield is not reduced, infected mushrooms are spotted or deformed and thus penalized in terms of quality. Verticillium disease is the most frequently occurring and serious fungus disease of the commercial mushroom.

Blotch is caused by bacteria on the mushroom cap. Blotch often appears on the sides and lower edges of the mushrooms. Typically, blotch has a bronze color, but cap splitting or a yellowish cast on the cap may

be signs of the disease. On very rare occasions the disease can cause the stipe of the mushroom to turn back and shatter, and the cap may also blacken. The pathogen needs a wet cap for 6 to 12 hours for disease to occur.

Keeping the biology, behavior, and requirements of the pests in mind is important in designing and executing a management program.

H.2. MONITORING THE FARM ENVIRONMENT

Identifying pests is but one phase of a successful pest management (control) program. Information regarding when colonization occurs, the size of the initial population, and predictions on the future size of the pest population are an integral part of any management program. Monitoring pest populations provides this information.

Adult Insect Monitoring

The fourth type of monitoring involves assessing population levels of the adult female Sciarid and adult male and female Phorid; the adult male Sciarid is less easy to monitor as it rarely flies. Monitoring is accomplished by using a fluorescent black light as an attractant and a sticky surface or water to retain the flies. Monitoring adult insects serves several purposes.

1. Identifies the fly species present in the room, thus allowing for specific control measures.

2. Identifies invasion sites. Generally, the wharf end of a room, at the upper level, has considerably more flies than does the breezeway end. However, in severely cold weather, breezeways often serve as a bridge for fly movement between rooms.

3. Identifies when flies enter a room. This knowledge makes it easier to select the optimum time for corrective action. Growers will say no flies are around until after casing. Actually, flies appearing after casing generally are first generation flies from eggs laid 12 to 18 days earlier, not invading adults.

4. Evaluates present management programs. Comparisons can be made in control strategies from room-to-room, crop-to-crop, grower-to-grower, or season-to-season.

H.3. DECISION MAKING BASED ON THE DETERMINATION OF ECONOMIC LEVELS OF DAMAGE

Monitoring to estimate pest levels is one step in the direction of maximizing the return on pest management dollars. An integrated pest management system may call for either smaller pesticide quantities or fewer applications, both of which will reduce costs. Correct timing of applications is critical to pesticide performance. Flies alight on exterior walls at sunup and sundown, so this is when to apply exterior insecticides for maximum effectiveness. From another vantage, applying preventive sprays, fogs, or dusts before cropping begins limits the increase in disease and insect populations during harvest. Both of these timing considerations have profound economic implications, but more specific information is not currently available.

Additional data are needed before pesticide usage recommendations can be based on a cost vs. benefit basis. Two economic plateaus need to be defined:

1) ECONOMIC INJURY LEVEL -- the number of pests which, if not controlled, will result in economic loss; and

2) the ECONOMIC THRESHOLD LEVEL -- the minimum number of pests needed before control measures are initiated.

The ECONOMIC THRESHOLD LEVEL is also called the ACTION LEVEL and it occurs early in the crop and is the point when preventive chemical controls should be applied. These economic thresholds assume a mushroom farmer can predict crop yields. Such information is vital in deciding if income from additional crop yields will offset the cost of additional pesticide applications. Unquestionably, an economic-based integrated approach to pest management requires more information than is now available. Also required are pesticide and management skills to effect this system, as it is not based on routine pesticide applications.

H.4. DETERMINING PESTICIDE NEEDS AND ASSESSING EFFECTIVENESS

The point at which the number of flies in a growing room justifies the use of an insecticide is the ECONOMIC THRESHOLD. It varies with the stage of the crop. The ECONOMIC THRESHOLD also involves the crop loss anticipated when contrasted with the cost of pesticide usage. With so many factors affecting the ECONOMIC THRESHOLD, there is little wonder that it is not constant and varies from one season to another and from one grower to another.

Assessing Effective Insecticide Usage Via Monitoring

Effectiveness of insect management programs can be assessed via monitoring. Counts of adult insects from a pest management fly monitor (PMFM) provide a measure of a pest management program's effectiveness. Inspecting growing and harvested mushrooms also provides a basis for assessing the effectiveness of a pest management system. Monitoring the frequency and density of pest populations and the effects they cause allows a farmer to evaluate the effectiveness of his current pest management practices.

H.5. TECHNIQUES AND TOOLS TO MANIPULATE PEST POPULATIONS

The fourth procedure involved in the execution of Mushroom IPM is not actually a step, but rather the selection, integration, and implementation of several individual control techniques into a system. Some tools and techniques are well known and readily available to growers.

1. Fly Exclusion

The most effective way to deal with flies is to fly proof against invading adults. Cracks in walls, around air conditioners, and pipes are usual routes of initial fly invasion. Netting over doors and limiting the amount of traffic into a room at critical times greatly reduces the possibility of infestation. A 100-mesh or finer nylon screen installed over fan intakes, vents, doors, and other openings keeps flies out. When the screening is properly installed, flies cannot crawl under or around it. Install screening before Phase II composting begins and fasten the screen with batten strips, held tight with short nails or staples. Remember, screening on a fan reduces the amount of air the fan moves, so such adjustment in air volumes may be needed to supply the compost or crop with enough air.

2. Control of Phase II

Compost and air temperatures in excess of 130°F for a few hours kills flies at all stages. Temperatures of 140°F for 3 or more hours kills most disease and weed-mold fungi. Monitoring the air and compost temperatures during the pasteurization stage of Phase II composting insures the elimination of unwanted pests. After pasteurization, it is imperative to keep a pasteurized room (compost) free of pests as reintroduction neutralizes the positive effects of pasteurization.

3. Short Spawn-run and Casing

Required are fewer days at 75°F, optimum spawn running temperature or lower spawn run temperatures, more time needed by larvae to evolve into mature adults, and more time needed for one generation to complete its life cycle. Spawning must be a very sanitary operation. Workers' clothes and shoes must be clean and free of debris as is true for tools and equipment. Spawning should be the first job of the day.

Plastic on Mushroom Beds

Clear polyethylene film (1 to 2 mil) protects compost from infestation but eggs can be laid on the edges of compost not covered by plastic. A pesticide drench to the edges may be needed if monitors indicate flies are present.

Casing

Casing soil may be pasteurized to kill pests harmful to the mushroom crop. Most insects die at 130°F, but higher temperatures (140°F for 60 min) are required to kill some pathogens. After treatment, soil must be stored in a clean, closed building or covered with clean polyethylene film.

The number and kind of nematodes in peat moss varies with the location of the peat bog. Some peat moss packaged in sealed plastic bags and stored in a dust-free area may not require pasteurization before use. However, assess peat moss for the presence of nematodes before deciding if pasteurization is not necessary. Moisten the peat moss, hold at room temperature for 14 to 18 days, and assay for nematodes; dry, bagged peat may only contain eggs and the presence of eggs without larvae (worms) may result in a faulty conclusion.

4. Sanitation

Good sanitation practices eliminate breeding and roosting sites of insects. Remove or neutralize decaying organic matter (stumps and trash), stagnant water, rubbish, and garbage. Minimize dust around the farm by salting, paving, or oiling driveways and directing vehicles away from the growing room.

5. Crop Termination

Fly control at the end of the crop is equally important to that during cropping. Before removing the spent compost from rooms, wet the surface, walls, and woodwork and raise the compost temperature to 140°F for at least 4 hours. Flies in an infested room try to escape when the air temperature reaches 100°F and higher, so keep all cracks sealed and doors and vents closed; keep

the flies in the room so the steam kills them. Finally, pasteurize the emptied house (with the boards laid out) at 160°F for 6 hours or 150°F for 8 hours.

6. Pesticide Use

Pesticide usage might be restricted to events, suggesting the Economic Threshold level of damage will occur as determined by the use of monitors. Insecticides have value when used at the end of a crop, before pasteurizing, to prevent fly movement between rooms. Application of insecticides should be restricted to the time of day when peak fly movement occurs inside a growing room when adult flies are the target. Larvacides must be applied when larvae are susceptible for maximum effectiveness. Outside sprays are most effective when flies are resting, swarming, and roosting.

H.6. BROAD CONSIDERATIONS OF THE MUSHROOM FARM COMMUNITY

Finally, consider the entire mushroom farm community as an agroecosystem. An isolated farm has the best chance of quickly controlling pest problems but mushroom farming is not always an isolated business, and some isolated farms have continuing pest problems. Far too often, the pest management practices of one farm affect pest problems at another farm. Each room, block, and farm probably has a certain number of pests, called the background population. These populations are specific for each farm and will vary from crop to crop and season to season. Breezeway and outdoor monitors aid in establishing the background levels of insect populations. One reason background populations may vary is the direction and speed of the wind. Wind at peak periods of fly activity will carry some of the flies downwind, producing an increase in the size of the downwind background populations. The wise pest management manager should be aware of his neighbor's practices and problems and adjust his programs to anticipate expected problems from off-farm sources. The most effective management program can be amplified or negated by phenomena occurring somewhere else.

H.7. CONCLUSION

IPM works, and monitoring is the key to its success. Second, grower-to-grower cooperation can only aid in better management practices. The sharing and consolidation of knowledge gained by experience, mostly years of observation and experience coupled with precise record keeping, can greatly improve present pest management programs. Knowledge not shared is eventually lost and then needs to be rediscovered. Foresight, cooperation, and a willingness to accept new ideas will permit the use of integrated pest management and progress from the Pesticide Age to an age of more enlightened and more effective pest control.

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