A dairy manure handling system is a cost item that must meet many requirements. The ultimate goal of a manure handling system should be to improve management, provide positive environmental protection, and allow maximum utilization of manure nutrients. The best manure handling systems are usually developed as part of an overall plan for new construction, renovation or expansion. A well-planned system will be compatible with the type of housing and will include manure and wastewater from outside animal areas, the milking center, young stock facilities, and silage effluent. It should also be compatible with anticipated changes in housing and management over the next 8-10 years.

An integral part of an effective manure handling system is having adequate cropland available to utilize the manure nutrients or an alternative outlet for extra nutrients. Dairy expansions that include large increases in purchased feed and no increase in cropland often result in over application of manure nutrients. Manure handling systems, especially storages holding large amounts of manure, are a threat to the environment. Any good manure handling system will include backup plans to allow continuous operation even if key components malfunction. Advanced thought should be given to how a large manure spill, resulting from a damaged storage or broken pipe, can be contained before large quantities of manure reach nearby streams or lakes.

Hazards

Manure systems present hazards from asphyxiation, poisoning, drowning, and machinery entanglement and entrapment. Pumps, pits, and tanks can easily contain poisonous gases that will not be apparent until someone enters the tank and is overcome. Multiple deaths have occurred as a result of failure to follow appropriate procedures for working in these confined spaces. **Do not enter manure sumps, pits or storage tanks without appropriate safety apparatus and procedures.** No tool, pump part, or farm chore is equivalent in value to the cost of a human life!

Another common hazard is failure to provide adequate guarding at manure tank openings and push off ramps to prevent entry by people, tractor scrapers, or cows. All open storages or openings into storages must have adequate fencing, guards, or covers to prevent visitors, including small children, from gaining entry. **Everyone has an obligation to design, supply, buy, operate, and maintain manure storage and handling systems that are safe for workers and visitors.**

Handling Systems

A complete system allows for collection and removal of manure from the animal housing areas, treatment if necessary, transport to storage system, short and long term holding or storage, transport to cropland, and land application.

**Collection systems** include gutter cleaners and gravity flow channels in tie stall dairy barns and tractor scrapers, automatic alley scrapers, flushing, and slotted floors in freestall dairy barns. Outside yards, lots, and feeding areas can be cleaned with scrapers or in some instances flushing. Bedded pack and pen areas should be designed to allow cleaning with tractor loaders. New and major renovated pack areas should have sufficient access and clearance to allow use of large front end loaders for pack removal.

Scrapers with rubber edges or made from sections of large rubber tires provide less wear and polishing of concrete and tend to squeegee the floor. Metal blades or buckets with down pressure are more effective under freezing conditions. Manure may be pushed off an elevated lip directly into a spreader or pushed into a storage or collection gutter. In some cases it is pushed to an area with a buck wall for loading with a bucket loader.

Automatic freestall alley scrapers are often cost and labor savers on large farms and frequent operation provides cleaner alleys and cows. The cost and time required for maintenance of alley scrapers is often less...
than the total cost (labor, machinery, maintenance, injured animals) of daily tractor scraping. Unattended operation of alley scrapers where very small or new born calves could be dragged away by the slow moving blade is not recommended. Alley scrapers must discharge through a hole, over a collection channel, or off the edge of a storage. The drop off point for the manure must be located and protected to assure that people, animals or equipment will not inadvertently fall in.

Flush cleaning is a low labor method that allows for frequent cleaning and results in drier alleys and cleaner cows. Important components of flush systems are adequate water supply, water disposal system, elevations, slopes, pumps and pipes. Systems can successfully operate much of the year, even in cold climates, if adequate facilities are available to take care of storage of extra water. The most common problems with flushing systems are the quantity of water required and separating solids for reusing water. Farmers are often overwhelmed by the amount of water that must be handled and the need for more dilution water in recirculating systems than expected. Criteria for satisfactory flushing include water volume per flush, flow rate, duration of flush, velocity of water, and depth of water. In general, a 3 inch depth of water and 5 feet per second velocity are recommended. A 3% alley slope is often considered ideal. Steeper slopes will require more water and a higher flow rate, shallower slopes will require a high rate of water to maintain velocity. Water can be supplied from tip tanks, reservoirs with large gates that open or delivered through large pipes from high volume pumps or elevated holding tanks or ponds.

Slotted floors provide a method for immediate removal of manure from the animal area. Once beneath the floor, manure may be stored in an underfloor tank or removed by an automatic scraper, flushing, or a gravity flow channel. Manure stored under slats can result in gas, odor and moisture problems in enclosed barns and should be avoided. Keep animals and people out of enclosed barns and provide maximum ventilation during agitation and clean out if a manure tank is located under the slats. Floors may be configured with long parallel slats and slots, or oblong holes in a so called waffle pattern. Field observations indicate that animals seem to walk more surely on waffle slats but no research is available concerning either configuration. Slatted floors allow urine to drain quickly away and manure is pushed through the slots by animal traffic. The result is a drier environment for the cows’ hoofs. If used in extremely cold situations manure will eventually freeze and not go through the slots. Provide access for a tractor scraper to remove manure during cold weather.

Removal systems move manure from the barn to the field for immediate application or to storage. For immediate field application the manure may be loaded directly into a manure spreader from a gutter cleaner discharge or push off lip, or loaded with a front end loader. More liquid manure may be pumped from a collection channel, sump, or small tank that holds a day or two manure accumulation. If manure is to be pumped into a liquid spreader, wastewater from the milking center is usually included to make agitation and pumping easier. Manure can be conveyed to a
storage located at the barn by the gutter cleaner, tractor scraper, large piston pump, centrifugal pump, gravity flow pipe or gravity flow channel. Manure can be transported to satellite storages located away from the barn by trucks, large spreaders or pipelines.

**Manure storage systems** may be located at the barn or near the cropland that will receive the manure. If manure must be transported long distances, it is often more effective to provide satellite storages near the cropland. This allows the manure to be hauled to the storage during low labor periods and makes for more efficient spreading. Liquid manure, especially if solids have been removed, can be pumped long distances to satellite storages.

The storage must be compatible with the form manure is removed from the barn. Heavily bedded manure can be easily stacked in three sided bunker type storages or on simple hard surfaced or packed gravel pads. Storages should be designed to prevent clean water from running into them and to direct any leachate or runoff water from the storage away from streams to vegetative filter areas or holding ponds.

Liquid manure can be stored in properly designed concrete or steel tanks, concrete or membrane lined in ground storages and in some cases earth storages. It is critical that storages be located and constructed to assure that manure will not seep through storage walls or bottom to ground or surface water. Consult the USDA Soil Conservation Service or a qualified soils engineer regarding location and design of in ground manure storages. An annual inspection and maintenance program should be in place to assure continued safe operation of any type manure storage. **Liquid storages require appropriate signs, guards and fences to protect workers and visitors from unintended entry and possible loss of life.**

**Treatment Systems**

**Solids separation** will allow easier handling of liquid material, allows for recycling of water for flushing, and can provide a useful by-product. Separation systems can be categorized as gravity, screens, extruders, and cyclones. Settling tanks or basins use gravity and time to allow larger particles of liquid manure to settle or float out. Screens normally require some method to prevent particles from plugging or blinding the screen. This may be accomplished by sloping the face of the screen so material slides off or with mechanical scraping or vibration. Screens require a dilute material similar to that obtained with flushing systems. Extruders use screws, plungers, or belts to pack manure against a perforated cylinder, box, belt or plate. Liquid is forced out through the holes and the solids are discharged out the end. These devices tend to provide a drier solid and some will work with a less dilute, slurry consistency manure. Cyclone separators are similar to dust collectors. A very dilute flow of manure is introduced into a conical chamber that encourages large particles to move to the outside and allows liquid to pass through the middle. These separators are not common in dairy manure handling systems.

**Anaerobic digestion** or biogas production has been used by some large farms as a method to extract energy from manure and reduce odor that results from long term liquid storage. The biogas process converts complex organic material such as manure into biogas and low odor effluent. A heated digester with a 15-25 day detention time is normally required. The primary constituents in biogas are methane (natural gas), carbon dioxide and trace gases. Originally the primary interest was in energy production, usually electricity. Economics tended to favor farms with more than 200-400 cows. Even at this size most farmers chose not to bother with the extra expense and management requirements. Recently there has been interest in biogas digesters as a method to solve odor and nuisance problems associated with storing and handling large quantities of dairy manure. The process does not significantly reduce the amount of manure or the nutrient content, but does alter the form of the nitrogen. The effluent will be more liquid and homogeneous as a result of the digestion process.

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**DANGER**

DROWNING HAZARD!

SURFACE MAY BREAK THROUGH

KEEP OFF SURFACE

**DANGER**

DEADLY MANURE GASES POSSIBLE

ENTER PIT ONLY WITH:
- **SELF-CONTAINED AIR SUPPLY**
- **VENTILATION**
- **RESCUE HARNESS, MECHANICAL LIFT, STAND-BY PERSON**

Samples of manure storage warning signs that are available. Place one sign at each entrance/access point to a manure storage.
Composting is another form of treatment that dairy farmers are considering to reduce the odor and nuisance problems associated with dairy manure. Composting is an aerobic process that requires a material with good porosity, 40-60% moisture content and proper carbon to nitrogen ratio. Some form of mixing and or aeration is required to provide satisfactory composting. The process generates its own heat, reaching temperatures of 120-140°F. When properly done, composting will eliminate most odors and result in a stable easily handled dry humus like material. Most dairy manure requires some form of dry carbonaceous material such as straw, sawdust or wood chips to maintain the desired moisture content and carbon nitrogen ratio. Some dairy farmers have found an additional income source by charging municipalities or industries to take materials such as paper, cardboard, tree trimmings, etc. This is then mixed with the manure and after composting either spread on land or sold as compost.

Summary

Anyone considering major changes in manure handling or dairy housing should give careful thought to the various components of a complete manure handling system. A change in housing method from a heavily bedded tie stall barn to a freestall barn may render existing manure handling equipment useless. Large increases in cow numbers without an increase in land to spread manure on may result in application of manure nutrients at levels exceeding the crop removal rate. General guidance and requirements for handling manure in Pennsylvania is found in the Department of Environmental Resources publication *Manure Management for Environmental Protection*. Material and ideas about manure handling systems are available from cooperative extension offices, conservation district offices, Soil Conservation Service offices, equipment suppliers, builders, land improvement contractors and other farmers. Visit farms that have similar situations to yours and learn how the system is working. Any of the above individuals can help you locate farms to visit. A well planned manure handling system can result in a more efficient and environmentally friendly dairy.

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