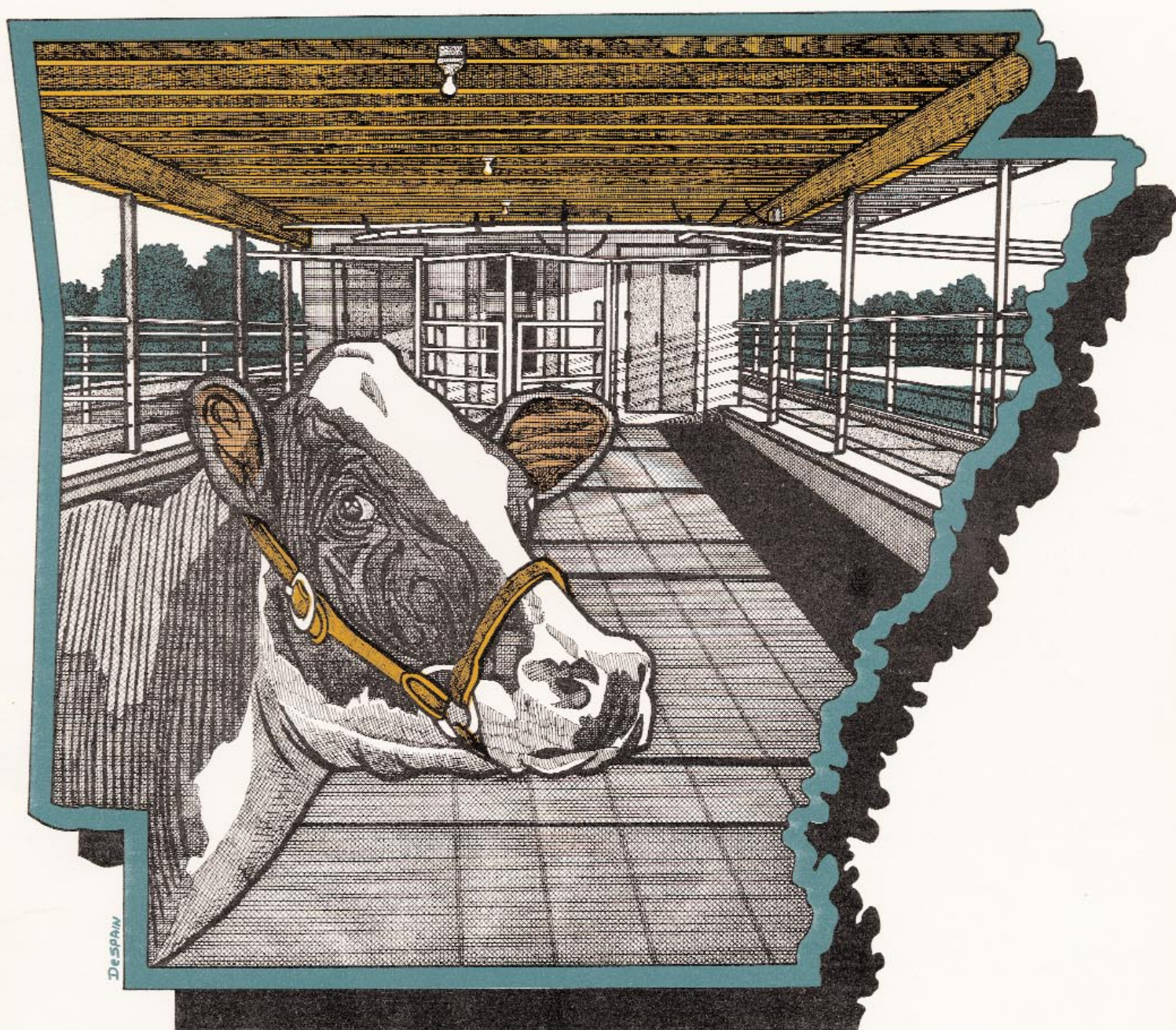


DAIRY MANURE and MILK CENTER WASH WATER MANAGEMENT



COOPERATIVE EXTENSION SERVICE, University of Arkansas, United States
Department of Agriculture and County Governments Cooperating

ARKANSAS DAIRY MANURE AND MILK CENTER WASH WATER MANAGEMENT

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INTRODUCTION

Good management is essential for dairy producers to remain profitable. Management includes record keeping, feeding for economical milk production, maintaining cow health, raising heifers, breeding cows, proper use of labor and sound manure management. Historically manure and milk center wash water management has been a low priority on many Arkansas dairies. However, with increasing public concern about the impact of animal manures on the environment and human health, it is in the dairy industry's interest to give the management of these potential pollutants a higher priority.

This publication provides dairy producers with information that will help them to voluntarily implement management practices for manure and the milk center wash water. Additional printed material and personal assistance is available at local county Extension offices and local Natural Resources Conservation Service (NRCS) offices.

■ Benefits of Manure Management

Proper manure management allows dairy producers to enhance the appearance of their facility, reduce the potential of the spread of diseases, increase milk production and use the manure as fertilizer. Also, many diseases in the livestock industry such as paratuberculosis (Johne's Disease), mastitis, leptospirosis, foot rot and others can be spread through fecal contamination. Proper manure management reduces the exposure of animals to these harmful diseases, which should result in less stress on the animal and a more productive, more profitable animal. With properly implemented manure management, the potential for pollution is minimized while milk production and the economic benefits of manure are maximized.

■ Potential Concerns

There are approximately 55,000 cows on 650 dairies in Arkansas. With a 1,200-pound cow producing about 98 pounds of manure a day, Arkansas dairies produce an estimated million tons of manure per year. If not properly managed, the volume of manure produced and deposited in the vicinity of the milking center (approximately 15 percent of the total volume) can have a negative impact on the environment. The potential for negative impacts of manure on the health and comfort of both humans and cows is also a concern. Milk center wash water is a source of concern because it contains milk solids, fat, casein, detergents, manure, soil particles and other substances. Due to its more dilute nature, the potential for wash water to cause problems is usually much less than for manure.

Table 1. Typical values for dairy manure production and characteristics on an as-excreted basis.

Animal	Size	Total Manure Production			Water	Nutrient Production, lb/day		
		lb.	lb/day	cuft/day		gal/day	%	N
Heifer	150	12.75	0.20	1.46	89	0.05	0.01	0.04
	250	21.25	0.33	2.43	89	0.08	0.02	0.07
	500	42.50	0.65	4.86	89	0.16	0.05	0.15
Dry Cow	900	73.80	1.17	8.75	88	0.32	0.10	0.25
	1,000	82.00	1.30	9.73	88	0.36	0.11	0.28
	1,200	98.40	1.56	11.67	88	0.43	0.14	0.33
	1,400	114.80	1.82	13.62	88	0.50	0.16	0.39
Lactating Cow	900	72.00	1.17	8.75	88	0.41	0.14	0.28
	1,000	80.00	1.30	9.73	88	0.45	0.16	0.31
	1,200	96.00	1.56	11.67	88	0.54	0.19	0.38
	1,400	112.00	1.82	13.62	88	0.63	0.22	0.44

Environmental Concerns

The primary environmental effects of proper manure management deal with maintaining the quality of surface and ground water. Manure contains nutrients and organic matter that normally benefit the environment, but if improperly managed, can reduce water quality. One source of potential problems is the nitrogen and phosphorus in the manure or the milk center wash water. Excess nutrients can increase the fertility of the water resources to the point that the amount of algae and aquatic plants in surface water are increased. Minor increases in vegetative growth can cause the plant and animal species in the water to change. The added algae and aquatic plants can also reduce the appearance and recreational use of streams and rivers. Decaying organic matter, from either the manure or the increased vegetative growth, can potentially reduce the amount of available oxygen. If enough available oxygen is reduced, a fish kill is possible.

Human Health Concerns

Groundwater quality can be reduced if nutrients, primarily nitrates, from manures leach to groundwater supplies. This access is possible if holding ponds are not properly sealed or if manure is applied too closely to sinkholes or rock outcroppings. High nitrate levels in drinking water may lead to health problems such as methemoglobinemia ("blue baby"), especially in young infants. While there have been no officially reported cases of "blue baby" in Arkansas, cases have been reported in other states.

Animal manures can also cause health problems due to the microorganisms in the manure. A class of microorganisms commonly a source of concern is fecal coliforms. These bacteria are found in the digestive tract of all warm-blooded animals including humans. They are not normally a problem except in high concentrations. Exposure to high concentrations can occur by direct contact with manure or with water that has a high concentration of fecal coliforms.

Note that a high concentration of fecal coliforms or nutrients in a body of water may be caused by animal production facilities, human septic systems or even natural sources such as wild animals and birds.

Animal Health Concerns

An animal's health, like a human's, can be adversely affected by microorganisms in manure. Since an animal's production and profitability depend on its health, reducing the risks of health problems due to animal manures is important. As indicated earlier, the incidence of mastitis in a herd can be reduced significantly by reducing the cow's exposure to manure. Usually the reduction in mastitis results in higher milk production rates and lower medical costs. Cleaner cows are also more easily prepared for milking. Management can reduce the level of nitrites in forages and water supplies, avoiding potential problems of nitrate poisoning such as digestive problems, reduced conception rates, reduced production and even death.

Sound manure management also has other advantages, such as improving animal and human comfort by reducing fly and odor problems. This increase in comfort makes for a better work environment for the producer as well as enhances the productivity of the animals.

■ An Overview of Manure Management Systems

A manure management system is based upon many factors. Some factors are controlled by the producer, and others are not. Manure management alternatives depend on:

- The type of existing dairy facility
- Producer preferences
- Number of cows milked
- Available land area
- Types of crops grown
- Available labor and equipment
- Climatic conditions
- Soil types
- Topography
- Existing regulations

The development of a sound manure management system is not a matter of applying a standard plan to a specific dairy. Rather it is the process of selecting several interrelated components and practices, and then custom designing the plan for a specific dairy. This means that several management systems may work for a given dairy. However, when all the factors are considered, usually one system is better than the others. Since each dairy operation is unique, its manure management system will also be unique.

All human sewage must be handled in a treatment system separate from the milk center wash water or the manure as required by Arkansas Department of Health regulations. The quantity of sewage from these facilities is usually very small and should be discharged into a septic tank designed for this purpose or some other approved disposal system. Information on septic tanks and other systems for this purpose can be obtained from the local Arkansas Department of Health office.

Manure Management Alternatives

In Arkansas, manure management systems are generally divided into liquid and dry systems. The distinction between liquid and dry is based not on the moisture content of the manure, but on whether water has been added to the manure. As a rule of thumb, if water has been added to the manure at any point, the entire system is classified as a liquid system. Otherwise, it is classified as a dry system.

Therefore, for a dairy to have a dry management system, the manure that is deposited in the premilk holding area should be dry scraped, then stored under roof to protect the manure from the weather. A dry management system also needs a separate system to collect, store and then land apply the milk center wash water.

A liquid system uses water to flush the manure from the premilk holding area into a storage facility until the manure is land applied. Typically the milk center wash water is piped to the same storage facility used for manure storage and contained until scheduled land application. The storage facility is usually a concrete tank, an earthen holding pond or a treatment lagoon.

Neither a dry or liquid system is better than the other; however, there are some advantages and disadvantages normally associated with the two types of systems depending on the specific site situations for each dairy operation.

Permit Requirements

A common concern for many dairy producers is whether their dairy will need a permit from the Arkansas Department of Pollution Control and Ecology (ADPC&E). All livestock and poultry operations

with liquid manure management systems are required by ADPC&E to have a Regulation No. 5 permit. This regulation has a broad range of requirements that include:

- System design requirements
- Public notification that a permit for a liquid system is being applied for
- Attendance at annual training meetings
- Annual manure and soil testing
- Annual reports submitted to ADPC&E

In contrast to liquid manures, ADPC&E does not require dry manure management systems to have a permit, but ADPC&E has regulatory authority over all sources of water pollution and encourages the use of best management practices (BMPs) to minimize the impact of animal manures on water quality. An animal waste management plan prepared for a liquid system or a dry system will meet the requirements of ADPC&E for protection of the state's water resources.

However, determining if a dairy needs a permit from ADPC&E is more involved than the general guidelines above indicate. This is because of the unavoidable addition of water to the manure deposited in the milking parlor. To balance environmental and economic concerns, ADPC&E has, after receiving input from the dairy industry, the Natural Resources Conservation Service (NRCS) and the Cooperative Extension Service (CES), established the following set of criteria for determining if a dairy needs a permit:

A permit will be required if:

- Water is used in the manure management outside of the milking parlor, or
- The dairy is milking more than 100 cows.

A permit will not be required if:

- The dairy is milking 100 cows or less, and
- Does not use water in managing manure outside the milking parlor, and
- A manure management plan is written and implemented.

The practical result of these guidelines is that a dairy can install either a dry or liquid system regardless of the number of cows. All liquid systems need a permit. Dry systems milking more than 100 cows also need a permit, due to the volume of water used to clean the milk room and milking parlor. Regardless of whether or not a permit is required, ADPC&E will eventually require a manure and wash water management plan be developed and implemented for all dairies. These plans will be based on current NRCS and CES recommendations.

Refer to the Extension publications on ADPC&E's Regulation No. 5 and the role of government agencies for additional information.

DRY MANURE MANAGEMENT SYSTEMS

Dry dairy manure management systems do not use water to collect, store and land apply the manure deposited outside the milking center. Also, the milk center wash water is managed separately from the manure.

■ Premilk Holding Areas

The premilk holding area is an important area in manure management because of the amount of time the cows are kept there. Holding cows 2 to 4 hours or more per day in this area results in about 15 percent of the manure generated by the dairy herd being deposited in a limited area. Since this may be the primary area for manure collection, *management of this area will probably determine whether the dairy is classified as having a dry or liquid manure system.* The size, construction, layout and management of the premilk holding area are critical for efficient manure management.

Premilk holding area with attached manure dry stack.



Size

The size of the premilk holding area depends on the number and size of cows to be milked. The holding area should be large enough to accommodate all of the cows that will be milked at one time. Making provisions for additional space to allow for expansion is usually a good idea; however, excessive oversizing requires more time to clean and more materials such as concrete and fencing to build. Large cows such as Holsteins need about 15 square feet for each cow. With smaller cows, such as Jerseys, 12 square feet per cow is acceptable.

If feasible, consider placing the lanes by which cows exit the parlor adjacent to the premilk holding area. This allows the holding area and exit lanes to be managed as a unit.

If a holding area large enough to hold all the cows at once is cost or size restrictive, making the area smaller and milking in shifts is a possibility. But, this approach typically increases time and labor requirements because two or more sets of cows need to be managed. Also, if the second set of cows is allowed to wait outside the premilk holding area prior to milking, the size of the heavy use area around the milk center may be increased. This increase in size results in more time and labor required for manure management.

Construction

The holding area is normally the same width as the milk barn and long enough to accommodate all the cows. This “long narrow” approach facilitates manure collection by providing a straight path for the manure to be scraped or flushed.

To further facilitate manure handling, the floor or pad of the holding area should be paved and have a 2 to 4 percent downward slope away from the milking parlor. There should be a 0 percent (flat) slope across the width of the pad. The floor should be grooved or left moderately rough to prevent cows from slipping. Curbs 8 to 10 inches high should be used to keep the manure in the holding area.

The combination of concrete pad with a 2 to 4 percent grade and 0 percent cross slope combined with high curb reduces the cost and difficulties of any future conversion to a liquid or flush system. The slope aids in the flow and scouring action of water from a flush system.

Enclose holding areas with strong fencing and gates to keep the cows in the holding area prior to milking.

Roofing

A roof over the holding area is beneficial in both wet and dry waste management systems. Usually a roof over the premilk holding area and storage facility is necessary for a system to be classified as “dry.” Roofing protects the collected and stored manure from rainfall and is necessary to meet the condition of no added water to the manure management system. Preventing the addition of water not only keeps the manure classified as a dry manure, it also makes handling the manure easier using dry manure handling equipment such as scrapers, front end loaders and manure spreaders. A partial wall helps keep blowing rain out of the holding area. This wall may be a movable canvas or plastic curtain. A wooden or tin wall is also possible.

Roofed premilk holding area with cooling fans installed.



A second benefit of covering the holding area is the weather protection it provides the cows. Building a roof to increase the comfort of the cows is a common practice. The roof provides shade in hot weather and a way to mount electric fans and sprinkler systems to cool the cows. A wall provides protection from cold winter winds. A movable or partial wall allows for cross breezes in hot weather.

One practice that is used to increase cow comfort is misting or sprinkling. The basic idea of sprinkling is to wet the backs of the cows. The evaporating water will then cool the cows. In humid regions such as Arkansas, fans are needed to ensure that evaporative cooling takes place. The key to effective sprinkling is to get the cows' backs wet but not so wet that water runs down the cows' sides.

Two areas of concern with sprinkling are related to using too much water. Water that runs down the the sides of the cows may contaminate the udder and teats which can increase mastitis and the somatic cell counts in the milk. The second concern is that if enough water from the sprinklers reaches the holding area floor, the manure system may be classified as a liquid operating system and a permit would be required by ADPC&E.

Management

In dry systems, manure is usually scraped from the holding area after each milking or at least daily. In Arkansas the manure is usually scraped by hand. However, some larger dairies scrape with tractors or front-end loaders. The manure can be scraped into a manure spreader for immediate land application or scraped into a stacking shed and stored until land application can be made. In some situations the

manure may be wet enough that it is difficult to handle with scraping equipment. If the holding area is protected from the weather, some drying can be accomplished by scraping just prior to each milking rather than immediately after each milking. This may improve the manure handling characteristics for some dairy operations.

Dry handling systems may require a periodic washing down of the holding area for sanitation reasons. Before washing down these areas, scrape them thoroughly. If washing down of these areas is too frequent or an excessive amount of water is used, the system may be considered a liquid waste management system and will require a permit from ADPC&E.

■ Manure Storage

Dry dairy manure is stored in facilities where manure is stacked under roof to exclude rainfall. To facilitate clean out, these stacking sheds are normally made of wood with concrete half walls and bottoms. They are normally designed for a minimum of 45 days of storage capacity for land application when weather allows. The floors should slope into the shed to keep higher moisture manures contained. Generally the floor slope should be less than 1 foot of drop for each 10 or 12 feet of length to allow the tractors to climb out when loaded. If possible, the stacking shed should be longer than it is wide. The minimum width should be set by the width of the tractor used to remove the manure. The widest part of the tractor (whether it is the bucket or the tires) should determine the minimum width of the shed.

When building new facilities, carefully consider site options. Ideally the storage unit should be located so that manure can be scraped directly into the storage area. Consider scraping manure directly from the holding area into a manure spreader parked in a dry stack. This saves time and labor by avoiding loading the manure spreader at a later date.

■ Dry Manure Utilization

The most common way to use dry dairy manure is to land apply it as a fertilizer with a manure spreader. When field and weather conditions permit, land apply the manure every few days rather than stockpiling large volumes of manure. Stockpiling reduces storage capacity, which can be critical in the event of poor application conditions or broken equipment. Also, it can be difficult to devote the time and labor necessary to empty a full stacking shed given the heavy time and labor constraints found on most dairies.

Refer to the section on determining manure application rates for information on determining the amount of manure to apply.

■ Milk Center Wash Water

The milk center wash water is the water used in cleaning the milking parlor and the milk room. In dry dairy manure management systems, this water must be handled separately from the manure collected outside the milk center.

Volumes and Characteristics

The volume and consistency of wash water resulting from cleanup operations in the milk center vary with the type of milking system and equipment used, the size and number of milk tanks and general operational and management procedures.

Most dairy operations in Arkansas require between 5 and 10 gallons of wash water per cow per day to clean the milk center and milk parlor. The total amount of wash water generated daily varies from less than 100 gallons per day in a milk center with 40 cows milked with bucket milkers to more than 1,000 gallons per day in large milking parlors. The majority of Arkansas dairy farms produce less than 500 gallons of wash water a day.

Handling and Disposal Systems

The two basic approaches for managing the wash water from the milk center in a dry system are the single tank and double tank systems. In the single tank system, the wash water and the solids such as manure and feed particles are stored and disposed of together. In the double tank system, the solid and liquid components are separated for storage and disposal. In both systems, the disposal method is land application. Traditional below-grade septic systems are not recommended because the milk fat in the wash water tends to cause most soils to plug, which leads to system failure.

Single Tank Systems

In a single tank system, a large holding tank holds several days' accumulation of wash water with additional volume for emergency storage. A minimum of 15 days' holding time is recommended. The tank may be made of concrete, steel or fiberglass.

The tank needs to be pumped out on a regular basis. Ideally the tank should be agitated prior to pumping so that the solids are removed with the liquid. If this is not done, the solids eventually have to be removed separately, probably by hand. This operation is labor intensive and possibly dangerous, especially in closed tanks, due to dangerous gases generated by the decomposition of the organic matter in the wash water.

The wash water is usually land applied using a liquid manure tank or “honey” wagon. An irrigation system capable of handling solids can also be used. A tank wagon has the advantage of the selection of application site. However, under wet conditions, problems such as rutting and soil compaction can occur. An irrigation system avoids these problems but may be a more expensive option, especially if a tank wagon is already available.

Table 2. Typical tank sizes for single tank systems for storing milk center wash water.

No. Cows	Minimum Volume		Tank Size	Maximum Volume		Tank Size
	Gallons	Cubic Feet	Feet x Feet	Gallons	Cubic Feet	Feet x Feet
25	1,875	250	8x8	3,750	500	10 x10
50	3,750	500	10 x 10	7,500	1,000	14 x 14
75	5,625	750	12 x 12	11,250	1,500	16 x 16
100	7,500	1,000	14 x 14	15,000	2,000	18 x 18
150	11,250	1,500	16 x 16	22,500	3,000	20 x 20
200	15,000	2,000	18 x 18	30,000	4,000	24 x 24
300	22,500	3,000	20 x 20	45,000	6,000	32 x 32

Minimum Storage based on 5 gallons/day/cow and 15 days of storage.
Maximum Storage based on 10 gallons/day/cow and 15 days of storage.
Tank sizes are approximate and based on 6 feet of storage volume.

Land application of dairy manure with a tank wagon.



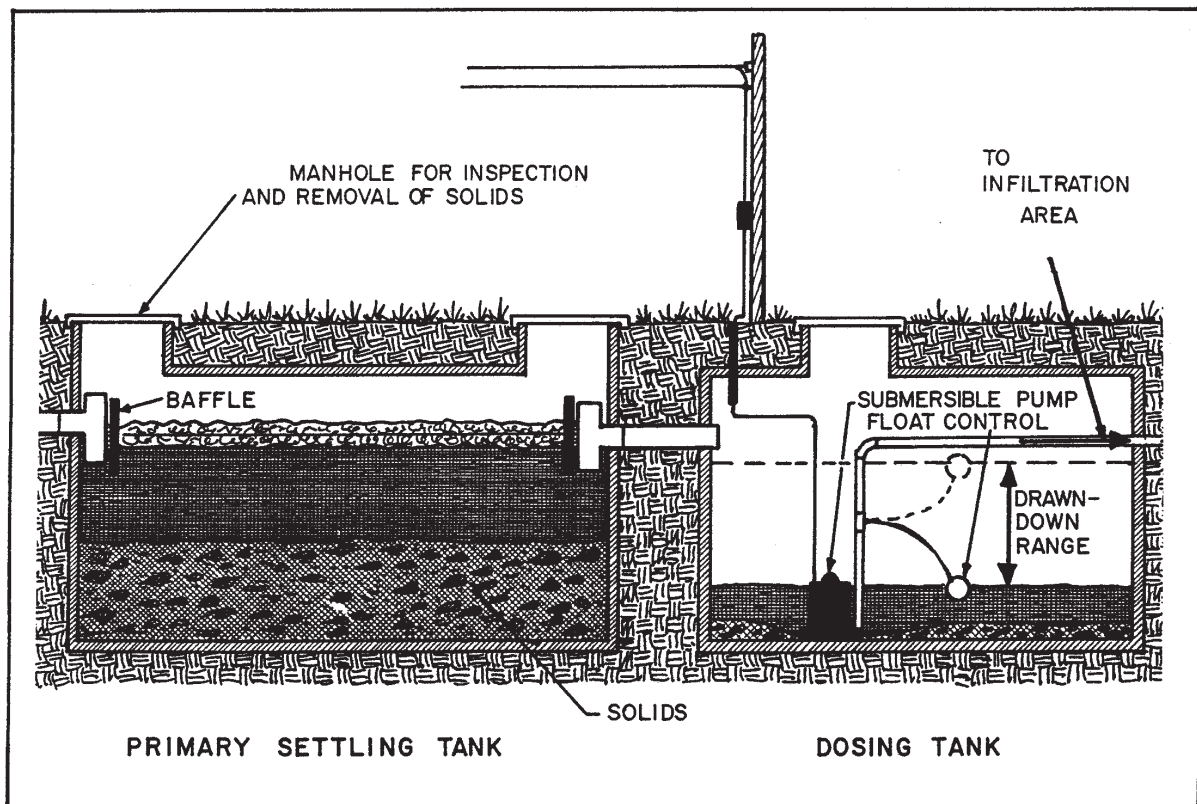
Double Tank Systems

In a double tank system, the first tank is used to settle out most of the solids. The second tank provides liquid storage prior to land application. Separating as many solids from the wash water as possible in a settling tank reduces problems in pumping and distributing the wash water. This allows simple, relatively inexpensive automated land applications systems to be installed.

A settling tank holding capacity of 20 to 40 gallons per cow milked is needed to ensure good separation of solids. Some solids float to the surface and others settle. Baffled inlets and outlets prevent floating material from leaving the tank and slow down incoming wash water. The settling tank needs to be cleaned out periodically. The time between cleanouts depends on the amount of solids in the wash water and the size of the tank. The typical clean-out frequency is six to eight weeks. If excessive solids are allowed to accumulate, they flow into the liquid storage tank, which can prevent the pumping system from working properly.

If the settling tank is emptied before it is 1/3 to 1/2 full, a tank wagon can be used. If a tank wagon is not available, a septic tank clean-out service is an option. If the work is contracted, regularly scheduled service should reduce cost by avoiding emergency service and difficult clean out jobs.

Double tank system with submersible pump and float control.

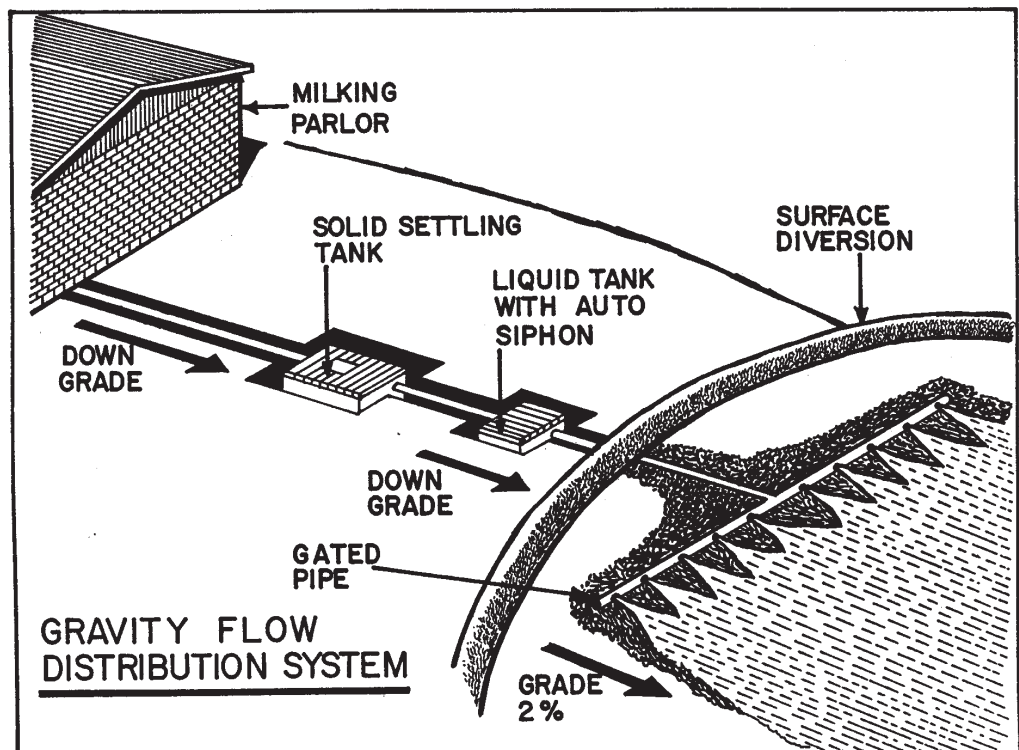


The second tank is used to store the wash water. Typically the liquid storage tank has a system installed that automatically empties the tank every three to five days. The periodic emptying of the tank allows the vegetation in the application area to rest between applications.

In the double tank system there are two basic methods to empty the liquid storage tank. If the elevation difference between the storage tank and the application site is sufficient, an automatic siphon system can be used. In these systems, the siphon triggers when the tank is full, and the water flows until the tank is empty. Another option is an electric pump with a float switch that automatically turns the pump on and off.

Apply the wash water using an overland flow system or by sprinklers. With the overland flow system, the water is discharged from a header pipe with multiple outlets. The objective is to get a thin uniform sheet of water flowing across the application area. Site selection is the key to making these systems work. Consider the soil, land slope, vegetation and proximity to important land features such as bedrock, outcrops, streams, ponds, etc. These systems also require the header pipe to be correctly designed and installed. The outlets also need periodic cleaning to prevent plugging and uneven flows. For an overland flow system, the water can be supplied by either a siphon or by pump.

Gravity flow milk center wash water disposal system with land application by overland flow.



The sprinkler system consists of two or more sprinklers and an irrigation pump. The uniformity of the slope and vegetation of the application area is less critical for sprinkler systems than for overland flow systems. However, to function satisfactorily, the system needs to be carefully designed to match the pump's volume and pressure capacities with the pipe's pressure losses, elevation changes and the sprinkler's required operating pressures. Normally at least a 3 Hp pump delivering at least 22 gpm at 35 psi is required. The pump should be able to pass at least 3/8-inch solids and fitted with a properly sized intake screen. In addition, due to the demanding application, a durable pump designed for waste water usage is recommended. The minimum sprinkler nozzle size should also be 3/8 inch. Professional assistance should be sought in selecting components of a sprinkler system.

Milk center wash water solids settling and liquid storage tanks with wash water sprinkler and overland flow distribution options.



Table 3. Typical tank sizes for the solids separation tank in double tank milk center wash water systems.

No. Cows	Gallons	Cubic Feet
25	1,250	167
50	1,250	167
75	1,500	201
100	2,000	267

Tank size based on 20 gallons/cow/day and a 1,250-gallon minimum.

Table 4. Typical tank sizes for the liquid storage tank in double tank milk center wash water systems.

No. Cows	Minimum Storage		Maximum Storage	
	Gallons	Cubic Feet	Gallons	Cubic Feet
25	375	50	1,250	167
50	750	100	2,500	334
75	1,125	150	3,750	501
100	1,500	201	5,000	668
125	1,875	251	6,250	836

Minimum Storage based on 5 gallons/day/cow and 3 days of storage.
Maximum Storage based on 10 gallons/day/cow and 5 days of storage.

LIQUID MANURE MANAGEMENT SYSTEMS

In a liquid system, the premilk holding area is cleaned by using large volumes of water to wash manure from the holding area into a storage facility. The water used to clean the holding area may be fresh water or recycled water from the manure storage facility. The primary advantage of liquid systems is the lower labor requirements to collect and store the manure. The labor requirement for spreading the manure may be higher for a liquid system depending upon the method selected for land application. An irrigation system has relatively low labor requirements while a system utilizing a tank wagon may have significant labor requirements. If properly designed, they tend to do a better job of cleaning than dry scrape systems. The disadvantages include higher initial equipment cost and large volumes of manure to store due to the extra water added for handling the manure plus any collected rainfall.

Like the dry system, the components of a liquid system can be divided into the premilk holding area, the storage system and the manure utilization system.

■ Premilk Holding Areas

As a rule, the design features of the premilk holding area are the same for the dry and liquid systems. The exception deals with the slope of the floor and curbing. The floor must be paved with a 2 to 4 percent grade with a 0 percent cross slope, and 8- to 10-inch curbs are strongly recommended. Sometimes a 1/4- or 1/2-inch crown along the center of the holding area is used to force some water toward the curbs for extra scouring. However, if the flush system is not properly designed, too much water will go to the curbs, and the center of the holding area may not be cleaned satisfactorily. Without the correct slopes and curbs, a liquid system is unlikely to function properly. To work correctly, the flow volume should be at least 75 gallons per foot of holding area width. The initial depth of the flush water flow should be 4 to 6 inches.



Premilk holding area with holding pond.

■ Flush Systems

The three basic types of flush systems are the tipping tank, gated tank and wash down systems. With each of the systems, the manure is flushed or washed after each milking to prevent manure from drying and becoming more difficult to flush from the area. Due to the number of factors involved in designing and installing a flush system, seek professional assistance.

Tipping Tanks

Tipping tanks are tanks that flush the holding area by tipping over, dumping the flush water. They are usually cylindrical tanks with about 4/10 of the diameter left open and mounted on an axle through the ends. Care should be taken to locating the pivot points on the tank. If they are incorrectly positioned, the tank may be very difficult to tip due to the weight of the water. The tank should be positioned so that the water flows in a straight line, but if this interferes with cow traffic, mount the tank at a slight angle to one side of the flush alley. The fill pipe should be high enough above the tank so it does not interfere with tipping the tank. Filling, as well as tipping the tank, is usually done manually. Tipping tanks have the advantage of being relatively inexpensive. They also work well when converting a dry scrape system to a flush system.

Gated Tanks

Gated tanks are stationary tanks that are emptied by opening the tank's gate. The tank's gate may be a rectangular lift gate or some type of valve. Gated tanks can be mounted outside the holding area and the flush water delivered either directly to the holding area or through pipes. A discharge manifold at the milk center wall is used to spread the flow of flush water across the width of the holding area. Gated tank systems have the advantage of not having the tank in the holding area, but they can be more difficult and expensive to install.

Wash Down Systems

With a wash down system, a high volume, high pressure pump and hose are used to manually wash the area. A typical system includes a supply tank, a booster pump and a hose with a flow-control nozzle. Wash down systems have the disadvantage of requiring a little more time and labor than a tank system. They have the advantage of flexibility in that they can wash down vertical surfaces and other areas not cleaned by flush tank systems. If fresh water is used, the same system can be used to clean inside the milk center and the premilk holding area. They also work better than tank systems when the slope of the floor is not correct or not uniform. In some cases, due to the cost and difficulties of upgrading the holding area floor, dairies converting from a dry system to a liquid system may want to install a wash down system.

■ Storage Systems

Manure that is handled as a liquid is stored in tanks, holding ponds or treatment lagoons. Storage tanks and holding ponds are similar in that they are designed only to hold the liquid manure and rainfall. Lagoons, which are significantly larger than holding ponds, provide manure treatment as well as storage. The purpose of treatment is to

reduce the pollution potential of the manure through biological, physical and chemical processes. A significant reduction in nutrients in the liquid portion of the manure can occur with a lagoon as a result of biological treatment and settling of manure solids. This combined effect makes the liquid easier to pump and better suited for recycle flushing. It also reduces the fertilizer value of the manure being land applied and stockpiles nitrogen and phosphorous if the solids are not removed and land applied annually, as is common for holding ponds and tanks. For more details, refer to the Extension publication on liquid manure systems.

The size of these storage and treatment facilities is determined by the number of animals, the amount of water used to clean facilities, milking center wash water, water added by precipitation, treatment volume and the planned number storage days. Additional storage must be provided to contain the runoff from the drainage area for a 25-year, 24-hour storm. A certain freeboard distance is also required for safety and management considerations. For earthen holding ponds and lagoons, the required freeboard is one foot. The freeboard for open tanks is 6 inches. The minimum storage times for Arkansas conditions are 45 days for manure storage tanks and 120 days for earthen holding ponds and lagoons. Normally 180 days of storage is recommended where practical. Holding ponds are usually the least expensive alternative to construct. All of these liquid operating systems should be designed to meet NRCS guidelines and will need a permit from ADPC&E prior to construction and implementation.

■ Liquid Manure Utilization

The two most common uses of liquid manure are as a source of flush water for manure handling and as a fertilizer source for forage crops.

Recycle Flush Water

Dairy manure that has had considerable amounts of water added to it and is stored in a holding pond or treatment lagoon may serve as a source for recycled flush water to clean the premilk holding area, feeding areas or freestall alleys. This can be an important source of water and cost savings when the availability of fresh water is limited. Recycling of flush water also reduces the size required for holding ponds and treatment lagoons. Due to health concerns, recycled flush water cannot be used to clean inside the milk center.

Land Application

The final use of liquid dairy manure is to fertilize forage crops. The manure can be applied with a tank wagon for tanks and small holding ponds. However, for larger holding ponds and lagoons, irrigation systems are preferable because they are less labor intensive, making it easier to properly manage the water level in the storage units.

One of the critical elements of land applying liquid manures is the removal of manure solids from the storage facilities. Tanks and holding ponds should be thoroughly agitated at each cleanout to mix the floating and settled solids into a pumpable slurry. If this is not done, storage capacity is reduced and the manure solids build up over time to the point that a drag line or back hoe may be needed to remove the manure and solids. For tanks, small pit pumps or the vacuum pumps on the tank wagons can be used to agitate the manure. For holding ponds, propeller-style agitators do a better job of agitation.

While holding ponds and tanks should be agitated and pumped completely empty at every cleanout to remove solids, lagoons are designed with solids storage and manure treatment volumes. The design life of a lagoon is normally about 5 years but can be increased to as much as 20 years. The longer the design life, the larger the treatment lagoon. The lagoon needs to be renovated by completely dewatering it and removing the solids at the end of the design life. Between renovations, only liquid from the water surface is pumped for land application.

For more information on holding pond and lagoon management, contact your local Cooperative Extension office or NRCS office.

Refer to the section on determining manure application rates for information on determining the amount of manure to apply.

■ Milk Center Wash Water

When manure is stored in a storage tank, holding pond or treatment lagoon, the best option for the milking center wash water is to store and land apply it with the manure. The additional water dilutes the manure and improves pumpability. Normally, the wash water from the milking parlor is simply piped to the storage facility. The extra volume necessary to hold the milking center wash water must be included when sizing the manure storage facility and will normally range from 0.5 to 1.5 cubic feet per cow per day.

COMPONENTS COMMON TO DRY AND LIQUID SYSTEMS

The material covered so far has been specific to either dry or liquid management systems. However there are elements of manure management that apply to both dry and liquid systems. These common components concern the management of cattle and manure outside of the milk center and premilk holding area.

■ Heavy Use Areas

Heavy use areas are those areas where cattle tend to congregate. The typical site has little or no vegetative cover and may have an accumulation of manure. These areas can increase the potential for foot rot, mastitis, other diseases and fly infestations. In addition, these areas can contribute to reduced water quality due to runoff. Emphasizing soil, vegetation and animal management in these areas can reduce the potential for water quality damage. In addition to these physical concerns, there is the concern about how these heavy use areas appear to the general public. There is a tendency for people to have the perception “that which looks bad, must be bad.” This tendency has resulted in unfounded environmental complaints against dairies.

The goals of managing heavy use areas are to improve and maintain herd health, reduce the potential for water pollution and improve farm appearance. The general idea is to keep heavy use areas as small as practical, place them in the best location possible and manage any runoff water to protect the water quality. How these concepts are implemented depends on the type of heavy use area being considered.

Travel Lanes

Travel lanes are used to control cow traffic around the farm. Using well-designed travel lanes increases the producer's control of cattle movement and helps keep the damaging effects of cattle movement to a limited area. Lane width should be as narrow as possible, while allowing for any possible equipment traffic and/or tractor scraping. Keep the amount of time cows spend in the travel lane at a minimum, reducing the amount of manure deposited in this area. Careful planning of water, feed and loafing areas will help move cattle along the travel lanes.

To minimize the movement of soil and manure particles, do not locate travel lanes on steep slopes. Lay out the lanes so that any water runoff occurs across the shorter width of the lane rather than down

the length of the lane. In studies of feedlots, a 15 percent slope 340 feet long lost 2 cubic yards of soil per cow in a year. A shorter 7 percent slope only lost 0.6 cubic yards of soil per cow in a year. In addition, fill low spots to prevent standing water and the resulting muddy conditions.

Ideally, travel lanes should be located so that filter strips can be placed between them and environmentally sensitive areas such as streams and ponds. Where the risk of excessively muddy condition exists, gravel over a geotextile underlayment or possibly concrete should be considered to minimize the effect of the muddy conditions on cow health.

Feeding And Watering Areas

There are two basic approaches to managing the heavy use areas associated with feeding and watering. The first is to have permanent areas set aside for feeding to minimize the total area impacted by these activities. The second is the frequent movement of feeders to minimize damage to the vegetation and allow it to recover quickly.

Permanent feeders may need concrete aprons to keep the cows out of the mud while feeding and drinking. Concrete aprons can be designed to allow for convenient scraping or flushing of the accumulated manure. Roofs provide shade for the cows and weather protection for the feed.

With temporary feeders, be careful to keep the feed in a portable trough and not on the ground. Feeding hay in bale feeders reduces the amount of waste feed. Move portable feeders regularly to minimize muddy conditions and severe damage to the vegetation. Movement allows vegetation a chance to reestablish in the damaged areas.

The same general principles that applied to feeding areas also apply to watering areas. Paving may be needed to help reduce excessively muddy conditions. In some situations, portable waterers may be an option.

Loafing Areas

Many dairy producers provide shade to reduce heat stress on the cows. Time spent in these areas by cows results in problems similar to those in watering and feeding areas. The area becomes denuded of vegetation and mud and manure accumulate. If the shade is provided by trees, excessive use of the area around the trees can kill the trees,

which reduces the available shade. While shade is important to cow productivity and should not be eliminated, it can be managed. If portable shade is provided, move or rotate it on a regular basis to allow vegetation to recover. If cows receive their shade from trees, alternating which trees are used with temporary fencing may be possible.



Shaded loafing area.

Another option is to have several loafing areas that are used in rotation to preserve the vegetation. This approach may fit as a part of a rotational grazing system. If a permanent loafing lot is used it should be kept as small as possible and located away from environmentally sensitive areas. A very slight slope helps to promote drainage and reduce muddy conditions. Excessively steep slopes result in erosion and should be avoided. Fill low spots to prevent standing water and excessively muddy conditions. Loafing mounds may be an option.

Maintaining Heavy Use Areas

Heavy use areas that are concrete can be dry scraped or flushed on a fairly frequent basis. While installing concrete areas is usually an expensive option, it does provide for an extra level of cleanliness. Unpaved areas should be scraped just enough to prevent excessive manure buildup. When they are scraped, leave a 2- to 4-inch layer of compacted manure. This crust forms a seal and helps prevent water and nutrient infiltration into the soil, thereby reducing the chances of contaminating groundwater. Low spots that tend to collect and puddle water should be filled and graded to prevent standing water and excessively muddy conditions.

The manure collected from the heavy use areas should be land applied immediately or stored in either stacking shed or liquid storage system.

■ Vegetated Filter Strips

One of the key concepts of managing heavy use areas is conditioning or treating any water that runs off these areas. Vegetated filter strips are the recommended way of providing this conditioning. Filter strips are a band of vegetation on the down slope side of heavy use areas designed to remove sediment, organic matter and other pollutants from runoff. Filter strips operate by causing solids to settle out of water, allowing water to infiltrate the soil and providing opportunities for the plants and soil to process and utilize organic materials and nutrients.

Filter strips are normally vegetated with grasses that are suitable to the site and that will adequately filter runoff. A filter strip may require some earthwork before seeding. Often, however, existing pasture areas with well-established forage can serve as the filter strip. The width, or length of flow, of a filter strip is based primarily on the slope of the land in the strip. Steeper slopes require wider filter strips.

Filter strips require some management for successful and continued operation. The management objective is to maintain a uniform stand of vegetation and avoid conditions where relatively large volumes of water flow across a small area. Avoid overgrazing and traffic damage to the vegetation. Fertilizer requirements for filter strips may also be different from surrounding areas. Occasionally removing sediment and organic material that have been deposited in the filter strip may be necessary.

Table 5. Recommended flow lengths for vegetated filter strips.

Ground Slope	Length of Flow
0% - 3%	30 ft
3% - 8%	50 ft
Greater than 8%	100 ft
Critical Landscape Features	100 ft

■ Clean Water Diversions

Another objective that is common to dry and liquid manure management systems is minimizing the amount of clean water that comes in contact with manure. By preventing the addition of extra water, the size of the manure storage facility will be reduced for a liquid system and a dry system will be more easily managed.

The diversion of extra water begins with roofing the premilk holding area. This prevents the accumulation of rainfall in the holding area and reduces the volume of manure to be handled. Since roofs collect rain water, gutters may be needed to divert it away from manure sources. An alternative to gutters is small drainage ditches under building eaves that help move the water away from the manure. Do not use drainage ditches if they will be located inside heavy use areas.

A clean water diversion may also be needed when runoff from adjacent areas flows across heavy use areas. Usually, berms and ditches work well to divert this clean water runoff. If clean water must be routed through heavy use areas, consider buried pipe or culverts. This type of clean water diversion is only needed where clean water runoff flows across heavy use areas.

■ Stream Crossings

One place where manure comes in contact with clean water is where cows loaf in streams or cross them on their way to and from pasture. Manage cattle in ways that reduce the cow's impact on streams and creeks. This can be accomplished by relocating feeders, waterers, loafing areas and shade. Fencing is an option, but it is often not required.

When it is necessary for cows to cross streams, the addition of manure to the water as they cross is usually not as great a concern as erosion or excessively muddy conditions that can be caused by the traffic. Often for rocky soils and graveled stream beds, very little corrective measures are needed. However, when these conditions do not exist, gravel on a geotextile underlayment or a concrete crossing are options. In extreme cases involving deep, narrow streams and ditches, a culvert or bridge may be the preferred option.

■ Determining Manure Application Rates

In Arkansas the most common method of manure utilization is as a soil amendment and fertilizer. Land application makes the manure's nutrients available to the crop. It also helps to maintain soil fertility, improve soil tilth, increase water-holding capacity and improve soil aeration. When properly managed, manure applications are an excellent way to maintain and improve forage production.

To maximize the fertilizer value of the manure, apply the proper mix of manure and commercial fertilizer to meet the crop's nutrient needs. Exceeding the crop's nutrient needs can increase the risk of nitrate poisoning for the cattle. It also increases the chances of impairing ground and surface water quality.

The key to determining manure application rates is to balance the crop's nutrient needs with the nutrients already in the soil and the nutrients that will come from the manure. A nutrient budget for each field should be developed. Assistance in developing a nutrient budget is available from NRCS personnel or Water Quality technicians and will meet the requirements of ADPC&E. In addition, your local county Extension agents can help in collecting and analyzing manure, soil and forage samples. They can assist in equipment calibration and application rate calculations. Additional information and publications about manure utilization are also available from the county Extension office.

■ Management And Maintenance

An element that is common to both liquid and dry manure systems is proper management and maintenance. If a manure management system is not operated and managed as designed, the potential production, health and environmental benefits are reduced. This results in a reduction in the returns on the capital, time and labor invested in the system. Timely manure management combined with routine inspection and maintenance is the best way to maximize the benefits of manure management.

SUMMARY

Managing manure and the milk center wash water is a vital part of the overall management of a dairy. Good management helps ensure healthy productive cows, protects the environment and improves relations with the neighbors. Poor management can cause cow health problems, reduce milk production, pollute the environment and result in complaints from neighbors.

The key component of good management is the development and implementation of an effective manure management system. For a manure management system to be effective, it must fit with other farm management practices, be economical to install and operate, be conducive to herd health and be environmentally sound. When making decisions in developing a manure management system, some of the factors that need to be addressed are:

- Current regulations regarding animal manure management;
- Milk center wash water management;

- Design of the premilk holding areas;
- Design, implementation and management of manure handling and manure storage facilities;
- Design, implementation and management of heavy use areas;
- Utilization of the manure; and
- Incorporating the management of the final manure handling system into routine farm practices.

The last point could possibly be the most important consideration. The ideal manure management system for a given farm cannot be designed and implemented without the input of the individuals managing the farm. In addition, if a system is installed that does not function properly or is mismanaged, the benefits of manure management can be severely reduced.

The most important component of any manure management system is management. *Without proper management, no system will work as well as it should.*

BIBLIOGRAPHY

Agricultural Waste Management Field Handbook. 1992. USDA-Natural Resources Conservation Service.

Dairy Housing and Equipment Handbook, MWPS-7. 1985. MidWest Plan Service. Iowa State University, Ames, Iowa.

Dairy Manure Management: A Supplement to Manure Management for Environmental Protection. 1986. Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.

Dairy Manure Management: Strategies for Recycling Nutrients to Recover Fertilizer Value and Avoid Environmental Pollution. 1991. H.H. Van Horn, R.A. Nordstedt, A.V. Bottcher, E.A. Hanlon, D.A. Graetz, C.F. Chambliss. Florida Cooperative Extension Service Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida.

Livestock Waste Facilities Handbook, MWPS-18. 1993. MidWest Plan Service. Iowa State University, Ames, Iowa.

Management of Dairy Cattle in Hot and Humid Weather. 1995. Protiva Technical Services, a unit of Monsanto Company, St. Louis, Missouri.

Regulation No. 5: Liquid Animal Waste Management Systems. 1993. A. Rieck, K. VanDevender, and J. Langston. Cooperative Extension Service, University of Arkansas, Little Rock, Arkansas.