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Runoff Water Management for Animal Production and Environmental Protection

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Introduction

With livestock operations, one of the first considerations when addressing production and environmental practices is the collection, storage and utilization of manure. One aspect that is often overlooked is the impact of runoff water on manure management. During a rain, the water will do one of several things. It may evaporate back into the air. It may infiltrate into the soil. Or, it may move as surface runoff. Vegetation and surface depressions may provide temporary storage or retention of the water, but eventually it will evaporate, infiltrate or run off.

Runoff concerns start when the water comes in contact with animal holding and traffic areas. Typically, due to heavy use, these areas are not vegetated and have manure on top of or mixed into the surface. Under these conditions, the runoff water can carry nutrients, sediment and microorganisms from the heavy use area into streams and lakes. This extra loading of nutrients, sediment and microorganisms raises environmental as well as human and animal health concerns.

Runoff water also increases the amount of mud located in cattle and equipment traffic areas. Excessive mud not only causes traffic problems for cattle and equipment, it also increases the potential for cattle health problems. In addition, on farms with manure holding ponds and lagoons, runoff water has the potential to greatly increase the volume of liquid manure that needs to be stored and land applied. This will increase the cost of application and shorten the effective storage time.

Runoff Volumes

To understand the factors that affect runoff volume the equation below is helpful.

Runoff Volume = (Inches of Rain - Infiltration - Evaporation) x Area of Concern

This equation shows that less rain and a smaller area of concern will reduce the runoff volume. Increasing infiltration and evaporation will also reduce the amount of runoff.

Unfortunately, it is usually difficult or impossible to control these factors. Rain and evaporation are weather conditions that cannot be influenced. Usually, infiltration is also beyond control. No infiltration occurs when rain falls on roofs and concrete surfaces. In vegetated areas, the vegetation serves to slow surface water movement, which increases the time for infiltration and evaporation to occur.

Because of the factors that influence runoff, it is difficult to predict volumes. However, looking at a couple of example situations can help to provide a feel for potential runoff volumes. The maximum runoff will be generated when infiltration and evaporation are zero. Assuming they are zero can be a reasonable assumption for such areas as roofs and concrete surfaces. Under these conditions, a 1-inch rain generates 0.62 gallon of

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runoff water for each horizontal square foot of surface. This means that in a 1-inch rain, a 25- by 100-foot (2,500 square feet) roof area can generate 1,550 gallons of runoff water.

If you assumed that half the rainwater falling on grass either evaporated or infiltrated, the same 1-inch rain would generate over 13,000 gallons of runoff water per acre or 0.31 gallon per square foot.

Runoff Management

Since very little can be done to reduce runoff volumes, the existing runoff must be managed. The three basic concepts of runoff management are to keep the clean water clean, manage the heavy use areas and treat the runoff water from heavy use areas.

Key Concepts of Runoff Management

- Keep the clean water clean.
- Manage heavy use areas.
- Treat the runoff water from heavy use areas.

Keeping the Clean Water Clean

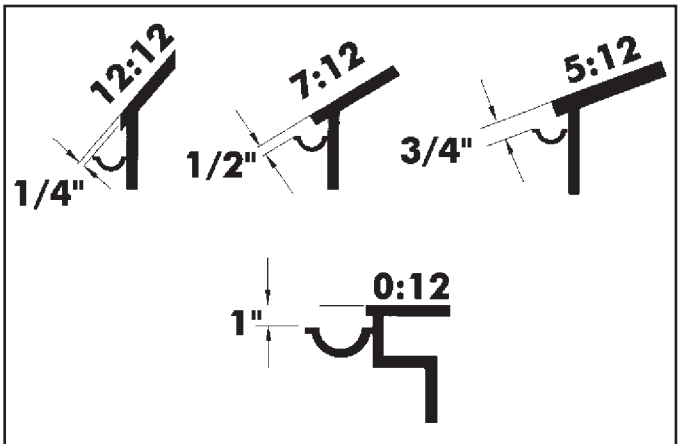
The idea is to prevent clean runoff water from entering heavy use areas or manure storage units. The clean water that enters these areas can pick up nutrients, sediments and microorganisms. Avoiding this is accomplished by redirecting the flow of runoff water. The runoff water that needs to be redirected comes from roofed areas or ground surfaces up-slope from heavy use areas or manure storage units. Where water does not enter heavy use areas or manure storage units, it is usually not necessary to redirect runoff.

Diverting Roof Runoff Water

If the runoff is from a roof, there are two options. The first is to use gutters to direct the runoff water to downspouts. At each downspout, the water can be either released to flow away from the heavy use area or enter a pipe or drainage channel to flow to an acceptable release point. Normally, a gutter system is designed for the heaviest 5-minute rain event that is expected to occur about every 10 years. In Arkansas, this means the northern counties should design for a 0.6-inch rain. The southern counties should design for a 0.65-inch rain. When the gutter system is used to prevent roof water from entering manure storage units, a 25-year 5-minute rain event should be used. In Arkansas, this means the northern counties should design for a 0.65-inch rain. The southern counties should design for a 0.75-inch rain.

The second option is to use drainage channels under the roof eaves to catch runoff water and direct it around the heavy use area to an acceptable release point. Drainage channels under the roof eaves should not be used if they will be located within a heavy use area or there is less than a 12-inch roof overhang. In addition, if blowing rain is a concern, such as with a free stall barn or feed barn, unguttered roof runoff water may contribute to problems inside the buildings. Drainage channels may be open surface channels or gravel-filled trenches with perforated pipe in the bottom. All surfaces beneath roof eaves, including drainage channels, should be designed to move the water away from the building and to avoid standing of water. In general, they should be sloped at a 1 to 5 percent grade away from the building. All drainage channels should also be protected from erosion by vegetation, gravel or concrete.

Roof runoff control systems will often contain a combination of gutters and drainage channels as well as areas of unmodified drainage where the runoff water does not need to be redirected. The decision of where to use gutters and drainage channels is affected by owner preferences and site conditions. Larger roof areas require larger gutters and larger and/or more downspouts. Also, there are often concerns about snow and ice damage to gutters. However, the reduction in the amount of water entering premilk holding areas and free stall barns under windy conditions may justify the additional expense. With proper placement, the potential for snow and ice damage is reduced. Situations where a heavy use area is under a roof's drip line will typically require either the use of gutters or the moving of the heavy use area.



Proper gutter placement is important to protect against snow and ice damage. Steeper pitch roofs require less clearance. Adapted from WQ322, *Roof Gutters for Dairy Barns*, Department of Agricultural Engineering, University of Missouri-Columbia.

Diverting Ground Surface Runoff Water

Surface diversions are usually used to redirect the runoff water from up-slope areas. These diversions catch the runoff water and divert the flow to an acceptable release point. They should be vegetated to prevent erosion. In certain situations, gravel-filled trenches with a perforated pipe may be appropriate. They are sometimes used in situations where it is desirable to redirect the flow of water that occurs beneath the ground surface.

As indicated previously, steps should be taken to prevent erosion and standing water in the diversions. When designing surface diversions, care should be used to consider not only the flow of water but also vehicle and animal traffic. Since large volumes of water and significant flow rates are possible, care should be used where the roof and ground runoff water is released to prevent erosion.

Assistance in the design of both roof and surface water diversions is available through local county Cooperative Extension Service and Natural Resources Conservation Service offices.

Managing Heavy Use Areas

Proper management of a heavy use area starts with the design of the area itself. Ideally, it should be no larger than necessary to handle the flow of cattle and equipment. Excessively large areas take land out of other potentially productive uses and increase the volume of rainwater being exposed to the soil/manure mixture of the heavy use area. However, areas that are too small or poorly laid out will not meet animal traffic and confinement needs. In addition, the flow of animal and equipment traffic in the area should be considered when the placement of fences and gates is determined.

One of the biggest problems of heavy use areas is getting them to support cattle and equipment traffic during the wet periods of the year. Reducing the volume of water and the time of exposure to the water helps the heavy use areas stand up to the traffic. The clean water diversions discussed earlier reduce the amount of water entering the heavy use area. Proper surface grading of the heavy use area helps to move the water off the area and prevent standing water. A cross slope of ¼ inch per foot should be enough slope to ensure drainage without causing excessive erosion. Avoid steep slopes as they will cause the runoff to form gullies and washes. In addition, the distance water flows should be kept to a minimum.

In soils where clean water diversions and proper grading will not be sufficient to avoid excessively muddy conditions, practices such as gravel (with or without geotextile underlayment), coal ash products or concrete are options. Remember that the best approach is to address drainage and clean water diversion problems first. Then, if necessary, consider constructing surfaces to support cattle and equipment traffic.

After a heavy use area is installed, routine management determines the time cattle are in the area and the frequency of manure removal. With the exception of total confinement areas, the amount of time cattle are on the heavy use area should be kept to a minimum. This reduces both manure accumulation and the traffic the area is exposed to.

The frequency of scraping depends on many factors. Heavy use areas with minimal manure accumulations and earthen surfaces may not need much, if any, scraping. It may be desirable to scrape some concrete surfaces, such as premilk holding areas, more than once a day. When scraping earthen and graveled areas, care should be taken not to remove soil or gravel, which will affect surface drainage. Any low spots should be filled to reestablish a uniform grade. In earthen areas, a 3- to 4-inch layer of soil/manure mix will help to seal the surface and prevent infiltration, which helps to protect groundwater. In addition, this soil/manure layer tends to help reduce the amount of soil erosion. However, the retention of moisture increases the importance of good surface drainage.

Assistance in the design and maintenance of heavy use areas is available through local county Cooperative Extension Service and Natural Resources Conservation Service offices.

Treating the Heavy Use Area Runoff

Since there will always be some runoff water leaving heavy use areas, it should be treated to reduce its sediment and nutrient loading. One option is to catch and store the runoff water for later treatment by land application. However, the Arkansas Department of Environmental Quality regulates this approach since it is considered a liquid waste system.

The more common approach is to use vegetative filter strips to treat runoff water. Filter strips are bands of vegetation down-slope of heavy use areas designed to remove sediment and nutrients from runoff water. Filter strips operate by causing solids to settle out of the runoff water, allowing water to infiltrate into the soil and providing opportunities for the plants and soil to process and use nutrients. For filter strips to be effective, the water needs to move as a uniform sheet across the filter strip. Filter strips lose effectiveness when channelized flows occur.

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.

Recommended Filter Strip Widths

Ground Slope	Length of Flow
0 - 3%	30 ft
3 - 8%	50 ft
Greater than 8%	100 ft
Up-slope from such landscape features as springs, seeps, sinkholes, wells and rock outcrops	100 ft

Adapted from NRCS Conservation Standard Filter Strip 393-(1).

Filter strips require some management for successful and continued operation. The objective is to maintain a uniform stand of vegetation and have the runoff flow as a uniform sheet of water across the surface. Overgrazing and traffic damage to the vegetation needs to be avoided. Excessive vegetative growth and sediment deposits may also cause channelized flows to occur. Fertilizer requirements for filter strips may also be different from surrounding areas. Therefore, it may be necessary to occasionally mow and remove plant material and sediment that has been deposited in the filter strip.

Assistance in the design and maintenance of vegetative filter strips is available through local county Cooperative Extension Service and Natural Resources Conservation Service offices.

Summary

The design and routine management of livestock operations should address rainfall runoff as part of their manure management practices. With proper design and management, the adverse effects of excessively muddy conditions on production can be minimized. In addition, the water quality impacts are also minimized. The key concepts to runoff management are to keep the clean water clean, manage the heavy use areas and treat the runoff water from heavy use areas. Assistance for all three of these concepts is available through local county Cooperative Extension Service and Natural Resources Conservation Service offices.

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