

Feedlot Design and Environmental Management for Backgrounding and Stocker Operations

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Kentucky's cattle industry represents the largest beef cattle herd east of the Mississippi, ranking eighth in the nation for number of beef cows. This industry is extremely important to Kentucky's economy. However, pollution can come from a variety of sources on cattle operations. Pasture-based systems with little or no vegetation, confinement facilities operated without a comprehensive nutrient management strategy, or any operation that does not implement appropriate best management practices (BMPs) can degrade natural resources that agricultural producers, and all Kentuckians, depend on for scenic beauty, recreation, and health and safety.

Environmental regulatory agencies pay attention to cattle operations, and specifically backgrounding and stocker operations, because many facilities have the potential to discharge nutrients, sediment, pathogens, and other pollutants to the surface and groundwater. These discharges degrade valuable water resources, put human health at risk, and make producers vulnerable to environmental fines that can be as much as \$25,000 per day. It is not the intent of environmental regulators to punish livestock producers. In many cases, regulators try to mitigate pollution problems by cooperating with producers and local conservation districts.

One legal requirement that can resolve many pollution issues is an implemented Agricultural Water Quality Plan (AWQP), which involves the installation of site-specific BMPs. Some producers view environmental regulations and the required Kentucky AWQP as an "iron fist" approach for protection of the environment. On the contrary, BMPs have been designed by scientists and land-grant university researchers, and if implemented and managed effectively, they can actually improve productivity for beef cattle producers. For example, if managed properly, rotational grazing and proper grazing use, two BMPs recommended by the Kentucky AWQP, give cattle an adequate amount of high-quality forage, which can improve reproduc-



Figure 1. The cattle on this stocker operation have overgrazed the area and have direct access to surface water, a combination that pollutes the water resources.

tive productivity, post-partum recovery in cows, and growth rates in offspring. In addition, the forage regrows more quickly and plant diversity is greater than in continuously-grazed systems, resulting in increased cattle productivity and pasture yields. These BMPs also protect the environment by conserving vegetation, which filters runoff and prevents erosion. This simple example demonstrates that BMPs can protect the environment while also improving livestock production.

This publication discusses site evaluation strategies, production area management techniques, and a variety of facility types for intensive cattle production that preserve natural resources and improve production. Proper selection of facilities and management systems and implementation of BMPs can help producers achieve regulatory compliance and create a sustainable operation that can be passed on safely to the next generation.

Site Evaluation and Environmental Factors

Many problems can arise if the location for the production area is not carefully chosen. There have been cases where nothing could be done to correct the pollution issues of existing open feedlot facilities because the location was not selected with environmental impacts in mind. These facilities were ultimately forced to either spend an exorbitant amount of money to achieve

environmental compliance or shut down. Producers need to consider a holistic approach when planning an intensive beef cattle production enterprise. Take the following site evaluation and environmental factors into account when choosing a site for a production operation.

Topography and Drainage

Usually the rougher the topography (hills, steep slopes), the more drainages and streams are present. These drainages can transport nutrients and other pollutants to streams and nearby water bodies, so their location relative to new facilities must be considered during the site selection process. A slope of at least 2% is needed to provide drainage and avoid standing water, but any slope above 6% should be avoided because it is difficult to control the drainage at higher slopes, and pollutants could be released to the waters of the Commonwealth. Ideally, producers should site cattle facilities on land with a slope between 2 and 6%; however, excavation of less-than-ideal land is an option.

Economic factors also need to be weighed when selecting a site. Construction of an elaborate production system is expensive on hilly land, but because this land typically costs much less than prime farmland, that expense might be offset. Flat ground is preferable because it requires a smaller footprint for a confinement operation, and it facilitates the transportation and land application

of manure, but the cost of flat land is typically higher. However, the desirable attributes of flat land in addition to the environmental benefits may offset the initial cost over time.

Many producers choose less productive ground for building confinement operations, but these producers must be careful to place the facilities on summit positions. The adjoining slopes can be used for grazing or feedlot production, but BMPs should be used to manage runoff and prevent off-site discharge of pollutants. Ideally, drainages or swales should not be used for feeding areas because they convey pollutants. Instead, fence these areas to exclude livestock and allow the vegetation to filter runoff.

Fifty percent of Kentucky's topography is moderate or heavy karst. In these areas, the landscape is composed of limestone bedrock that dissolves after years of rain and runoff. The limestone caves beneath the soil and the conduits that lead to them (swallow holes, sinkholes, sinking streams, blue holes, etc.) provide a means for surface water pollution to reach groundwater resources. This potential is of concern for confinement feeding operations, since nutrient runoff from backgrounding operations in the surface water can easily reach groundwater resources that are often used to supply drinking water to rural communities. Account for karst features during the site selection process by protecting them with vegetative buffers and by placing facilities as far away as possible. In addition, never use karst features for waste holding ponds or any type of waste disposal or construct waste holding ponds anywhere above them—karst features are easily contaminated.

Soils

When selecting a site, use soil maps to examine soil properties in terms of building site development, septic systems, crop production, construction materials, and water management. Soil types have multiple influences on foundations for facilities, absorption of effluent from septic fields, utilization of nutrients, and ability to create holding ponds for liquid manures. The soil type, depth of soil, depth to water, depth to rock, and rock characteristics are all factors that contribute to a soil's suitability for differ-

ent purposes. Soil information, however, only provides a general site assessment and does not eliminate the need for more specific engineering measurements.

Soil is invaluable for livestock operations, as it beneficially reuses the nutrients in animal manure and can save producers money; however, the soil type affects the yield potential of crops and the ability of that soil to adsorb and break down nutrients. There are basically two types of processes that control the beneficial reuse of nutrients in manure: biological and chemical. A basic understanding of how these mechanisms work to increase soil fertility beyond sustainable concentrations is needed to understand why BMPs are recommended, because an increase in fertility can ultimately result in discharges of pollutants to the environment.

First, the beneficial bacteria in soil use biological processes to change manure into nutrients that plants can use. There are literally billions of beneficial bacteria in soil that can destroy harmful pathogens and break down pollutants into harmless substances. However, if the water table is high, oxygen in the soil may be insufficient to support these beneficial bacteria, and contaminants released into the soil could pollute groundwater and create a discharge from the site.

Second, there are chemical processes that use the charge of ions to adsorb nutrients to soil particles, which prevents

the nutrients from leaching into ground and surface waters.

Well-drained soils are best for producing crops and providing the optimum environment for the mineralization of nutrients found in manures. The permeability rate should be at least 0.2 inches per hour. The soil profile should not have a restrictive layer to a depth of 40 inches. A silt-loam texture is preferred with a black or dark brown colored topsoil. The subsoil should be colored either reddish-brown or yellowish-brown. There should be no gray mottling throughout because this is an indication of poor drainage or flooding—the application area should never be placed in a floodplain. Likewise, the slopes should be between 0 and 3%.

Climate

Precipitation and other sources of moisture can create challenges for waste management and mud prevention. For backgrounding and stocker operations, less precipitation or moisture makes environmental compliance much easier. Figure 2 shows that the eastern United States has a moisture surplus, and that most of Kentucky has a surplus of at least 10 inches, meaning that precipitation exceeds evaporation by more than 10 inches each year. Therefore, backgrounding and stocker operators in this part of the country must carefully consider the effects of precipitation when selecting and managing facilities.

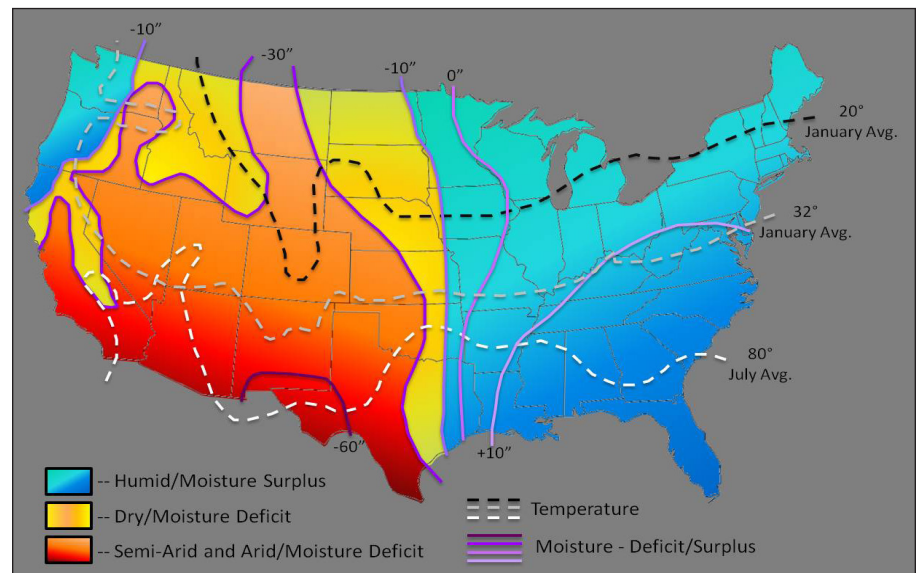


Figure 2. Regional moisture deficits and surpluses in the United States.

In addition to an overall moisture surplus, Kentucky gets about the same amount of precipitation each month, while other factors like cloud cover vary month to month. The more cloud cover in a given month, the less potential for evaporation and higher temperatures, so in months with more cloud cover, the moisture surplus poses even more of a problem for cattle operations. In Kentucky, these cloudy months often occur in the winter, causing mud and degraded pen conditions. These concepts are demonstrated by Figure 3, which also demonstrates why environmental agencies have issues with cattle operations utilizing outdoor unimproved earthen lots, especially in the winter.

Microclimate

Microclimate encompasses site-specific weather issues like prevailing wind, orientation of the facilities, and solar radiation. The location of the facility in respect to prevailing wind direction and the proximity of neighbors downwind of the production facility can have a bearing on how the production facility functions and is perceived.

There is much debate on whether animals need structures to protect them from the rain, winter winds, and solar radiation. Cattle can handle extreme cold but not heat combined with high humidity. Given that Kentucky's climate is temperate, with mild, wet winters and hot, humid summers, operators should focus on protecting cattle from solar radiation, winter winds, and moisture. To provide protection from solar radiation, orient beef cattle shade structures in an east-west direction. Site rectangular barns for winter feeding so that the back side protects cattle from the prevailing winter wind, which in Kentucky comes from the south or southwest. Orient open-sided buildings to the southeast so that solar radiation can dry the approaches into the barn and driving rains from the south can be avoided. In addition, create hardened surfaces in barns and under shade structures to limit the creation of mud, which can also draw heat and energy out of animals.



Figure 3. High precipitation and cloud cover in the winter create mud and degraded conditions for cattle operations.

Providing a permanent roofed structure can be expensive, so consider using portable shade structures to provide relief from solar radiation. These structures can be moved as cattle are moved to adjacent pastures. If a roofed shelter is not feasible, provide windbreaks in the cold season. Elevate constructed windbreaks on mounds to allow cattle to reach higher ground that drains, thus limiting mud creation. Wooded areas or constructed windbreaks can provide shelterbelts for animals and provide a buffer for neighbors downwind of the facilities. They should be planned during the site selection process. Woodlands or windbreaks should be created to protect cattle from storms originating from the north and east. It is not advisable to give cattle full access to trees because the foot traffic can expose the roots and kill the trees.

Remodeling and Expansion

Many sites considered for back-grounding operations have some pre-existing infrastructure. However, older livestock facilities were not constructed with the environment in mind. Remodeling can be performed on existing structures, but the finished facilities will probably lack the holistic approach

needed to protect the environment. So, when choosing a site, you should consider the cost and technology needed to upgrade properly.

Producers often expand livestock enterprises to the limits of operational constraints to maximize profits and lower costs. Therefore, when selecting a site for the initial facility, take into account extra space that may be needed to expand and remodel in the future without negatively affecting the environment. Expansion includes all aspects related to the infrastructure used for a production operation, such as buildings, structures, courtyards, roads, and fences. The location of these structures also affects the organization of utilities (electricity, natural gas, and water). Planning for expansion needs to take into account soils, drainage, protection from weather, and space requirements. Other issues that need to be considered are the locations for sewer, fuel storage for equipment, and methods of solid waste disposal. Consult a professional agricultural engineer to design a facility that can be expanded with minimal negative environmental effect.

Production Area Management

Livestock producers need to develop a holistic plan for the production area to increase efficiency and protect the environment. The production area for a cattle facility is more than just a barn for housing animals; it also includes pastures, drainageways, ponds, feed and manure storage structures, loading/unloading areas, feeding areas, animal housing, and dead animal disposal facilities. Manage the production area properly to enhance animal health and herd production while also preventing the discharge of pollutants that can pose a threat to the environment and human health. These goals can be accomplished by strategically choosing and implementing management practices, structures, and facilities. For example, cattle feed efficiency increases if the feeding area is kept clear of mud and manure (Table 1, Figure 4). Choosing a facility that minimizes mud, diverts clean water, and provides a system for collecting manures improves system efficiency while protecting the environment, a win-win situation.

Improving herd production starts with creating an optimum environment. To optimize cattle performance, health, and efficiency, provide livestock with clean unfrozen drinking water, air flow, and forages. In general, provide animals with an environment that includes shade, windbreaks, adequate space, and structures that reduce the generation of mud, such as mounds, roofed shelter, and appropriate hardened surfaces.

Drinking Water Sources

Clean drinking water is necessary for optimum production. An average-sized animal consumes approximately 10 to 20 gallons of water per day. Supplying water for a large number of animals can be a significant cost, depending on the water source. Some producers use natural water sources like streams because they believe that cattle prefer to drink from open water bodies instead of fountains, especially



Figure 4. Mud accumulation in this earthen lot requires cattle to consume additional feed to generate more energy and maintain performance.

just after arriving to the farm. However, allowing livestock access to streams causes many problems. First, these surface waters, including streams and ponds, can contain a variety of pathogens that can cause herd health to deteriorate. Many producers claim that cattle prefer to drink from sources that people might consider unclean, such as ponds in which animals loaf and even excrete urine and feces or streams in which polluted surface runoff water flows. Scientific studies show, however, that animals that have access to clean water outperform cattle that drink polluted, or otherwise dirty (i.e., pathogens, sediment, algae, etc.) water. In addition, allowing cattle access to surface water pollutes the water downstream, where it may be used for drinking water or recreation. Exclude cattle from all water bodies such as ponds and streams. Establish alternative water sources, including developed springs, gravity-fed structures below ponds, and city water sources, so that grazing cattle do not have to travel more than 600 feet

to obtain water. This practice promotes uniform pasture grazing and an even distribution of the nutrients contained in manure.

Surface Types

There are two basic types of surfaces used in cattle facilities: earthen and paved. Many times producers have unpaved surfaces that were created accidentally from areas that used to contain vegetation but have eroded away into an earthen or dirt lot (Figure 5). Using "accidental" eroded surfaces is not the correct way to establish a feeding area. Feeding areas must be planned, created, and maintained intentionally and properly.

The pressure sustained by the feeding-area surface needs to be considered. A cattle hoof applies more pressure on a surface than a human foot or a D9 bulldozer (Table 2). Because cattle can disturb soil more than a bulldozer can, the surface for a feeding area needs to be planned to reduce disturbance and the generation of mud. Different surface

Table 1. Relationship between mud depth and feed efficiency.¹

Mud Depth (in)	Feed Intake (Difference, %)	Daily Gains (Difference, %)	Additional Feed Required (Difference, %)
4 - 8	-15 - -8	-14	12 - 13
12 - 24	-30	-25	20 - 25

¹ Alberta Feedlot Management Guide.

Table 2. Pressure created by different stressors.

Stressors	Pressure (psi)
Human	13.8
D9 CAT Dozer (Track)	16.1
Cattle	26.8

types can withstand varying degrees of pressure (Table 3). The surface chosen to hold and feed cattle must be stronger than the pressure that cattle traffic applies, and concrete is the best choice for this application because it is the strongest. If concrete cannot be used for the entire feeding area, use it near feed bunks, waterers, or anywhere cattle congregate. Other surfaces that can withstand large amounts of pressure and reduce mud generation include compacted gravel and compacted clay. It is unacceptable to make no improvements and to use only topsoil for a feedlot.

Create adequate surfaces to support cattle by installing heavy-use area pads on stable soils and using the appropriate layers and thickness of rock along with the recommended non-woven geotextile fabric. Other types of surfaces can be created using lime-stabilized soils, coal combustion by-products, blends using cement, or placed concrete.

There are two types of coal combustion by-products: Flue Gas Desulfurization (FGD) and fly ash. FGD is a dewatered mixture containing sulfites, sulfates, lime, and some water and is a self-cementing product. Fly ash is available as Class C and Class F. Class C is a self-cementing product, but it is not readily available. Class F needs to be mixed with cement to become a self-cementing product. Proportions need to be blended based on the characteristics of the material. Pads should be constructed between May and September to provide warm temperatures for optimum curing. Do not use a pad for 28 days after construction so that curing can take place. Consult an experienced engineer when planning to install FGD or fly ash pads.

Table 3. Load-carrying capacities of different cattle surfaces.

Surface Type	Pressure (psi)
Soft clay or sandy loam	13.8
Firm clay or fine sand	27.8
Dry clay or compact fine sand	41.7
Loose gravel or compact coarse sand	55.6
Compact sand and gravel mixture	83.3
Soil cement (12% mixture)	2,400
Concrete (6-inch reinforced)	6,000



Figure 5. An earthen lot used to hold cattle with no runoff structures or BMPs to control off-site movement of pollutants.

To eliminate the creation of ruts, place concrete or heavy-use area pads around all waterers, feed troughs and other feeding areas, hospital pens, and areas where animals congregate. Finish concrete with a grooved surface to provide traction and reduce slipping. Do not place an open lot on a slope greater than 6%, because it will be too difficult to control runoff. When cattle are housed in open lots with minimal slope for drainage, install mounds or roofed structures to limit the creation of mud and provide a dry place for cattle to bed down.

The space needed to adequately house cattle depends on the surface and climatic conditions; however, a paved feeding area generally requires less space per animal compared to an unpaved area (Table 4). The surface type also affects the slope needed to provide

adequate drainage (Table 4). Slopes of 2 to 4% are recommended for paved areas to facilitate cleaning. Slopes of 4 to 6% are recommended for unpaved feeding areas, but the runoff still needs to be controlled and managed, as unpaved surfaces can produce as much runoff as paved surfaces because of the undulations caused by hoof pugging.

Stocking Density

No matter what surface a producer decides to use for a facility, the stocking density has an effect on the amount of mud and manure generated. High stocking density results in the deposition of more manure on less surface area, which requires frequent bedding changes or scraping to maintain a dry, manure-free area. Additionally, a high stocking density in unimproved lots means more foot

Table 4. Facility design specifications.

Facility Type	Animal Environment	Surface Type	Area Needed per animal (ft ²)	Slope Needed (%)
Total Confinement	Controlled	Paved	50-70 ¹	2-4
Partially Roofed Confinement	Some protection, 3 sides	Paved	50-70	2-4
Open Feedlot	Little or no cover or protection	Unpaved	400-800	4-6 ²
		Paved	80-150	2-4

¹ Producers need to consider animal size, feeding areas, areas around drinkers, depth of bedding, and frequency of cleaning.

² Any slope over 6% makes it difficult to control the speed of the water.

traffic over a given area. High moisture conditions combined with high foot traffic allows moisture deeper into the soil, which causes a deep layer of mud to form. Installing mounds within open lots reduces mud generation by providing an area that drains.

Manure and Stormwater Management

Manure storage is one of the most important issues to address with a livestock operation of any kind. Given the high price of inorganic fertilizers, livestock producers should be aware that animal manure has value and should be managed to capture as great a return as possible from it. Capturing maximum return requires analyzing manure for nutrient concentration, calibrating manure application equipment, and calculating application rates based on realistic yield goals and existing soil fertility.

Manure Storage

It is not uncommon for producers to have storage structures that can only hold a week's worth of manure or to have no storage at all, forcing these producers to and scrape and haul on the same day. This type of management ensures that manure is spread when the ground is frozen and immediately before and after rainfall events, when vegetation is not able to efficiently use the nutrients. These practices waste nutrients and money and can lead to pollution of valuable water resources.

A lagoon or waste storage pond is one way producers can manage runoff, silage effluent, and liquid manures. The Natural Resources Conservation Service (NRCS) requires a minimum storage capacity for solid and liquid manures of 120 days but recommends 180 to 240 days. Approximately 180 days of storage is needed for a twice-a-year land application: just before and right after corn-growing season. Manure could also be applied to other crops, such as sorghum-sudan grass, following each cutting. Fields used for fall applications of manure should be planted in winter wheat to capture nutrients and reduce runoff. When crops or forages are not removed from fields where manures are applied, soil fertility increases, which reduces the amount of manure that can be applied, adsorbed, and utilized over



Figure 6. A recently scraped cattle feeding area.

time without creating runoff or leaching into surface or groundwater.

Liquid-based manure management systems are difficult to manage, and therefore have the greatest potential to pollute the environment. First, liquid-based management systems are often not cost effective if the manure must be hauled over a mile from storage. Second, the acreage needed for land application is significant, sometimes more land than the producer owns or has available. In addition, lagoons in particular are almost always undersized, usually because they receive clean water that should have been diverted elsewhere.

Stormwater Management

Every square foot of roof area generates about 15 gallons of runoff per year, based on average annual precipitation minus evaporation. For example, a roof measuring 75 by 150 feet produces approximately 160,000 gallons of clean water runoff per year. Diverting this clean water from a concrete feedlot of the same dimension using gutters and downspouts reduces the amount of water that needs to be managed by half. This diversion reduces the expense associated with lagoon or other liquid manure storage construction and maintenance.

Producers need to manage runoff with some type of structure, such as a holding pond or lagoon. These structures should never fill to the top. Instead, extra storage capacity must be available to capture

additional rainfall and runoff from a 25-year, 24-hour storm. This extra space or safety net is called "freeboard." It is required in a waste storage structure in addition to the space needed to accommodate manure produced on the farm. A lack of freeboard can result in overflows during rain events. When producers do not properly manage freeboard, illegal discharges that degrade natural resources can result. For this reason, nearby states, including North Carolina, have banned lagoons and storage ponds. Innovative producers should move away from liquid-based manure systems, as slurries or solids are much easier to transport and solids can be transferred off the farm as compost. Increased fuel costs are also incentive to consider slurry or solid waste management systems, as fewer trips are necessary and greater distances to fields can be accommodated.

Not only do producers need to have the infrastructure to manage liquid and solid wastes properly (i.e., manure handling equipment, manure storage, and fields for land application) but they also should be guided by an understanding of nutrient management concepts. Figure 6 shows a concrete feeding area that has been cleaned to remove accumulated manure, which is a good practice. However, the manure was pushed into a poorly-managed waste holding pond for which the freeboard was not managed, which allowed manure to overflow into a nearby stream (Figure 7).

Recommended Facilities

Generally speaking, across the United States there are three different kinds of beef housing facilities for intensive cattle production: open lot, barn with lot, and total confinement. Variations within each system exist when surfaces, mounds, and shade are included in the design. When considering any beef housing system, the most important factor to take into account is that the facility is not allowed to have any sediment, pathogens, nutrients, or any other form of pollution move off-site. Simply put, there cannot be a discharge of pollutants leaving the operation.

Out of the three different types of housing systems, total confinement is ideal because of the high moisture conditions in Kentucky. Open lots and partial confinement are not ideal, but they can be utilized providing proper site selection, stocking rates, and BMPs are in place.

Typically there are multiple benefits to the producer, cattle, and environment when a producer transitions from open lots to confinement systems, including the following:

- Animal comfort and feed efficiency generally increase.
- Cost is reduced.
- Clean water is easily diverted, and the amount of liquid that must be managed is reduced.

Covered Confined Facility

An ideal backgrounding facility for Kentucky is a totally covered facility with a concrete or slatted floor. A totally confined facility could include a liquid-based system that requires a holding pond or lagoon; however, producers should instead move towards a solids or slurry-based manure management system. Outdoor liquid-based systems are more expensive and difficult to manage than a slurry or solids-based system, mostly because Kentucky receives a lot of precipitation, and managing an outdoor liquid manure storage system includes managing unpredictable and otherwise clean rainwater.

A solids-based manure system requires stackable solid manure. Most cattle manure is a slurry, but if mixed with either a bedding or waste forage,



Figure 7. A poorly managed manure storage pond with inadequate freeboard space.

such as hay, it becomes a stackable solid. A covered manure stack pad would also be necessary with this type of system to provide the capacity needed to store manure until it is land-applied immediately before a crop is actively growing.

A slatted floor system (Figure 8) can be used and managed well if it utilizes deep pits capable of holding manures for long periods of time (180 days). The ability to divert roof runoff into the pits to be used on an as-needed basis allows producers to dilute the manure and breaks up the solids for land application (Figure 9). The bottom floor of the pit needs to have an

adequate slope to allow manure with a high solids content to move by gravity to the area where it can be pumped out.

A ventilation system should be included in confinement structures, as the humidity in Kentucky can create less-than-ideal conditions within the facility for optimum cattle production. Proper ventilation can enhance animal comfort by improving air movement and may reduce sloppy conditions.

A totally enclosed production facility is usually the most expensive option when looking simply at the cost per head; however, the cost for this type of holistic



Figure 8. A confinement facility with a slatted floor and deep manure storage pit.

management may not be much greater than other options in the long run. This type of structure can help producers eliminate environmental compliance costs and can increase production efficiency, which increases profits. When bedded or scraped properly, total confinement facilities allow for a higher stocking density than open lots, and the valuable manure can be easily removed and used as fertilizer. Confinement facilities decrease the land area needed for holding animals and reduce the amount of water that must be managed. Cattle can even gain better in confinement, if managed properly.

Partially Roofed Confinement Facility

The second best option for backgrounding facilities in Kentucky is partially-roofed confinement facilities like the facility pictured in Figure 10. This type of facility requires both liquid waste and solid waste management systems. Without a liquid collection system, runoff can move off-site and pollute the environment. Figure 11 demonstrates how one important pollutant, phosphorus, can move off-site from a partially-roofed confinement facility and increase the concentration of that pollutant in the soil.

In partially-roofed confinement systems, animals are free to move inside and outside. In terms of waste management, the two areas can be managed separately. The manure from the outside area usually behaves more like a slurry than a solid, making it more difficult to manage. Scrape outside areas regularly, especially prior to a rainfall. Install mounds to allow cattle to get out of the mud or manure packs. Mounds also encourage cattle to spend more time outdoors and reduce the amount of cleaning necessary in the barn.

Blend this slurry-like material with waste hay or bedding, which allows it to be stacked, stored, and land-applied later. Store this material in a covered area to prevent the material from becoming wet, which would allow nutrients to leach away. If the outside material is not combined and stacked, more management is needed—a slurry requires additional equipment and more careful management than stackable solids. The inside of the barn may contain bedding



Figure 9. An example of a guttered confinement facility with a diversion for diluting manure pits.

and usually does not need to be cleaned out as often as the outside. For some backgrounding operations, it may be possible to clean out the inside portion of a barn in the spring and apply this bedding material directly to a crop field. This situation is ideal, but there must be enough land area available for land application; otherwise, the soil can become overloaded with phosphorus, which can pollute the environment.

Producers with partially-roofed operations need to manage storm water by diverting as much clean water away from the production area as possible. This often requires installing and maintaining working gutters and downspouts for livestock buildings. This roof water can then be discharged to areas where it does not come into contact with manure. Also consider creating grassed waterways that divert runoff away from the uncovered lot. Diverting this water reduces the volume of water that needs to be managed and lessens the potential



Figure 10. A partially-roofed backgrounding facility.



Figure 11. Soil test phosphorus concentrations adjacent to the partially-roofed backgrounding facility shown in Figure 10.

environmental impacts of the facility. For more information about this BMP, see the University of Kentucky Cooperative Extension publication *Stormwater BMPs for Confined Livestock Facilities* (AEN-103).

Unroofed areas of these facilities should have a buffer below them that provides at least 60 feet of enhanced vegetation to trap, filter, and utilize pollutants

running off the unpaved feeding area. Inter-seed the areas adjacent to open lots that receive runoff from those lots with forages suitable for hay production that are capable of removing nutrients (i.e., timothy, orchardgrass, and perennial rye). These forages filter, trap, and utilize nutrients that are then removed from the facility with grazing or with harvesting the forage for hay. For more information about this BMP, see the University of Kentucky Cooperative Extension publication *Enhanced Vegetative Strips for Livestock Facilities* (ID-189). Producers could also allow these areas to drain to a liquid storage system such as a lagoon.

Open Feedlot

Open feedlot designs are the least-suitable facility type for backgrounding operations in Kentucky. These facilities are not well-suited for Kentucky's climate, as high temperatures, humidity, and precipitation decrease animal performance and increase the volume of polluted water that needs to be managed. In addition to hot, humid summers, Kentucky winters are too wet to prevent excessive mud generation and too cold to allow vegetation to actively grow and hold soil in place. This combination of factors results in soil erosion and the degradation of water resources. When overstocked, open feedlot systems denude vegetation needed to hold the soil in place, causing nutrients, pathogens, and sediment generated by the cattle to reach surface waters without being filtered, trapped, or utilized by plants (Figure 12).

Unimproved open feedlot designs are common in Kentucky and have the potential to degrade the environment and increase the risk of human health problems; however, by installing BMPs, producers can reduce this pollution potential. For example, producers with open feedlots should not place feeding areas along streams or give cattle full access to these streams simply because it is convenient. Instead, locate feeding areas in upland areas and provide alternative water sources, which will allow vegetation along the slopes to filter pollutants before reaching environmentally sensitive areas like streams, sinkholes, and drainageways. When implementing BMPs, producers should consider the



Figure 12. A poorly managed open feedlot that discharges polluted runoff directly into a stream.

location of environmentally sensitive areas (sinkholes, streams, springs, drainageways, ponds, etc.), manure handling areas, and animal housing and feeding areas (winter feeding areas, feed bunks, etc.). These areas in a pasture or production area have the greatest potential for off-site movement of pollutants.

BMPs are required by law to achieve environmental compliance and conserve natural resources. The local conservation district and Natural Resources Conservation Service (NRCS) office are great resources for advice on BMPs and might have ideas on how cost-share dollars could be used to implement these practices. If producers cannot obtain cost-share funding, they should implement BMPs that will make the greatest impact based on the amount of money spent. Producers using an open feedlot design could potentially implement a variety of BMPs. The BMP checklist on the next page is provided as a guide for producers with open lot systems.

Regulatory Requirements and Cost Share

Animal feeding operations and confined animal operations are not allowed to have a discharge of pollutants from the operation. Kentucky Administrative Regulation 401 KAR 5:005 states that an operator of an agricultural waste handling system or animal feeding operation must have a Kentucky No Discharge Operational Permit (KNDOP). This permit is required for all animal feeding operations that use a liquid waste handling system

and requires producers to inspect their facilities and keep records of manure management practices. If a discharge does occur and cannot be controlled, the producer might need to obtain a Kentucky Pollutant Discharge Elimination System (KPDES) permit instead of a KNDOP. To get a KNDOP, a producer must have a current Agriculture Water Quality Plan (AWQP) and a Nutrient Management Plan (NMP).

An AWQP describes the BMPs that a producer is employing in any of six areas: forestry, pesticides and fertilizers, farmstead, crops, livestock, and streams and other waters. Every producer in Kentucky has been required to create and implement an agricultural water quality plan since 2001. These water quality plans not only help protect the environment, but they also increase livestock productivity.

A NMP is a five-year plan that comprehensively addresses how nutrients are managed on the operation. The plan should outline the methods used to determine the amount of nutrients produced, how those nutrients will be managed or land-applied, the realistic yield goal for the crops receiving nutrient applications, the existing soil fertility, and the strategies used to limit runoff, leaching, and volatilization.

Cost share is available from state and federal agencies to develop a Comprehensive Nutrient Management Plan (CNMP), which is an extremely detailed version of a Nutrient Management Plan written by an engineer or a contractor. The CNMP can also be used to obtain a KNDOP

BMP Checklist and Suggested Guidance Documents

- ❑ Place shade structures in the feedlot to provide livestock with relief from the heat and to lure cattle away from streams and ponds. Small animals need approximately 7.5 to 13 square feet per animal, while large animals need approximately 19 to 27 square feet per animal.
 - *Shade Options for Grazing Cattle* (AEN-99)
- ❑ Install alternative water sources such as developed springs or gravity-fed watering systems, making sure that cattle do not have to travel more than 600 feet to obtain water.
 - *Alternative Water Source: Developing Springs for Livestock* (AEN-98)
 - *Drinking Water Quality Guidelines for Cattle* (ID-170)
- ❑ Exclude livestock from streams, ponds, sinkholes, and any other environmentally-sensitive areas.
 - *Riparian Buffers: A Livestock Best Management Practice for Protecting Water Quality* (ID-175)
 - *Sinkhole Management for Agricultural Producers* (AEN-109)
- ❑ Strategically place mineral and salt blocks away from riparian areas.
- ❑ Implement proper grazing use and rotational grazing practices to protect soil and preserve pasture quality.
 - *Pasture Feeding, Streamside Grazing, and the Kentucky Agriculture Water Quality Plan* (AEN-105)
 - *Planning Fencing Systems for Intensive Grazing Management* (ID-74)
- ❑ Install stream crossings to prevent erosion and stability problems.
 - *Stream Crossings for Cattle* (AEN-101)
- ❑ Install windbreaks and mounds to provide protection from the elements and reduce mud.
- ❑ Install heavy-use area pads around areas that receive a lot of traffic, such as waterers, feeders, shade structures, mineral blocks, and windbreaks.
 - *High Traffic Area Pads for Horses* (ID-164)
 - *Using Dry Lots to Conserve Pastures and Reduce Pollution Potential* (ID-171)
- ❑ Clean manure from congregation and feeding areas. Apply this manure to a crop field or place it in a covered stack pad for later application.
 - *Paved Feeding Areas and the Kentucky Agriculture Water Quality Plan* (AEN-107)
- ❑ Manage mortalities by composting or some other legal means of disposal.
 - *On-Farm Composting of Animal Mortalities* (ID-166)
 - *On-Farm Disposal of Animal Mortalities* (ID-167)
- ❑ Control erosion by implementing proper grazing techniques and installing structures such as gully erosion structures where appropriate.
 - *Building a Grade Stabilization Structure to Control Erosion* (AEN-100)
- ❑ Relocate mineral blocks, feed wagons, and ring feeders to reduce the generation of mud and the accumulation of manure.
- ❑ Provide facilities or structures to reduce the creation of mud, especially during the winter months.
 - *Strategic Winter Feeding of Cattle using a Rotational Grazing Structure* (ID-188)
 - *Woodland Winter Feeding of Cattle: Water Quality Best Management Practices* (ID-187)

from KDOW. A current Agricultural Water Quality Plan, as described above, is also required in order to obtain cost-share funding for BMP implementation. In some situations a current Agricultural Water Quality Plan will provide a higher ranking for eligible projects. Contact the local Conservation District for questions regarding eligibility for state and federal cost-share funds.

Summary

Managing liquid-based manure systems and open lots can be difficult and increases costs and pollution potential. The most economical way to manage manure, nutrients, and runoff is to develop an integrated, confined system that diverts clean water and manages the nutrients to generate crops without increasing soil fertility beyond agronomic levels. Livestock producers who do not implement integrated holistic systems must implement site-specific, costly BMPs to protect the environment and avoid potential fines.

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