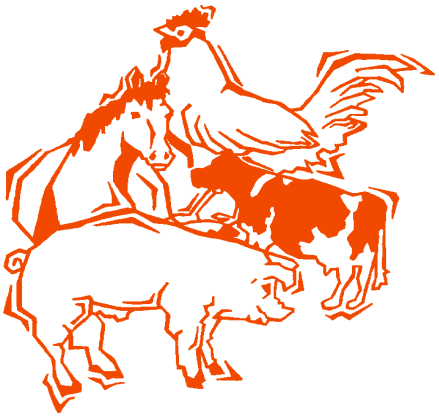

MANAGEMENT

Feedlot Manure Management no. 1.220

by J.G. Davis, T.L. Stanton and T. Haren [1]

Quick Facts...

Under prolonged muddy conditions, animal performance can drop as much as 25 percent.

The nutrients excreted in cattle manure in Colorado have a fertilizer value of $34.2 million every year.

Aim for pen moisture of 25 to 35 percent to control odor, fly and dust problems.

Pens designed with a minimum of 3 percent slope are best for managing excess moisture and collecting runoff.

Seepage from runoff holding ponds is required by law to be less than 1/4 inch per day.

Many concerns at feedlot operations are directly linked to pen maintenance and manure management. Odors and dust problems, animal health and performance, water runoff and protection of groundwater and surface water are all interconnected within confined feeding operations. Studies have shown animal performance to be reduced by as much as 25 percent under prolonged muddy conditions. Respiratory problems occur, and treatment costs dramatically increase, if pens are constantly dusty. Improper pen cleaning can result in low areas that collect water, or a rough surface that impedes effective and efficient runoff control. Aggressive pen cleaning can damage the underlying compacted "hard pan" and contribute to groundwater contamination.

Therefore, it is necessary to take an integrated approach to feedlot pen maintenance and manure management. Encompassing so many variables will, however, result in compromises between opposing performance objectives. For example, low initial construction costs might equate to higher maintenance costs. Another common compromise is between dust and odor control. If the feedlot surface is too dry, dust will become a problem. If it remains too wet, odor is a great concern. Compromises often are needed in an integrated approach if the overall feedlot goals are to be met.

Typically, there are about 1,000,000 cattle on feed at any one time in Colorado. Each 1,000-pound animal produces between 50 and 60 pounds of manure and urine per day with a moisture content of about 90 percent. By the time the manure is removed from the feedlot, its moisture content has dropped to less than 40 percent. The nutrients excreted in the manure from these cattle have a fertilizer value of $34.2 million every year (Table 1). How these nutrients are managed determines whether they are an economic benefit or an environmental liability to the feedlot operator. Nitrates from manure can be leached to groundwater, and excessive nutrients in surface water can lead to overgrowth of aquatic plants, which use up the oxygen and suffocate fish. Nutrients can be lost or conserved for future crop use at every stage: in the production units, in storage, and after the manure is applied back to the land.

Table 1: Fertilizer value of manure from feeder cattle in Colorado.

Fertilizer nutrients in cattle manure (lb/ton on an as-spread basis)	Total fertilizer nutrients in Colorado feeder cattle (million lb/year)	Fertilizer value ($/yr)
23 lb N	46 million lbs N	$11.0 million
24 lb P_2O_5	48 million lbs P_2O_5	$15.2 million
33 lb K_2O	66 million lbs K_2O	$8.0 million

To calculate fertilizer value, the following prices were used: mono-ammonium phosphate, $305/ton; urea, $290/ton; and muriate of potash, $145/ton. These figures do not include the manure produced by sheep and dairy cattle housed in feedlots.

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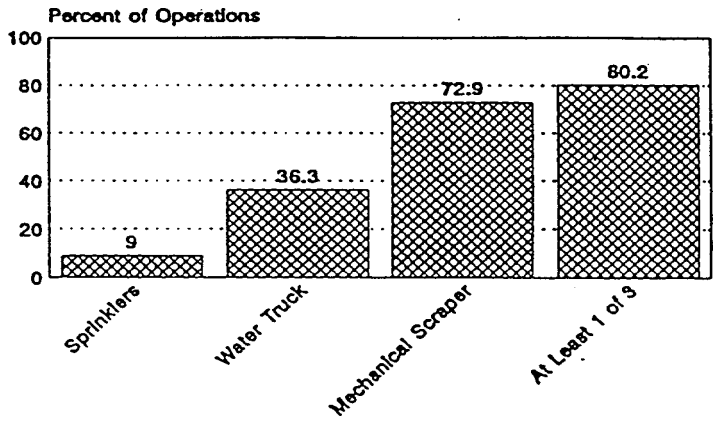

Figure 1: Dust control practices on beef feedlots of 1,000 or more head.

Dust Control

Dust can threaten not only the health of cattle (Franzen, 1984) and people, but can also compromise a feedyard's ability to continue to operate. The major source of dust in the feedyard comes from the pens. However, dust also can come from roads, service areas and feed processing. Generally, the peak time for dust occurs around sunset, when the temperature starts to cool and cattle become more active.

The best way to control dust is through proper pen design and maintenance of surface moisture levels. Routine cleaning of pen surfaces also helps to minimize dust problems. A recent survey (Figure 1) suggests that most feedyards use a mechanical scraper as the main tool in their dust control strategies. Keep the loose manure layer less than 1 inch deep and pen moisture between 25 and 35 percent. Too much moisture will increase odor and fly problems; too little moisture will promote difficulties with dust.

Pen size and shape dictate the type of water distribution system to use. For example, large, deep pens probably require fence line sprinkling systems, while shallow pens may favor mobile equipment. Selecting a sprinkling system assumes that the feedyard has adequate amounts of water beyond drinking water needs.

Windbreaks also may be used to control or capture fugitive dust. Fast-growing poplar trees planted along the perimeter of the feedyard will provide shelter from the wind and may largely contain any fugitive dust.

There are numerous surface amendments and chemical agents being evaluated for dust control. Fly ash looks promising. Other compounds that have been considered include sawdust, apple pumice, ligno sulfate and gypsum.

Fence Line vs. Mobile Sprinklers

The decision to install fence line sprinklers versus acquiring mobile equipment is a tradeoff between initial cost, maintenance, depreciation and labor. The permanent fence line sprinkling system investment may initially approach $1,000 per pen. However, continued labor expense is minimal once the system is operational. Drain the system in the fall to prevent freezing, although dust can still be a problem in the winter.

Mobile equipment is expensive. A used 8,000 gallon tanker may exceed $60,000 initial cost, plus it will require a driver and operating expenses. For a medium- to large-size feedyard, there may not be enough time to haul water to raise the pen moisture.

Odor Control

Offensive odors from feedlots are closely related to manure management. If you are siting a new feedlot, select an isolated location downwind from neighbors with an adequate and well-drained land base. Design the feedlot to accommodate frequent scraping, and keep manure stockpiles dry and covered. When manure is applied to land, the timing and placement of the manure can be managed to reduce odor concerns. Apply manure when the wind is calm, preferably in the morning, and incorporate it as soon as possible.

Stocking Rate

Surface moisture can be manipulated through stocking rate changes. However, linear bunk space, water trough space and pen square footage may be limiting and may preclude increasing stocking rate enough to achieve the desired pen moisture. Stocking rate can be altered by increasing the number of head per pen or by reducing pen square footage using panels or electric fence. Temporary fencing also gives flexibility during periods of above-average precipitation.

Manipulating stocking rate of feedyard pens to control the amount of feces and urine produced per pen is an economical dust-control strategy. Know the area and weight per animal. For example, a 1,000 pound steer allocated to 125 square feet of pen space produces about 28 inches of moisture per year or 0.08 inches per day (Table 2).

Stocking density has a significant influence on the animal and environmental performance of a feedlot. Stocking density partly determines the average moisture content of the pen surface. Each day, cattle add moisture to the pens through feces and urine. Determining how much moisture is desirable requires careful observation. This decision varies with management style and

Table 2: Manure moisture production in cattle feedlots (Sweeten, No. 7045)

	Average animal spacing (sq ft/hd)				
	75	100	125	150	175
Animal size (avg lbs/hd)			**Moisture (in/day)**		
400	.05	.04	.03	.03	.02
600	.08	.06	.05	.04	.03
800	.11	.08	.06	.05	.04
1,000	.13	.10	.08	.07	.06
1,200	.16	.12	.09	.08	.07

Front-End Loaders vs. Box Scrapers

*Two of the most common methods of manure removal are the **wheeled front-end loader** and the **box scraper.** Both are effective. The box scraper or other scraping devices, such as a paddle scraper or road grader, are more effective at: 1) providing a smooth pen surface that facilitates proper drainage, and 2) maintaining the integrity of the compacted protective seal or "hard pan" under feedlot pens.*

A wheeled front-end loader requires an experienced operator. For each bucket of manure accumulated with a wheel loader, the operator must shift gears four times while manipulating the bucket. This is most likely to result in an irregular pen surface at best or damage to the protective "hard pan." A combination of a wheeled front-end loader for major manure removal and a scraper for final cleaning and grading would be an effective compromise.

Stockpile Management

- *Locate manure stockpile areas away from watercourses and above the 100-year flood plain.*
- *Use grassed filter strips below stockpiles to reduce runoff volume by settling solids and removing nutrients.*
- *Sample soil downhill from stockpiles to monitor nitrate buildup.*
- *Locate manure stockpiles at least 150 feet downstream from any well.*
- *Protect wellheads with grassed buffer areas.*

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experience with the specific site and climatic conditions. Cattle size and rations also will influence moisture balance and the corresponding appropriate stocking rate. Typical pen stocking densities in Colorado are between 150 ft^2 and 300 ft^2 per animal.

Increase stocking density during warmer, dry periods and reduce density during wet or cool seasons. For both odor and dust control, the choice of stocking density should achieve a balance between a pen surface that is too dry versus one that is too wet. If this management goal is not achieved, more elaborate and expensive methods, such as sprinkling systems for dust control or frequent manure removal for odor control, will be necessary.

A combination of cattle density, sprinkling, spraying and precipitation may be needed. Cattle density alone may not be enough to control dust, especially in areas with high evaporation rates. Pens with light-weight feeder cattle, high winds (high evaporation), and low precipitation are at greatest risk for dust problems.

There are numerous options to consider when attacking dust problems. Each has advantages and disadvantages. It is important to have a plan in place and start prior to the time dust is a serious problem. Remember, water application is minimized by removing loose manure and dust from pens in a timely manner.

Manure Removal

The removal of accumulating manure reduces odors, controls fly larvae, and minimizes the potential for surface and groundwater contamination. Maintaining a firm, dry feedlot surface is an important factor in good animal health and a healthy environment.

Frequency of manure removal also varies widely, depending on size of lot and pen stocking rate. However, a thorough pen cleaning once per year is an absolute minimum. Most feedyards clean and prepare a pen prior to receiving new or "fresh" cattle. A feedyard operated year-round typically replaces cattle or "turns a pen" 2.5 times per year and conducts pen maintenance as frequently, weather permitting. Dairies also are concerned with animal health, comfort and cleanliness. Some dairies harrow their pens daily, with good results in both environmental and animal health benefits. While this is labor intensive for feedlots, it does indicate that pen cleaning as frequently as feasible for your specific operation is good management.

Stockpile Location and Management

Having adequate storage area to handle the quantity of manure production has many benefits. Primarily, adequate storage area provides the producer with flexibility in land application so that land application timing can be determined by labor availability, weather and field conditions, and crop nutrient needs, rather than by lack of storage space. Use the information in Table 3 to calculate how much manure you expect your livestock to produce, and be sure that your storage capacity is adequate.

The more control a feedlot manager has over the facility's manure handling, the more likely nutrients will be conserved and beneficially used. Composting manure requires additional land and equipment, but may be advantageous where markets are available.

Table 3: Manure production per 1,000-pound animal.

	As excreted	At time of spreading
Beef cattle	11.5 tons/yr (88% water)	1.6 tons/yr
Dairy cattle	15.0 tons/yr (88% water)	3.4 tons/yr
Sheep	7.3 tons/yr (75% water)	2.6 tons/yr

Insect Control

Feedlot pen maintenance and manure management also play an important role in insect control. Insect pests stress cattle and can greatly reduce performance. Insects reproduce and mature in wet areas such as muddy pens, wet manure piles, and wet spots around waterers and feedbunks.

One area commonly overlooked in pen maintenance is manure buildup directly under fencerows and adjacent to structures like waterers and feed bunks. These areas are not readily accessible with heavy equipment and require small equipment and/or manual labor. However, they are significant breeding areas for insects.

Keeping pens clean and dry will reduce insect populations, enhance performance, and minimize a feedlot's reliance on chemicals and other costly insect-control methods.

Resources

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Land-Base Calculation

Feedlot operators should have an adequate land base to spread their manure. If land base is inadequate, arrange to apply manure to other cropland or prepare to market it for composting or garden use. Sample the manure and provide the laboratory analysis to manure users so they can apply the manure at agronomic rates.

First, a feedlot operator must know how much manure nitrogen (N) is produced. Multiply the number of head by the tons produced (Table 3) to determine how much manure is produced. Multiply the tonnage by the lb N/ton in that manure (Table 1) to calculate how many pounds N are available for land application. Next, calculate how much crop removal there will be per acre. Multiply the expected yield by the average N content of the harvested crop to determine N removal by the crop. Finally, divide the pounds N produced in the manure by the pounds N used by the crop per acre. The result is the acreage required as a land base for your feedlot.

Runoff Management and Collection

Pens designed for good drainage (minimum of 3 percent slope from apron to back of pen with adequate mounds) help manage excess moisture. The primary goals of runoff management are to divert water from flowing across the feedlot or storage area, and to prevent direct runoff from the feedlot or the stockpiled manure into waterways. Runoff can be diverted by digging ditches and building berms. One of the primary principles of runoff management is to keep "clean water clean." In other words, direct clean water away from manure, whether manure is already stockpiled or still in the feedlot. Decreasing the volume of water used reduces the potential for runoff, so minimizing water waste from inefficient waterers and sprinklers not only saves money, but reduces runoff hazard.

Collect and store all wastewater and storm water runoff from pens. It can be evaporated, treated, and discharged, or applied to cropland as a source of water and nutrients. If it is applied to cropland, the irrigation application rate must be less than the infiltration rate, so that runoff does not occur from the cropland. Fence animals out of watercourses to eliminate direct deposition of manure into water. Runoff solids can be removed by directing the runoff through filter strips or grassed waterways or by using a sediment basin to settle the solids out. Removing solids from the runoff will reduce odors and prevent the pond from filling up with solids.

Management of Runoff Holding Ponds

Seal storage ponds and lagoons to prevent seepage. Seepage is required by law to be less than 1/4 inch per day if the pond contains storm water runoff only, but the seepage requirement is less than 1/32 inch per day if the pond stores processing wastewater (for example, manure flushed from a milking parlor) in addition to storm water runoff.

Seepage can be reduced by several methods, and manure itself has an ability to seal soil surfaces with time. Compact soil to a minimum 12-inch thickness. Take soil type into consideration during site selection. Locate ponds in the most impervious soil available. Soils must be loams or clays to compact well. Low permeability materials may be required in sandier soils. Installing synthetic plastic or geosynthetic impermeable liners or adding clay (bentonite) are a few of the ways to reduce seepage from runoff holding ponds. Keep livestock away from pond banks in order to maintain the seal. Wastewater holding ponds must be sited a safe distance from wells, a minimum of 150-feet downstream.