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FEEDLOT DUST CONTROL

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Dust from cattle feedlots can be a nuisance during prolonged dry periods. Depending upon feedlot location, dust can be a sanitation problem to neighbors and create a traffic hazard. In sufficient concentrations, feedlot dust can also impair cattle performance and irritate feedlot employees.

California research showed that peak dust generation occurs between 7 and 8 p.m., which coincides with experience in Texas. This is because cattle become more active at dusk, when temperature and wind velocity decrease.

Techniques

Dust control techniques for feedlots should prevent dust from becoming a problem, since it is not feasible to remove suspended dust from the air. There are several aproaches:

Feed Pens	Roads and Service Areas
Removal of excess manure	Water sprinkling
Increased cattle stocking rate	Oiling
Water application	Chemical application
Chemical application	

Water application is the most effective, economical and reliable means of controlling dust from feedpens. However, the other methods can be of supplemental benefit.

Manure Removal

An important step in reducing manure dust is removal of excess manure from corrals. Although the manure pack may contain stored moisture, dry, pulverized manure hampers dust control. Thus, minimizing manure accumulation increases dust control effectiveness. A maximum depth of 1 inch of loose manure is recommended.

Water

The most common and effective method of dust control is application of water to the feedlot surface. In California research, properly sprinkled feedlots generated up to 18 times less dust than untreated lots. Dust levels rose more than 850 percent whenever water treatment was discontinued for 7 days.

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Strategy Water treatment should begin before dust becomes a problem. When water is applied to feedlot surfaces, a balance between effective dust control and the control of odors and flies is necessary. Maintain moisture content of the surface manure at 25 to 35 percent.

During dry weather, surface manure may contain only 7 to 10 percent moisture, causing severe dust problems. The moisture can be raised to the desirable level by an initially heavy water application, by animal crowding, or by both, followed by a daily water sprinkled treatment program. The sprinkler water can provide moisture for aerobic stabilization of the manure. A moisture content of between 25 and 40 percent is required for rapid aerobic bacterial activity, which produces little unpleasant odor.

Avoid overwatering. Excessively wet spots support anaerobic decomposition, the primary source of feedlot odor. Manure with 25 to 85 percent moisture also provides a good environment for fly breeding, especially under fence lines, and other locations where there is little cattle traffic.

Rates and timing Adjust water application rates according to weather conditions, animal size and manure depth. Recommended initial application rates should be at least 1 gallon per square yard per day (0.18 inches per day) until a 25 to 35 percent moisture level is reached in the loose manure near the surface. Thereafter, water should be applied at one-half to three-fourths gallon per square yard per day (0.09 to 0.13 inches per day) while the weather remains dry. For recently scraped feed pens, one-fourth gallon per square yard per day is recommended.

California research showed that daily watering gave significantly better dust control than alternate day watering. Watering frequency has proved to be a more critical factor than depth of loose manure on the feedlot surface.

Water treatment for dust control within the feedyard will increase the relative humidity, which in humid weather, can impair the animals' ability to lose body heat by evaporation during the hottest part of the day. In humid climates, apply water treatments during the early evening hours. This coincides with the period of heaviest dust activity.

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Equipment The following types of water application systems have been used for feedlot dust control:

Irrigation Equipment

Permanent sprinklers
Fence line sprinklers
Shade-mounted sprinklers
Protected risers (inside pen)
Portable big gun sprinklers

Mobile Equipment

Water tankers
Water trucks

If designed to provide adequate coverage of the feedpen and proper application rates, these systems are about equal in controlling dust. Pen size and shape are a major factor in equipment selection. For example, deep pens are difficult to cover with mobile equipment and may require supplemental sprinklers. Large or irregularly shaped pens may also require special equipment or extra sprinklers. Pens with shades may require mobile sprinkling from both feed and cattle alleys to obtain good coverage without creating a mud problem under the shades. The shaded area is kept moist by the cattle and should receive little or no water. Feed bunks should also be kept free from sprinkling water.

Permanent sprinkler systems

Permanent sprinkler systems (Figure 1) can treat large sections of a feedlot surface simultaneously. Sprinkler systems require little labor and can be fully automated to apply water at the correct time every day.

Major disadvantages to permanent sprinklers are high initial cost, frequent maintenance and dependence on relatively calm weather for uniform distribution. Routine inspection of the entire system will prevent or minimize poor distribution or overwatering. Sprinkler heads placed inside feedpens can hamper pen cleaning. Sprinkler systems can be damaged from freezing or impact during idle seasons. Permanent sprinkler systems are inflexible because they must be designed, installed and operated for a particular feedlot configuration. The system may not function properly if the feedlot is expanded or the water pumping rate is altered. Vacant pens will receive water. Stationary sprinkler systems installed after a feedlot is built may not be optimally designed and may be expensive. If such sprinkler systems prove ineffective initially, they cannot be rendered completely effective, and have little salvage value.

Solid set sprinkler systems require a constant supply of clean water. These systems need to be carefully engineered with respect to sizes and placement of pumps, pipes and nozzles. Many system configurations have been used successfully. Water droplet size is related to spray nozzle design and hydraulic pressure.

High capacity systems (sprinkler irrigation or mobile equipment) with large droplet sizes and low pressures can be operated less frequently and for short periods. They require fewer spray nozzles, lateral lines and risers. However, they are more likely to lead to ponding of water on the feedlot surface unless spray pattern and duration of water application are carefully controlled.

Low capacity sprinklers are characterized by high pressure (50 to 60 pounds per square inch), small nozzle size (5/64 inch to 3/32 inch), small droplet diameters and narrow sprinkler spacing (40 to 50 feet apart). These high pressure systems reduce the likelihood of surface ponding, and can sometimes be

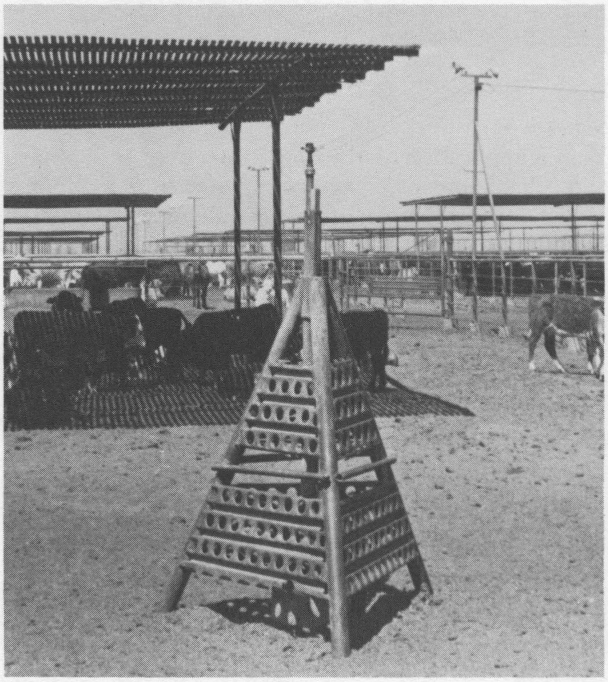

Figure 1. Permanent sprinkler systems can be fully automated to treat large areas of the feedlot at once. Uniform coverage is achieved under ideal conditions of operation.

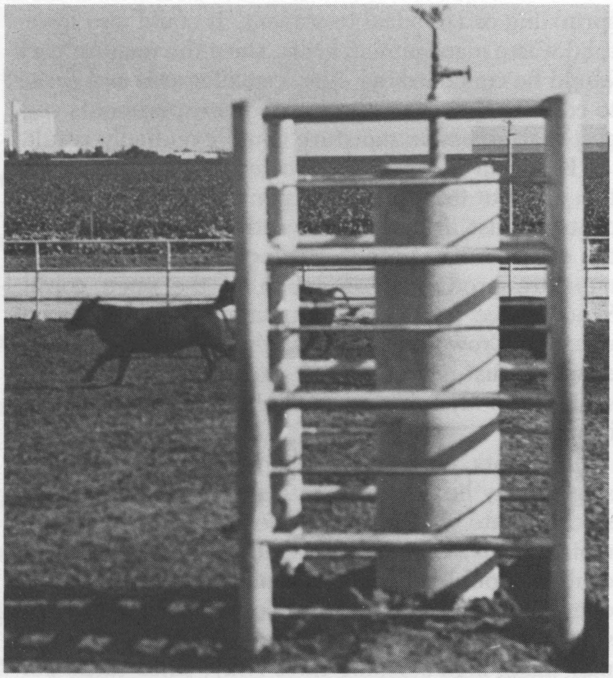

Figure 2. Dust control sprinklers need to be well protected from possible damage by manure collection machinery and cattle.

operated frequently throughout the day to relieve heat stress. However, water distribution patterns are adversely affected by high winds, and there is more evaporation loss from small droplets.

Sprinkler heads can be implanted inside the pens and encased for protection (Figures 1 and 2). They can be mounted on fences in cattle alleys or mounted atop sun shades. Nozzle spacings, diameters, discharge rates and operating pressures are interrelated, and should be selected for each precise application. Small nozzles (1/8 inch diameter), closely spaced to provide considerable overlap, will provide the most uniform distribution pattern available.

Mobile equipment Mobile tankers or tank trucks (Figure 3) cost less initially than permanent sprinkler systems and are more versatile. With skilled operators, equal or better watering uniformity can be achieved. Spray patterns from mobile equipment can be more easily adjusted to compensate for high winds. Evaporation loss is probably lower. With properly designed discharge nozzles, all areas of the feedlot, even corners, can be treated. Dusty trouble spots in a feedyard can be treated heavily without sprinkling the entire lot. Mobile equipment for dust control can be readily adapted to changes in feedlot configuration and for dust control in alleyways.

Major disadvantages of tank trucks include high labor costs, high operating expense, difficulty in gaining quick control over dust and the need for backup equipment.

Mobile units used for feedlot dust control vary from standard two and one-half ton trucks outfitted with 4,000 to 5,000 gallon tanks, up to large tankers with a 6,000 to 9,000 gallon capacity. The tanker capacity recommended for a particular feedlot can be estimated from Figure 4.

Mobile units should be outfitted with 40- to 120-horsepower pumps supplying 500 to 2,000 gallon per minute discharge rate. As many as six nozzles controlled by air valves may be installed. An elevated main nozzle with 80- to 120- foot trajectory is required, with at least one lower nozzle for uniform distribution within 6 to 80 feet of the water tanker or truck. A typical custom-built elevated nozzle with 3/8-inch by 7- inch opening tilted from the vertical in two dimensions is shown in Figure 5.

The operating efficiency of mobile units is highly dependent upon time required to load the unit, travel to and return from the feedpens being watered. Optimum turn-around time for fillup, hauling, water application and dead haul is 15 minutes per load. In large feedlots, provide more than one water loading station. These loading stations can be either overhead (elevated) tanks or earthen ponds. If ponds are used, a tractor PTO driven, long-shaft, centrifugal pump with 2,000 to 4,000 gallons per minute capacity can be used to load the water tanks or truck.

An elevated filler tank (Figure 3) should have a 5,000- to 10,000-gallon capacity and be supplied either with pond or well water at the rate of 1,000 gallons per minute. A 9- to 12-inch gravity discharge pipe at the bottom can fill the truck or tanker at the rate of 1,000 to 2,000 gallons per minute.

Increasing Cattle Stocking Rate

The quantity of moisture added to the feedlot surface in the form of feces and urine is controlled by animal spacing (area per animal) and body size. The amount of manure moisture generated is shown in Table 1. A 1,000 pound steer at a spacing of 125

Animal size (average lbs. per head)	Average animal spacing, ft²/hd				
	75	100	125	150	175
	Moisture, inches/day				
400	0.05	0.04	0.03	0.03	0.02
600	0.8	.06	.05	.04	.03
800	.11	.08	.06	.05	.04
1000	.13	.10	.08	.07	.06
1200	.16	.12	.09	.08	.07

Table 1. Manure Moisture Production in Cattle Feedlots.

square feet per head produces about 28 inches of moisture per year or 0.08 inches per day. Light replacement cattle may produce only half as much manure moisture as slaughter-weight cattle. This moisture, together with precipitation and water released through digestion of organic matter and precipitation, may not be enough to offset evaporation from the feedlot surface in some years.

Average daily evaporation from a feedlot surface has not been measured directly, but can be estimated from soil evaporation data (Figure 6). For 8 or 9 days after a heavy rainfall the soil surface is wet. Rapid drying occurs at rates of 0.2 inches per day or more and almost equals evaporation from standing water. When the soil or manure surface is no longer saturated, the drying rate drops sharply to approximately one-tenth the peak rate. Such a low rate is probably never reached in a feedlot because wet manure is continually added and the surface is mixed by cattle hoof action. Also, drying rates increase with wind speed, with 15 miles per hour winds causing up to 2.4 times greater evaporation than the constant rate of 0.018 inches per day depicted in Figure 6.

Whenever moisture produced by the cattle and by precipitation is consistently less than daily evaporation rate, dust will become a problem. The number of days until dust problems arise cannot be estimated from available data. In dry weather, dust problems are often noticed first in pens with light replacement cattle and where the moist manure pack has been removed recently.

Stocking rates in Texas and the Southwest range typically from 100 to 150 square feet per head. Research in California showed that when stocking rates were increased to 70 to 80 square feet per head no detrimental effects on daily gain were observed and feed conversion was slightly lower. Under carefully managed conditions, crowding can be a more economical method of dust control than either water sprinkling or chemical treatment. It could also lower solid waste management costs, since the manure pack would be concentrated over a smaller area and easier to collect. However, the California experiments suggest that excessive moisture could eventually result.

Research in Arizona indicates that a space allocation of about 0.1 square feet per pound of live weight controls dust in moderate weather. On hotter days, the cattle concentrate in shaded areas, reducing the moisture production in much of the open corral. Shade space per head limits animal spacing in hot weather. Crowding cattle together during hot weather when dust conditions are worst, without compensating for body heat loss, can affect performance and health.

Feedlots with good drainage (3 to 6 percent slopes) may be able to use this control method. The stocking rate would need to be reduced during high moisture periods. For instance, the stocking rate could be doubled during extremely dry weather, then decreased if rain falls. Portable fences may facilitate stocking rate adjustments. Unpredictability of rainfall may make high stocking rates risky, since cattle performance is measurably lowered by muddy conditions.

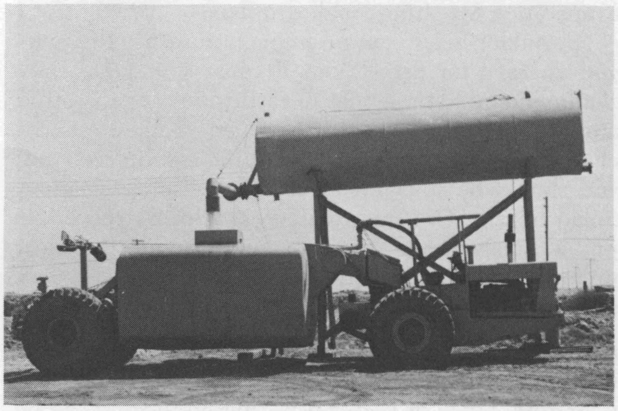

Figure 3. The cost effectiveness of mobile equipment such as this water tanker depends upon proper equipment sizing, placement of loading facilities, equipment reliability and operator skill.

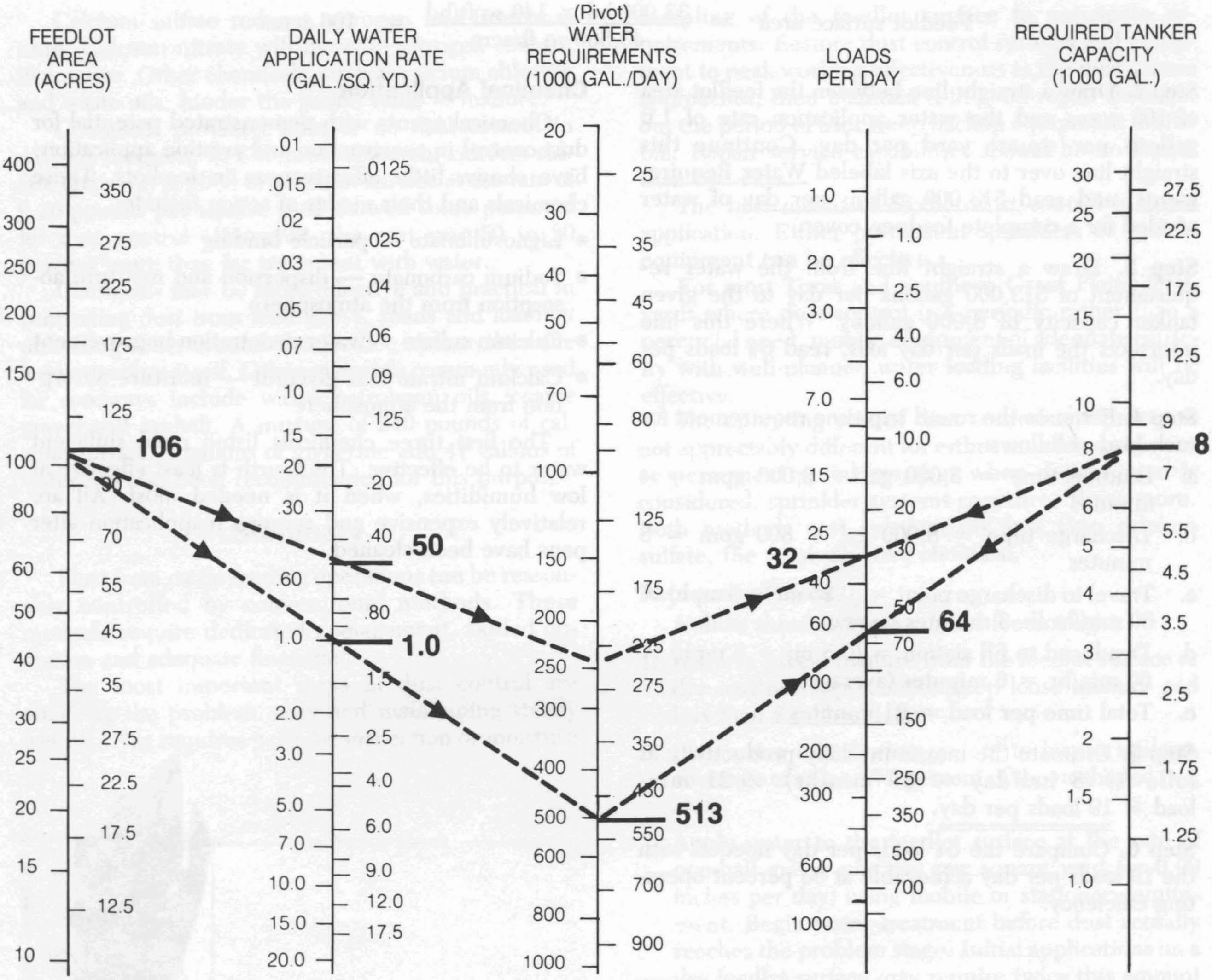

Figure 4. Nomograph for estimating the optimum size of water tankers or trucks for feedlot dust control.

Example Problem

Computing Water Requirements and Tanker Capacity for Dust Control

Given: A 33,000 head cattle feedlot operating at almost full capacity is developing a dust problem. Cattle spacing is 140 square feet per head. The manager has located a new water tanker with 8,000 gallon capacity, 800 gallons per minute discharge pump and ground speed of 5 mph loaded. A 2,000 gallons per minute gravity loading station will be located at one end of the feedlot.

To determine: Will this tanker provide adequate dust control?

Solution: (Use Nomograph — Figure 3.)

Step 1. Calculate the feedlot surface area:

$$\text{Feedlot surface area} = \frac{33{,}000 \text{ hd} \times 140 \text{ sq ft/hd}}{43{,}560 \text{ sq ft/acre}} = 106 \text{ acres}$$

Step 2. Draw a straight line between the feedlot area of 106 acres and the water application rate of 1.0 gallons per square yard per day. Continue this straight line over to the axis labeled Water Requirements, and read 513,000 gallons per day of water needed for a complete feedpen cover.

Step 3. Draw a straight line from the water requirement of 513,000 gallons per day to the given tanker capacity of 8,000 gallons. Where this line intersects the loads per day axis, read 64 loads per day.

Step 4. Estimate the round trip time requirement for each load as follows:

a. Loading time = 8,000 gal ÷ 2,000 gpm = 4 minutes

b. Discharge time = 8,000 gal ÷ 800 gpm = 8 minutes

c. Travel to discharge point = (0.25 mi ÷ 5 mph) × 60 min/hr = 3 minutes (average)

d. Deadhead to fill station = (0.5 mi ÷ 5 mph) × 60 min/hr = 6 minutes (average)

e. Total time per load = 21 minutes

Step 5. Estimate the maximum daily productivity as follows: (8 hrs/day × 50 min/hr) ÷ 21 min/load = 19 loads per day.

Step 6. Compare the 64 loads per day needed with the 19 loads per day achievable at 83 percent operating efficiency.

Answer: No, the 8,000 gallon tanker will not be adequate for peak application rates of 1.0 gallons per day per square yard. It would be adequate for the maintenance application rate of 0.5 gallons per day per square yard when operated at 13.5 hours per day (32 loads per day) during the dust season, or when supplying only 60 percent pen surface coverage at the maintenance application rate with 8 hours per day.

Chemical Application

Chemical agents with demonstrated potential for dust control in construction and aviation applications have shown little effectiveness in feedlots. These chemicals and their modes of action include:

- Lignosulfonate — particle binding
- Sodium carbonate — dispersion and moisture absorption from the atmosphere
- Calcium sulfate — water penetration improvement
- Calcium nitrate and glycerol — moisture absorption from the atmosphere

The first three chemicals listed need sufficient water to be effective. The fourth is least effective at low humidities, when it is needed most. All are relatively expensive and require reapplication after pens have been cleaned.

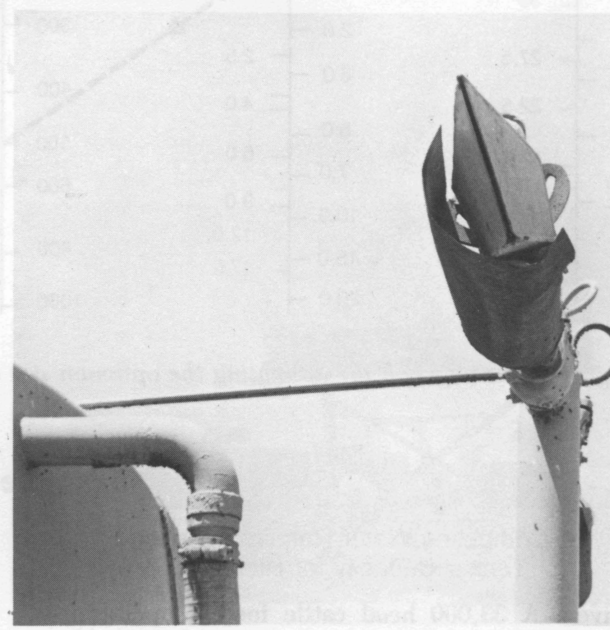

Figure 5. Typical custom-designed pressure nozzle for uniform distribution of water from a mobile tanker or water truck onto the feedlot surface.

Calcium sulfate reduces nitrogen loss from manure. Calcium nitrate will increase nitrogen content in manure. Other chemicals, such as calcium chloride and waste oils, hinder the resale value of manure.

Chemicals provided little or no dust control in Arizona research. In California research, calcium sulfate (gypsum) applied to a feedlot surface at the rate of 0.36 pounds per square yard showed some potential for dust control. However, the cost was 50 to 80 percent more than for treatment with water.

Chemicals may be more effective and practical in controlling dust from feed alleys, roads and loading/unloading areas around the feedlot, rather than the feedlot surface itself. Other materials commonly used for roadways include waste petroleum oils, coarse gravel and asphalt. A mixture of 240 pounds of calcium nitrate, 3 gallons of glycerine and 47 gallons of water has also been recommended for this purpose.

Summary

Dust from cattle feeding operations can be reasonably controlled by conventional methods. These methods require dedicated management, skilled operation and adequate financing.

The most important steps in dust control are attacking the problem early and maintaining steady control. This requires periodic inspection or moisture sampling of the feedlot surface to anticipate requirements. Restore dust control systems and equipment to peak working effectiveness as the dust season approaches, then maintain it in good repair throughout the period of use. Keep backup equipment available. Repair service capabilities should be no longer than two days.

The best means of feedlot dust control is water application. Either permanent sprinklers or mobile equipment can be effective.

For most Texas and Southern Great Plains feedyards where dust control is a periodic rather than a perennial need, mobile equipment of adequate capacity with well-planned water loading facilities will be effective.

The operating cost of dust control equipment is not appreciably different for either mobile equipment or permanent sprinklers, but when depreciation is considered, sprinkler systems cost three times more. Both methods cost substantially less than calcium sulfate, the most effective chemical.

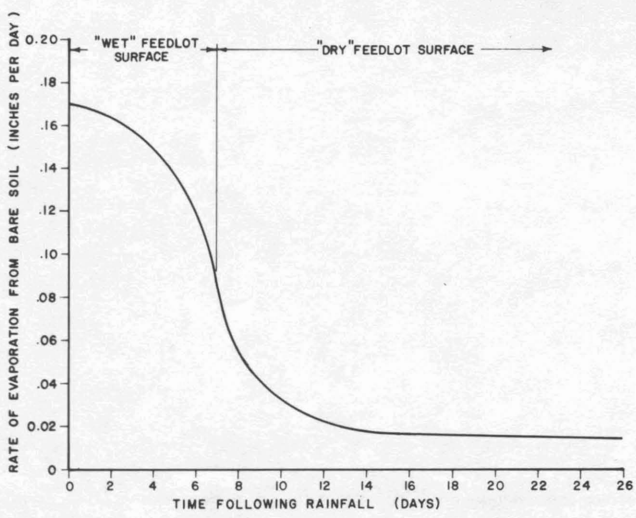

Figure 6. Typical daily moisture removal by evaporation from surface of "wet" and "dry" soil (Olton clay loam).

Recommendations

Follow these steps to control feedlot dust:

1. Remove excess manure from the feedlot surface as dry weather approaches. Keep loose manure pad less than 2 inches deep.
2. Plan water distribution system to insure uniform coverage of at least 75 percent of the unshaded pen area.
3. Apply water to the feedlot surface at the rate of one-half gallon per day per square yard (or 0.09 inches per day) using mobile or stationary equipment. Begin water treatment before dust actually reaches the problem stage. Initial applications on a dry feedlot surface may require twice this amount until manure moisture levels reach 25 percent.
4. Control dust on roads and alleyways using coarse gravel, waste oils, chemicals or water.
5. To control fly breeding, avoid watering vacant pens or overwatering beneath fencelines or feedbunks. Correct improper pen drainage to avoid wet spots where odors and fly breeding also occur.
6. When necessary and feasible, temporarily decrease cattle spacings to increase manure moisture, commensurate with operating constraints and animal health considerations. Installation of portable fences may facilitate animal density adjustment.

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