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BEEF CATTLE FEEDING HANDBOOK

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Control of Dust From Cattle Feedlots

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Dust from cattle feedlots can be a nuisance during prolonged dry periods. Depending upon feedlot location, dust can pose 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[1] showed that peak dust generation ocurs 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.

Dust Control 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 approaches to feedlot dust control:

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.

Removal of Excess Manure

An important step in reducing manure dust is removal of excess manure from corrals.[2] Although manure accumulations may contain stored moisture, dry, pulverized manure is a liability to dust control efforts. Thus, minimizing manure accumulation increases the effectiveness of dust control procedures. A maximum depth of 1 to 2 inches of loose manure is recommended.

Water Application

The most common and effective method of dust control is application of water to the feedlot surface.[1,3,4] In California research, properly sprinkled feedlots generated up to 18 times less dust than untreated lots.[1,4] Dust levels rose more than 850 percent whenever water treatment was discontinued for seven days.[1]

Water Treatment Strategy

Water treatment should begin *before* dust becomes a problem. When water is applied to feedlot surfaces it is necessary to achieve a balance between effective dust control, and the control of odors and flies. The moisture content of the surface manure should be maintained at 25 to 40 percent, insofar as possible.[1,2]

During dry weather, surface manure may contain only 7 to 10 percent moisture. Severe dust problems can occur at this level. The moisture can be raised to the desirable level by an initially heavy water application and/or by animal crowding, followed by a daily water treatment program. The sprinkled 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 no unpleasant odor.

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

Application Rates and Timing

Water application rates should be adjusted 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.[1,3] Thereafter, water should be applied at ½ to ¾ gallon per square yard per day (0.09 to 0.13 inches per day) as long as dry weather persists. For recently scraped feed pens, the recommendation is 1/4 gallon per square yard per day.[3]

California research showed that daily watering gave significantly better dust control than alternate day watering.[1] Watering frequency has proved to be a more critical factor than depth of loose manure on the feedlot surface.

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

Water Application Equipment

The following types of water application systems have been used for feedlot dust control:[5]

Irrigation Equipment
- Permanent sprinklers
  - fence line
  - shade-mounted
  - protected risers (inside pen)
- Portable sprinklers ("big gun")

Mobile Equipment
- Water tankers or trucks

If designed to provide adequate coverage of the feedpen and proper application rates, these systems are about equal in controlling dust.[1] Pen size and shape are a major factor in equipment selection. For example, deep pens are difficult to cover adequately 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 therefore should receive little or no water. Feed bunks should also be kept free from sprinkling water.

Permanent Sprinkler Systems

Permanent sprinkler systems (Figure 1) are capable of treating large sections of the feedlot surface simultaneously. Sprinkler systems can be fully automated to apply water at the most opportune time of 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 is needed to prevent or minimize poor distribution and/or overwatering. Sprinkler heads placed inside feedpens can hamper pen cleaning. Sprinkler systems can suffer damage from freezing or impact during idle seasons, which may entail unscheduled and untimely repairs.

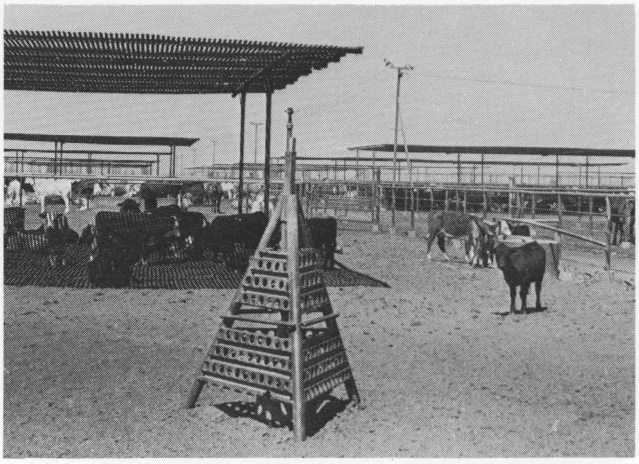

Figure 1 — Permanent sprinkler systems can be fully automated to treat large areas of the feedlot at once. Uniform coverage is achieved under ideal conditions of operation.

Permanent sprinkler systems are inflexible, in that they must be designed, installed and operated for a particular feedlot configuration. The system may not function properly if the feedlot is expanded, pens are relocated or the water pumping rate is altered. Stationary sprinkler systems installed after the feedlot is built may not be optimally designed and may be more expensive. If such sprinkler systems prove ineffective initially, they can not be rendered completely effective, and have little salvage value.

Initial costs of stationary sprinkler systems typically range from $3 to $10 per head of feedlot capacity. Operating costs (exclusive of depreciation) of $0.20 to $0.40 per head per year may be incurred.[5,6]

Solid set sprinkler systems require a constant supply of clean water for best performance. 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 (mobile or irrigation equipment) with large droplet sizes and low pressures can be operated less frequently and for shorter periods. Fewer spray nozzles, lateral lines and risers are required. 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).[7] High pressure systems reduce the likelihood of surface ponding, and can sometimes be operated frequently throughout the day to provide relief from heat stress. However, with high pressure systems water distribution patterns are adversely affected by high winds, and there is more evaporation loss.

Sprinkler heads can be implanted inside the pens (encased for protection), 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. It is believed that small nozzles (1/8 inch diameter), closely spaced to provide considerable overlap, will provide the most uniform distribution pattern available with sprinkler systems.

Mobile Equipment

Mobile tankers or tank trucks (Figure 2) have lower initial costs than permanent sprinkler systems and offer more versatility. 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, and evaporation loss is probably lower. With properly designed nozzles, all areas of the feedlot, even corners, can be treated. Dusty trouble spots in a feedyard can be treated heavily at times when sprinkling the entire lot would be unwise. Mobile equipment for dust control can be readily adapted to changes in feedlot configuration and for dust control in alleyways.

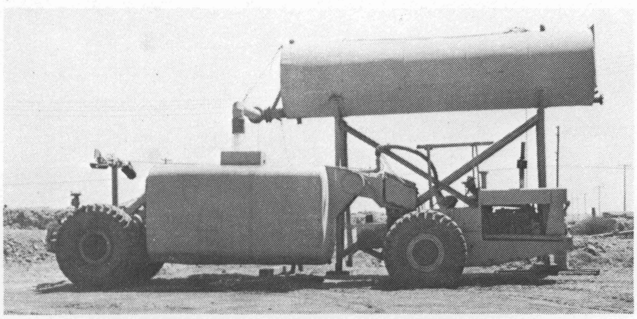

Figure 2 — The cost effectiveness of mobile equipment such as this water tanker depends upon proper equipment sizing, placement of loading facilities, equipment reliability and operator skill.

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 in case of breakdown.

Mobile units used for feedlot dust control vary from standard 2 ½-ton trucks outfitted with 4,000 to 5,000 gallon tanks, up to large tankers with 6,000 to 9,000 gallon capacity.[5] The tanker capacity recommended for a particular feedlot can be estimated from Figure 3.

The largest mobile units can cost up to $2 per head of feedlot capacity if purchased new. Used equipment may be available at a far lower cost, but must be outfitted with 40 to 120 hp pumps (500 to 2,000 gallon per minute output) and multiple nozzles. A main nozzle with 100 to 120 feet maximum trajectory is required, along with one or more additional nozzles to accomplish uniform distribution over the area within 6 to 100 feet of the vehicle. Operating costs of $0.04 to $0.14 per head per month up to $0.50 per head seasonally have been reported for mobile dust control equipment.[5,6]

It is important that an elevated filler tank be used to temporarily store water from the water source so that mobile units can be filled rapidly. The time required to return to the overhead filler tank reduces efficiency of mobile units. A turn-around time of 15 minutes per load (fillup, water application and dead haul) should be the goal.[5]

Increasing Cattle Stocking Rate

In dry weather, dust problems are noticed first in pens where the moist manure pack has just been removed. Light replacement cattle may produce only half as much manure moisture as slaughter-weight cattle.

Animal spacing (area per animal) and body size control the quantity of moisture added to the feedlot surface in the form of feces and urine. The amount of manure moisture generated in this manner is shown in Table 1. A 1,000 pound steer at a spacing of 125 square feet per head produces about 28 inches of moisture per year. This moisture, together with water released through digestion of organic matter and precipitation (17 to 21 inches per year in the Texas Panhandle), essentially offsets evaporation from the feedlot surface.

Table 1. Manure Moisture Production in Cattle Feedlots

Animal Size average lbs. per/hd	*Average animal spacing; Ft²/hd* 75	100	125	150	175
	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

Average daily evaporation from a feedlot surface can be estimated from Figure 4. For eight or nine days following a heavy rainfall the surface is wet.[7] Rapid drying occurs at rates of 0.2 inches per day or more and about equals evaporation from standing water.[8] When the soil or manure surface is no longer saturated, the drying rate drops sharply to about 1/10 the peak rate. It is doubtful, however, that such a low rate is ever 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 mph winds causing up to 2.4 times greater evaporation than the "constant" rate of 0.018

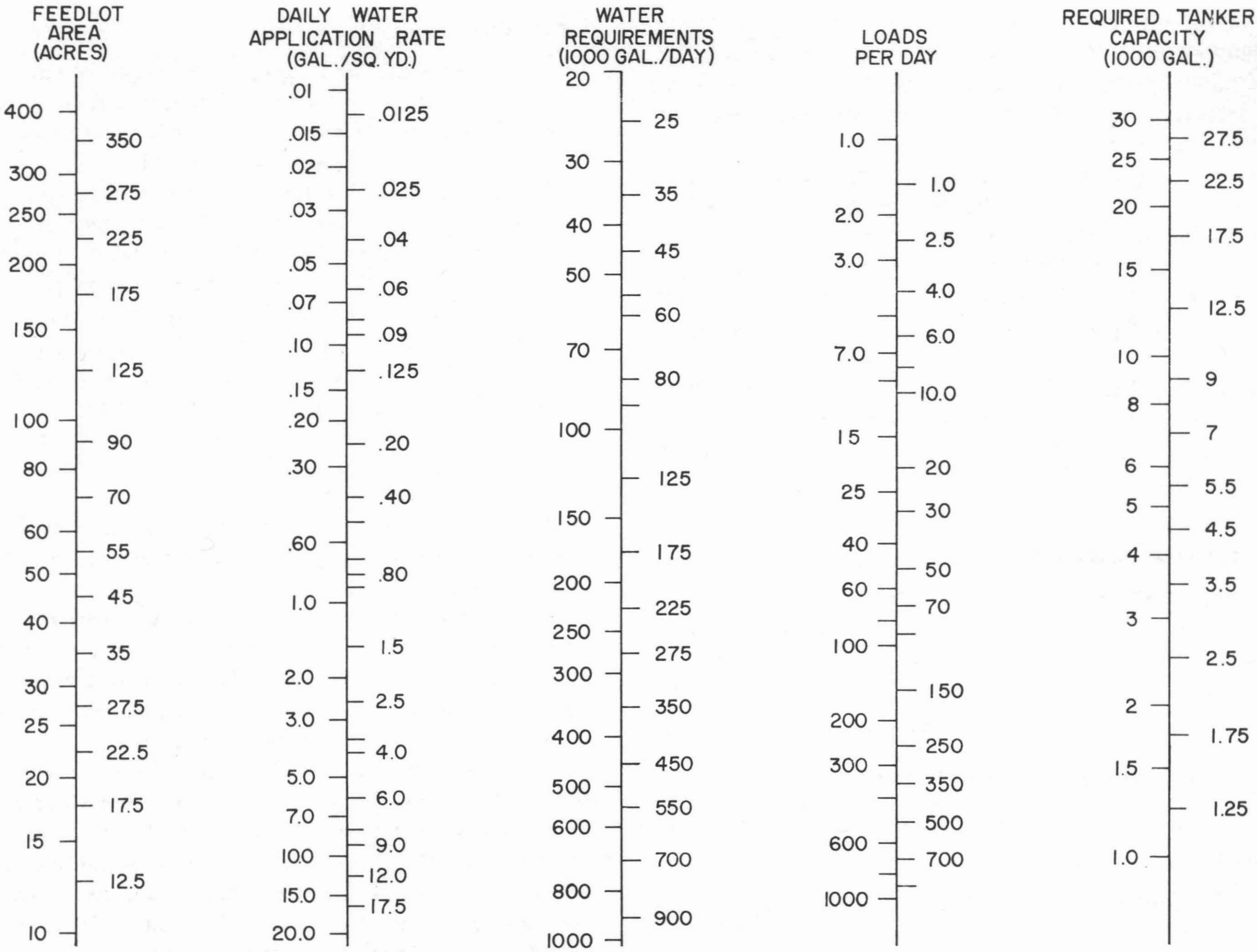

Figure 3. Nomograph for estimating the optimum size of water tankers or trucks for feedlot dust control.

inches per day depicted in Figure 4.

Whenever moisture produced by the cattle and by precipitation is consistently less than daily evaporation rate, dust problems will eventually follow. The number of days until dust problems do arise cannot be estimated from data presently available.

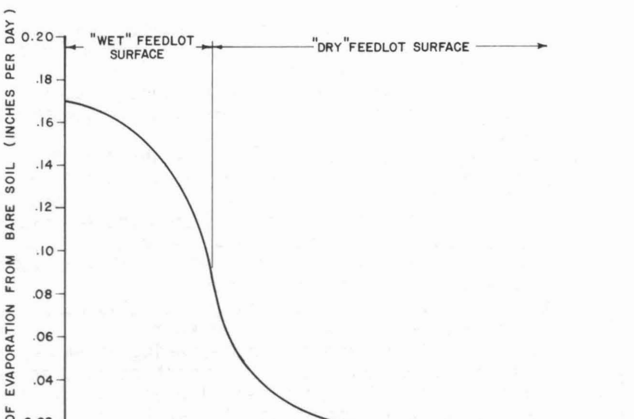

Figure 4. Typical daily moisture removal by evaporation from surface of "wet" and "dry" soil (Olton clay loam).[7]

Stocking rates in Texas and the Southwest typically range 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.[4,9] Under carefully managed conditions, crowding can be a more economical method of dust control than either water sprinkling or chemical treatment. It could also have the advantage of lowering 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.

According to Wiersma,[2] a space allocation of about 0.1 square feet per pound of live weight (10 square feet per cwt) should provide good dust control in moderate weather. However, on hotter days, the cattle concentrate in shaded areas, reducing the moisture production in much of the open corral. Shade space per head is the limiting factor on 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. Nevertheless, stocking rate would need to be adjusted during high moisture periods. For instance, stocking rate could be doubled during extremely dry weather, and then decreased if precipitation occurs. Installation of portable fences may facilitate stocking rate adjustments. Unpredictability of rainfall in the Texas High Plains may make high stocking rates somewhat risky, since cattle performance is measurably lowered by muddy conditions.

Chemical Application

Chemical agents with demonstrated potential for dust control have shown little effectiveness in feedlots.[10] These chemicals and their modes of action include:

Calcium sulfate–water penetration improvement

Lignosulfonate–particle binding

Sodium carbonate–dispersion and moisture absorption

Calcium nitrate and glycerol–moisture absorption from the atmosphere

The first three chemicals need sufficient water to be effective. The fourth is least effective at low humidities, when it is needed most.

Calcium sulfate gives some positive benefit in reducing nitrogen loss from manure. Calcium nitrate also will increase nitrogen in manure. Other chemicals such as calcium chloride and waste oils hinder the resale value of manure.

Wiersma[10] concluded that chemicals provide little or no dust control. All are relatively expensive and require reapplication after pens have been cleaned. In other research,[1] 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 (50 gallons total) has also been recommended for this purpose.[11]

Summary

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

The most important step in effective dust control is to attack the problem early and maintain steady control. This requires periodic inspection and/or moisture sampling of the feedlot surface to anticipate dust control requirements. Dust control systems and equipment should be restored to peak working effectiveness as the "dust season" approaches and should be maintained in good repair throughout the period of use. Backup equipment should be available at all times. Repair service capabilities should be two days or less.[5]

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

For most existing feedyards in Texas, where dust control is a periodic rather than a perennial need, it is believed that mobile equipment of adequate capacity with well-planned loading facilities will prove more attractive as a long-range alternative.

The operating cost of dust control equipment is not appreciably different for either mobile equipment or permanent sprinklers ($0.20 to $0.25 per head of throughput). But, when depreciation is considered, sprinkler systems are three times more expensive.[6] Both methods cost substantially less than calcium sulfate, the most effective chemical.

Recommendations

The basic objective in feedlot dust control should be to maintain a minimum accumulation of surface manure at a moisture content of 25 per cent to 40 per cent. The following steps can be followed to meet this objective:

1. Remove excess manure from the feedlot surface as dry weather approaches. Keep loose manure pad to less than 2 inches deep.
2. Plan water distribution system to insure uniform coverage of at least 75 per cent of the unshaded per area.
3. Apply water to the feedlot surface at the rate of ½ gallon per day per square yard (or 0.09 inches/day) using mobile or stationary equipment. Water treatment should begin *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 per cent.
4. Control dust on roads and alleyways using coarse gravel, waste oils, chemicals, or water.
5. To control fly breeding, avoid watering of vacant pens or overwatering beneath fencelines or feedbunks. Correct improper pen drainage to avoid "wet spots" where odors and fly breeding can also occur.
6. When necessary and feasible, temporarily decrease cattle spacings to increase pen moisture, commensurate with operating constraints and animal health considerations. Installation of portable fences may facilitate animal density adjustment.

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