Economic Analysis of a Water Truck for Feedyard Dust Suppression

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Abstract

Dust created in feedyards can adversely affect cattle performance. Dust suppression can be accomplished by moistening pen surfaces with traveling gun(s) sprinklers, solid-set sprinklers, and water trucks. This study specifically addresses the fixed and operational costs associated with a water truck for various sized feedyards.

Key Words: water truck, dust suppression, fixed costs, operational costs

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Introduction

With the presence of large concentrated cattle-feeding operations in the Texas Panhandle come dust emissions due to the region's semi-arid conditions. The issue of dust from an open-lot feedyard can be a nuisance to neighbors and can be a critical health problem for the operation's cattle, feedyard employees, and potentially nearby communities. These nuisance and health issues can be somewhat avoided by adapting a proactive approach to dust control by undertaking the use of dust suppression methods. One frequent method is the use of water application to the feedyard pen surface using solid-set sprinklers, traveling gun sprinkler system, or water truck systems. This study concentrates on the initial investment and operational costs associated with a water truck in 10,000, 30,000, and 50,000 head feedyards. Specific objectives were to:

- Conduct a literature review to establish the advantages/disadvantages of alternative forms of dust control.
- Conduct an economic analysis to determine capital investment and operating costs associated with water trucks to suppress dust.

Background

The Texas High Plains experienced high winds and daytime temperature with low humidity during the summer of 2000 (Auvermann et al, 2000). This situation caused pen surfaces to become dry and susceptible to airborne dust particles. Coupled with calmer winds and lower evening temperatures, dusty conditions occurred. These calm evenings gave way to dust plumes (Auvermann, 2000) (Figure 1).

Figure 1. Evening feedyard dust conditions.
Source: Dr. Brent Auvermann.

The semi-arid characteristics of the High Plains often create conditions similar to the summer of 2000 where the moisture content of the feedyard pen surface may reach levels as low as seven to ten percent causing excessive dust problems (Sweeten, 1982). The moisture content can be elevated "…by heavy water application and animal crowding, or by both …" This moisture also enables aerobic stabilization of the manure. "A moisture content of between 25 and 40 percent is required for rapid bacterial activity, which produces little unpleasant odor" (Sweeten, 1982).

According to Sweeten (1982), water application rates are dependent on weather conditions, animal size, and manure depth. Loose manure near the surface initially requires one gallon per square yard per day (0.18 inches per day) to reach 25 to 40 percent moisture levels. Subsequently, 0.09 to 0.13 inches of water are needed per day during dry conditions. This is equivalent to one-half to three-fourths gallon per square yard.

It is critical to understand the importance of the surface moisture content when implementing dust control techniques, but it is also necessary to understand the layers that make up the pen's surface. The feedyard pen surface is made up of three such layers (Figure 2). The almost shiny bottom layer is the "native" soil, also referred to as inorganic or mineral soil. The second or middle layer is commonly known as the moist interfacial or buffer layer composed of hard-packed manure and soil mixture. The recommended management objective for this layer is one to two inches in depth. The surface layer is typically non-compacted manure (Auvermann, personal communication). When the outer surface is two to four inches in depth and below 25 percent moisture (Figure 3), proactive dust control methods need to be incorporated into the feedyard's activities. At this depth, the loose manure can produce the hazy, dust plume during the typically calmer, late afternoon or evening hours of the day, as previously mentioned, Figure 1.

Figure 2. Three layers of a feedyard pen surface.
Source: Dr. Brent Auvermann.

Figure 3. Layer of loose manure in this pen is two to four inches in depth.
Source: *Manure Harvesting Frequency – The Key to Feedyard Dust Control in a Summer Drought.*

Ideal conditions for controlling dust emissions are keeping the loose manure layer less than one inch in depth and between 25 to 40 percent moisture as represented in

Figure 4. Too little moisture creates dust events while too much moisture increases the incidence of odor and fly problems (Davis et al, 1986).

Figure 4. Surface layer of loose manure of a recently scraped pen is less than an inch deep.
Source: *Manure Harvesting Frequency – The Key to Feedyard Dust Control in a Summer Drought.*

Feedyard dust control needs to be a mechanism already set in motion before dust becomes a problem. This proactive approach includes several methods such as removal of manure using equipment like a box scrapper or front-end loader, increasing the stocking rate, building shades that in essence increase cattle density, chemical application, and water application. Roads and service areas within the feedyard are predominantly controlled by oil or chemical applications along with water sprinkling.

There are several advantages of investing in a water truck to control feedyard dust including a lower investment cost than a solid-set sprinkler, and it is a more versatile and flexible method of water application. A skilled operator can achieve equal or better water uniformity. In the presence of high winds, spray patterns from water trucks can be more easily adjusted. Water can be applied to all areas of the pen with properly designed spray nozzles. Particularly bothersome dusty areas of the feedyard can be treated without applying water to the entire feedyard. Water trucks can also be utilized for dust control in feed alleys and services areas of the feedyard (Sweeten, 1982). Figure 5 illustrates a truck applying water to the feedyard pen surface.

Disadvantages of using a water truck included high labor and operating costs. There can be difficulty in water application during peak periods and time delay required to refill the water tank. In the case of equipment breakdown, additional equipment may be required as a backup. Also, the governmental cost-share program, Environmental Quality Incentive Program (EQIP), does not provide financial assistance to purchase a water truck.

Despite the disadvantages associated of a water truck, it remains one of the most common methods used for dust suppression in feedyards. This study was designed to help feedyard managers understand the economics of investing and operating a water truck to hopefully assist them in the decision-making process.

Figure 4. Water truck in operation.
Source: Dr. Brent Auvermann.

Data and Methods

Fixed, operational and total costs were estimated for a water truck system to suppress dust in 10,000, 30,000 and 50,000 head feedyards. This was accomplished by utilizing a water truck and a 4,000-gallon tank to apply 1/8th inch of water to the feedyard pen surface per application. It was assumed that fixed costs included the water truck and tank. One water truck was utilized for the 10,000 head yard, two water trucks operated in the 30,000 head feedyard, and three trucks were used in the 50,000 head yard. Depreciation of the water truck(s) was calculated using the straight-line method assuming a 25-year useful life for the truck with $10,000 of salvage value, and a 15-year useful life for the water tank with no assumed salvage value. Capital expenditure projections were provided by industry with a six percent discount rate used to put cost streams in current dollars. Again, using industry averages, the insurance premium was $132 per year. Initially, this appeared to be a relatively low insurance cost; however, feedyards typically purchase an insurance package that covers all feedyard assets including machinery and equipment. Tax, title and license are not charged because this equipment is not typically operated on public highways; however, a one-time $29 registration fee was assessed (Miller, 2007). Annual maintenance and repairs were assumed to be $2,000 per truck.

Operational costs are a direct reflection of the number of hours the equipment is utilized. Energy, labor, maintenance and repairs are the components of annual operational costs. Typically, in the Texas Panhandle, a water truck is operated six months of the year to control feedyard dust emissions from the pen surfaces, April 15 to October 15, or 184 days (Auvermann, 2007). A diesel fuel cost of $2.16 was utilized to operate the water truck(s) (*Texas Crop and Livestock Budgets for the Texas High Plains* for 2007.) Labor costs were assumed at $12.00 per hour based on industry input. Energy costs are the expenditures required to pump the water and were determined utilizing the following formulas:

KW = (.746 * Motor Horsepower) / 90% motor efficiency

Where: KW = kilowatt. # of kilowatts per hour

Total Energy Cost = KW * electricity cost * hours per year operated

Electricity costs were $0.10 per Kwh based on industry input.

In this study, it is assumed a well is available with a sufficient flow capacity to fill the 4,000-water tank; therefore, expenditures do not include the installation of a new well to pump groundwater. There are no costs included for the installation of an irrigation reservoir.

Cost estimates were calculated on a per head capacity and a per head marketed basis. This was accomplished by utilizing the *Southwestern Public Service Company Fed Cattle Survey for 1996 – 2000* to determine the five-year average cattle turnover rate for the 10,000, 30,000, and 50,000 head feedyards. A sensitivity analysis was conducted using three turnover rates (1.75, 2.00, and 2.25) to increase the applicability of results to feedyards with varying turnover rates.

Results

The initial investment cost of a 4,000-gallon water truck system was $154,771. It was comprised of $122,080 for the truck and $32,691 for the water tank. This translates into $15.48 on a per head of capacity basis for a 10,000 head yard. In the 30,000 head feedyard, two water trucks were utilized at $309,542, or $10.32 on a per head of capacity. Similarly, the 50,000 feedyard was projected to have investment costs for three water trucks at a total cost of $464,313, or $9.29 on a per head of capacity, Table 1.

Table 1. Estimated investment costs for water truck(s) for 10,000, 30,000 and 50,000 head capacity feedyards.

Head Capacity	Water Truck	Water Tank	Number of Water Trucks	Project Cost	Project Cost $/hd Capacity
10,000	$122,080	$32,691	1	$154,771	$15.48
30,000	$122,080	$32,691	2	$309,542	$10.32
50,000	$122,080	$32,691	3	$464,313	$9.29

Fixed costs for the water truck consisted of the annualized investment cost, depreciation, interest, insurance, and registration fee. Total annualized fixed costs were $19,739, or $1.97 on a per head of capacity basis for the 10,000 head yard while the 50,000 head feedyard had projected total annualized fixed costs of $59,218, or $1.18 on a per head of capacity, Table 2. The straight-line method was utilized to calculate depreciation using 25-years for the truck(s) with an assumed $10,000 salvage value, and

15-years for the water tank(s) with no assumed salvage value. Insurance was $132 with a one-time registration fee of $29.

Table 2. Projected annualized fixed costs for water truck(s) over a 25-year useful life for the truck and 15-year useful life for the water tank(s) for use in 10,000, 30,000, and 50,000 head feedyards.

Head Capacity	Project Cost	Ann[1] Fixed Cost	Annual Depreciation	Insurance & Registration	Total Ann Fixed Cost	Ann Cost $/Hd Capacity
10,000	$154,771	$12,916	$6,663	$161	$19,739	$1.97
30,000	$309,542	$25,832	$13,325	$322	$39,479	$1.32
50,000	$464,313	$38,748	$19,988	$483	$59,218	$1.18

[1] Ann meaning annualized.

Total operational costs varied from $18,041, or $1.80 on a per head of capacity basis, for one water truck in the 10,000 head yard to $86,205, or $1.72 on a per head of capacity, for three trucks in the 50,000 head capacity feedyard, Table 3. Applying 1/8th inch required 54 tanks of water or loads or 3.38 days in the 10,000 head feedyard working an eight-hour day. Similarly, the 30,000 head yard required 162 loads or 5.06 days. Two hundred seventy loads or 5.63 days were necessary to apply 1/8th inch of moisture in the 50,000 feedyard.

Components of the operational costs included pumping cost to fill the water tank, maintenance and repairs, labor, and truck fuel cost. Pumping cost ranged from $1,552 for the 10,000 head yard to $7,759 for the 50,000 head capacity feedyard. Annual maintenance and repairs were assumed at $2,000 per truck. Operating one water truck at a labor cost of $12 per hour resulted in a total annual cost of $8,424 in the 10,000 head feedyard, $25,272 to drive two water trucks in the 30,000 head yard, and $42,120 to operate three water trucks in the 50,000 head yard. At a rate of $2.16 per gallon, one water truck in the 10,000 head yard had annual diesel fuel costs of $6,065, whereas, $30,326 were the fuel costs in the 50,000 head feedyard.

Table 3. Projected annual operational costs for water truck(s) over a 25-year useful life for the truck and 15-year useful life for the water tank(s) for use in 10,000, 30,000, and 50,000 head feedyards.

Head Capacity	Pumping Cost	Mtc[*] & Repairs	Labor Cost	Truck Fuel Cost	Operational Cost	Operational Cost $/Hd Capacity
10,000	$1,552	$2,000	$8,424	$6,065	$18,041	$1.80
30,000	$4,655	$4,000	$25,272	$18,196	$52,123	$1.74
50,000	$7,759	$6,000	$42,120	$30,326	$86,025	$1.72

[*] Mtc meaning maintenance.

Estimated fixed and operational costs were combined to establish the total annual costs to operate a water truck(s) in three size feedyards to control dust emissions. Annualized fixed costs were $1.97, $1.32, and $1.18 (Table 4) for 10,000, 30,000, and 50,000 head feedyard capacities, respectively; whereas, the operational costs varied from $1.80 in the 10,000 head yard to $1.72 in the 50,000 head yard. Total costs in dollars on a per head of capacity basis were $3.77 in the 10,000 head yard, $3.06 in the 30,000 head yard, and $2.90 in the 50,000 head yard.

Table 4. Estimated fixed, operational, and total annual costs for water truck(s) based on a 25-year useful life for the truck and 15-year useful life for the water tank(s) for use in 10,000, 30,000, and 50,000 head feedyards.

Head Capacity	Fixed Costs $/Hd Capacity	Operational Costs $/Hd Capacity	Total Costs $/Hd Capacity
10,000	$1.97	$1.80	$3.77
30,000	$1.32	$1.74	$3.06
50,000	$1.18	$1.72	$2.90

The *Southwestern Public Service Company Fed Cattle Survey for 1996 to 2000* was utilized to determine the five-year average cattle turnover rate for the 10,000, 30,000, and 50,000 head feedyards. A sensitivity analysis was conducted utilizing three turnover rates, 1.75, 2.00, and 2.25. At a turnover rate of 2.00 in the 10,000 head yard, annual fixed costs were $0.99 and operational costs were $0.90, for a total of $1.89 per head marketed to operate one water truck. The same turnover rate, 2.00, resulted in annual fixed costs of $0.59 and operational costs of $0.86, totaling $1.45 per head marketed to operate the three water trucks required in a 50,000 head feedyard.

Table 5. Total annual costs for water truck(s) is based on a 25-year useful life for the truck and 15-year useful life for the water tank(s) for use in 10,000, 30,000, and 50,000 head feedyards.

Head Capacity	Turnover Rate (Hd Marketed/ Hd Capacity)	Fixed Cost $/Hd Marketed	Operational Cost $/Hd Marketed	Total Cost $/Hd Marketed
10,000	1.75	$1.13	$1.03	$2.16
	2.00	$0.99	$0.90	$1.89
	2.25	$0.88	$0.80	$1.68
30,000	1.75	$0.75	$0.99	$1.74
	2.00	$0.66	$0.87	$1.53
	2.25	$0.58	$0.77	$1.36
50,000	1.75	$0.68	$0.99	$1.66
	2.00	$0.59	$0.86	$1.45
	2.25	$0.53	$0.77	$1.29

Discussion and Implications

Annual total costs on a per head of capacity basis to apply 1/8th inch water per application using a water truck(s) for dust suppression in a 10,000, 30,000, and 50,000 head open-lot feedyard were projected at $3.77, $3.06, and $2.9, respectively, Table 4. According to the federal assistance guidelines of the Environmental Quality Incentive Program (EQIP) (Bade, 2007), water trucks are not eligible for cost-share assistance. This does not compare positively with the solid-set sprinkler that qualifies for EQIP where total annual costs ranged from $2.70 to $2.09 (Guerrero et al., 2006) for similar size feedyards. There is also increased management, labor and maintenance and repairs for a water truck as compared to the solid-set sprinkler system.

Even though a water truck system does not qualify for EQIP funding, a water trucks remains one of the most commonly utilized methods of dust control in a feedyard. It is not as costly as a solid-set sprinkler and is much more versatile and flexible for feedyard dust control. Water can be applied to troublesome areas without applying water to the entire feedyard. In addition, water trucks can also be utilized for dust control in feed alleys and services areas (Sweeten, 1982).

References

Amosson, S., J. Smith, L. Almas, F. Bretz, B. Guerrero and M. Freeman. Texas Crop and Livestock Enterprise Budgets for the Texas High Plains: Projected for 2007. Texas Cooperative Extension. Bulletin B-1241 (C1 & C2).

Auvermann, B., D. Parker, and J. Sweeten. 2000. Manure Harvesting Frequency – The Key to Feedyard Dust Control in a Summer Drought.

Auvermann, B. 2007. Personal communication. Texas Agricultural Experiment Station, Amarillo, Texas. June 22.

Bade, Norman. 2007. Personal communication. Assistant State Conservationist for Programs, USDA-NRCS. Temple, Texas. May 3.

Davis, J., T. Stanton T., and T. Haren. Feedlot Manure Management. Publication No. 1.220. Retrieved June 28, 2007 from: http://www.ext.colostate.edu/PUBS/livestk/01220.html.

Guerrero, B., S. Amosson, and L. Almas. February 2006. "Economic Analysis of Solid-Set Sprinklers to Control Dust in Feedlots." Report prepared for the Air Quality Initiative. Texas A&M University Agricultural Research and Extension Center, Amarillo, Texas. 14pp.

Miller, Robert. 2007. Personal communication. Potter County Tax Assessor Amarillo, Texas. August 22.

Queensland Government. 2003. Feedlot Water Management Series: Dust Control. Department of Primary Industries and Fisheries. Retrieved June 12, 2007 from http://www.dip.qld.gov.au/environment/5243.html

Southwestern Public Service Company (SPC). 1996-2000. Cattle-Feeding Capitol of the World – Fed Cattle Survey.

Sweeten, J. Feedlot Dust Control. 1982. Texas Agricultural Extension Service Bulletin L-1340.