Project Narrative

Name of the Project: Assessing the Water Demand for Sprinkler Dust Control on High Plains Feedyards
Geographic Area of the Project: Texas High Plains (TAEX Districts 1 and 2)
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Amount of Funding Requested: $20,000

Project Need, Description and Expected Outcomes

The frequency and intensity of public outcry over dust emissions from cattle feedyards in the Texas High Plains have increased dramatically during the summer droughts of the past several years. In response to external pressure and a growing sense that feedyard microclimate directly affects feed-to-gain performance, an increasing number of feedyard owners have elected to install solid-set sprinkler systems on newly constructed feedyards or expansions. Noting the trend, the public appears increasingly insistent on mandating sprinkler systems as a *de minimis* solution to the off-site dust problems posed by cattle feeding in confinement. Because the water requirements for dust control have not been well documented, however, the incremental aquifer withdrawals required to sustain a growing cattle industry do not yet reflect the probable effect of public pressure to mandate sprinkler systems on feedyards. The public needs to know the unintended consequences of its newly discovered policy preferences and how those consequences might affect other environmental values such as long-term water availability.

The currently accepted design criteria for feedyard sprinkler systems are based loosely on regional crop consumptive water use. These gross design criteria would triple the total consumptive water use by each feedyard using sprinkler systems during the 6-month “dust season” in the High Plains. However, because sprinkler dust control is decidedly *not* analogous to the crop irrigation paradigm, a model of feedyard moisture dynamics must be adapted to the unique physical processes and management features that distinguish feedyard moisture dynamics from those of irrigated cropping systems. Such a refined model will account for adjunct operations and management factors such as manure harvesting, stocking density modification, continuous manure deposition and application of supplemental moisture. The long-term objective of moisture application is to maintain a moisture content of 25-40% (wet basis) in the manure pack.

In this project, which builds on existing feedlot hydrology research being conducted at the TAES/USDA experimental feedlot in Bushland, TX, we propose a series of laboratory and field experiments followed by model validation to (a) validate the three-stage feedlot drying model proposed by Lott (1994); (b) adapt the modified Penman-Monteith evapotranspiration model (used in regional irrigation-scheduling networks) to link the three-stage drying model to weather data generated by those mesoscale weather networks; and (c) use the resulting composite model to predict the incremental water demand implied by mandating sprinkler dust control as an environmental policy measure. In the laboratory phase conducted in a greenhouse at the Bushland experimental feedlot, we will build small-scale, simulated feedlot surfaces with subsoil and compacted manure and add pre-measured moisture uniformly to each one. Treatments will include manure thickness (0.5”, 1” and 2”), manure surface roughness (qualitative; rough vs. smooth) and initial moisture content (30%, 45% and 70% wet basis). We will monitor greenhouse microclimate and the moisture status of each simulated feedyard surface over time using gravimetry, reconstituting each sample to its moisture status when removed and returning it to its original location. For linkage with future remote-sensing research, we will correlate gravimetry results with infrared temperature measurements of the manure surface.

In the field phase, we will use "environmental pens" equipped with a newly installed, solid-set sprinkler system at the TAES/USDA experimental feedlot at Bushland, TX. We will monitor feedyard moisture status using gravimetric analysis of manure from the corral surface. Real-time weather will be measured on the feedyard using an automatic weather station similar in every respect to the NPET network nodes. Evaporative losses from the corral surface will be used to calibrate the appropriate parameters in the modified Penman-Monteith equation.

In the modeling phase, we will use laboratory and field results to predict annual water use for dust control in cattle feedlots and project the implications of requiring sprinkler systems for feedlot dust control. We will install a remote, cellular-capable, automatic weather station (Campbell Scientific, Logan, UT) and in-line water meters on a sprinkler-equipped, commercial feedyard (a) to track actual water use and (b) to provide microclimate data to validate the Penman-Monteith feedyard evaporation model at the commercial scale.

Specific Issues Addressed

The proposed research addresses the following specific issues identified as a priority to TWRI/TAES:

1. Water resources: how much additional water would be required to sustain broad adoption of solid-set sprinklers as a standard dust control practice for cattle feedyards in the Texas High Plains?

2. Water management and conservation: how can we capitalize on existing evapotranspiration networks to evaluate design and operation options to optimize water requirements for sprinkler dust control?

3. Policy analysis: how would establishing sprinkler dust control as a Best Available Control Technology (BACT) for cattle feedyards affect the accuracy of current water-use projections, regional water planning efforts and interbasin transfer opportunities in the Texas High Plains?

Collaboration

Arturo Romanillos, TAES Feedlot Hydrologist – provide day-to-day supervision of project staff in the laboratory/greenhouse and field phases of the project.

USDA-ARS field staff (Bushland) – provide access to NPET network data to adapt the modified Penman-Monteith equation to predict feedyard evaporation rates as a function of manure depth, water applications and weather.

Dr. David Parker, WTAMU – co-supervise MS-level graduate student in environmental sciences at West Texas A&M University; provide day-to-day linkage with ongoing NPET network development efforts during all phases of the project.

Thomas Marek, TAES – facilitate access to historical NPET and Panhandle Regional Water Planning data in the modeling phase of the project; coordinate use of NPET algorithms through Don Dusek.

Ben Weinheimer, Texas Cattle Feeders Association – facilitate access to commercial feedyard(s) to measure water use by sprinkler dust-control systems.

Submitted by ___________________________

Approved for submittal ___________________________