Air Quality 101: Open-Lot AFOs

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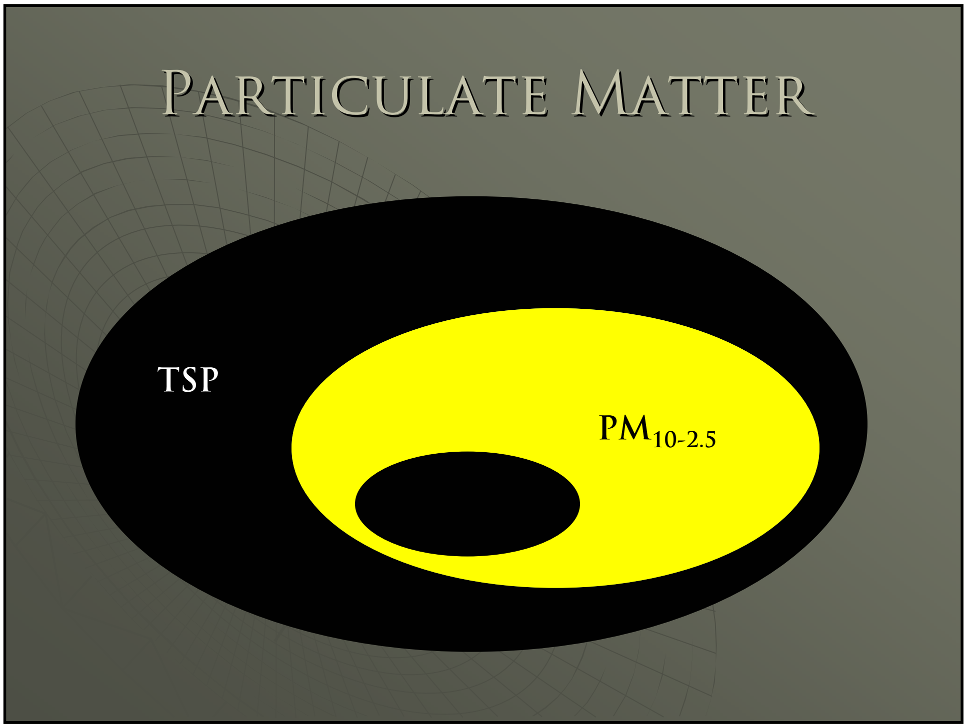
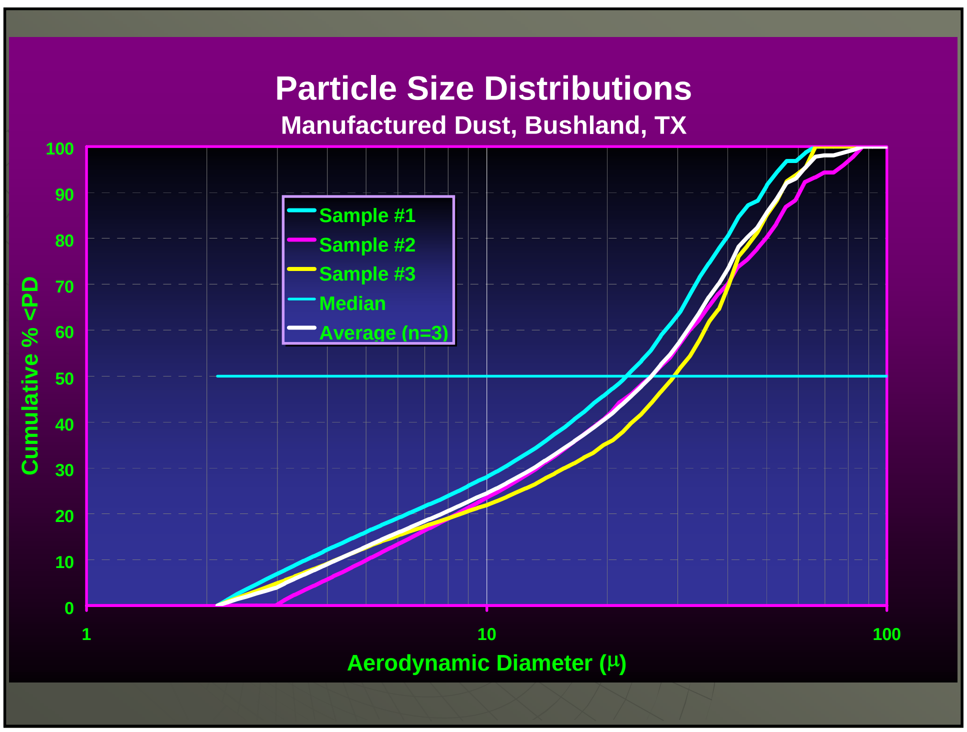
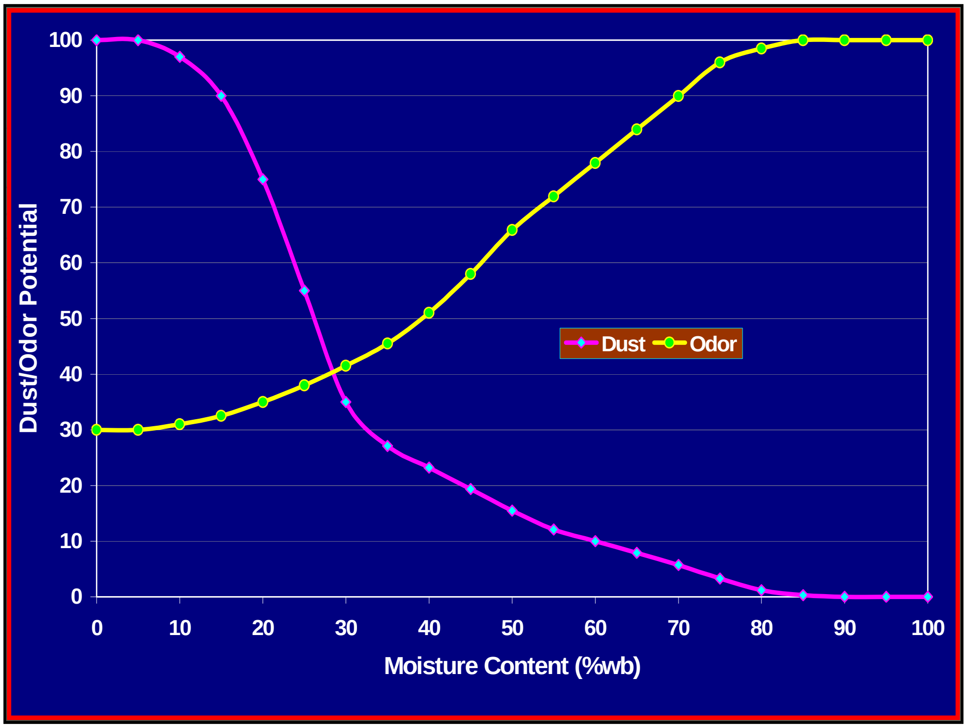
Outline

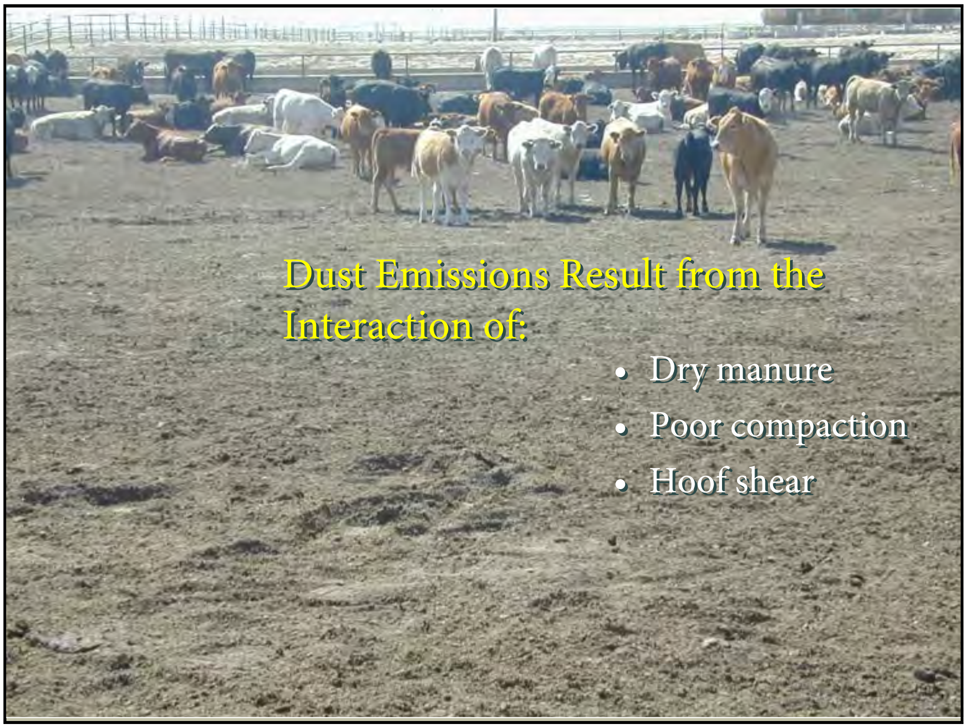
- Particulate Matter (PM)
  - Total Suspended Particulate (TSP)
  - Inhalable PM (PM_{10})
  - Respirable PM ($PM_{2.5}$)
  - Coarse PM ($PM_{10-2.5}$)
- Visibility
- Ammonia (NH_3)
- Odors


PARTICULATE MATTER
TSP
$PM_{10-2.5}$


Particle Size Distributions
Manufactured Dust, Bushland, TX
Cumulative % <PD
100
90
80
70
60
50
40
30
20
10
0
1
10
100
Aerodynamic Diameter (μ)
Sample #1
Sample #2
Sample #3
Median
Average (n=3)

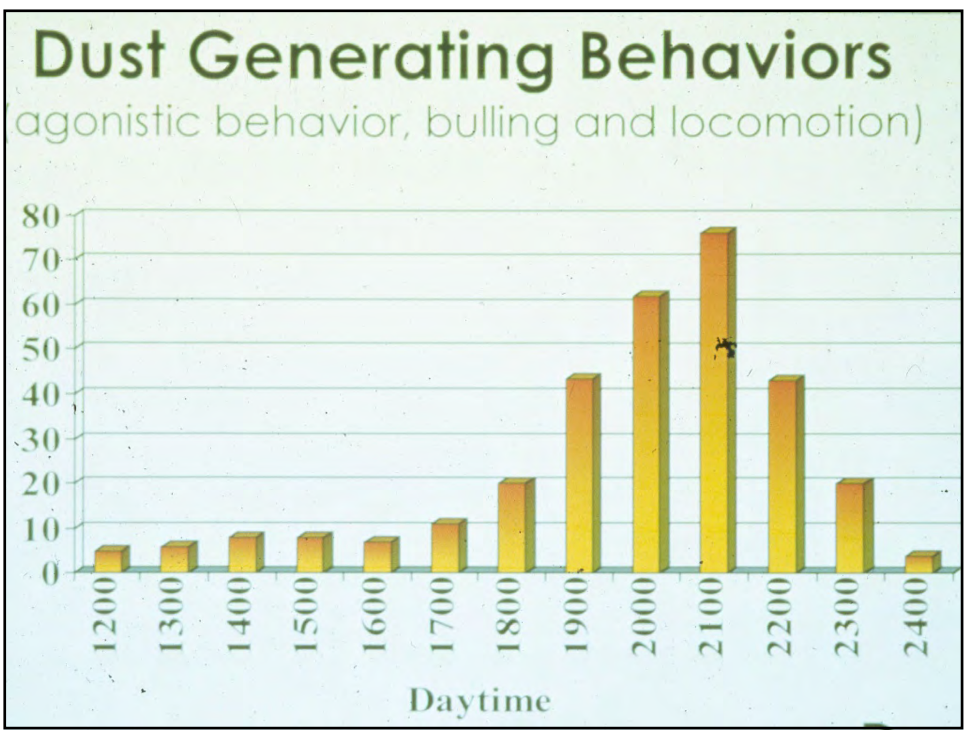

100
90
80
70
60
50
40
30
20
10
0
Dust/Odor Potential
0
10
20
30
40
50
60
70
80
90
100
Moisture Content (%wb)
Dust
Odor


Open-Lot Emissions Mechanisms and Principles of Control



Driver #1: Surface Manure Depth


Driver #2: Cattle Behavior


Dust Generating Behaviors
(agonistic behavior, bulling and locomotion)
80
70
60
50
40
30
20
10
0
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
Daytime

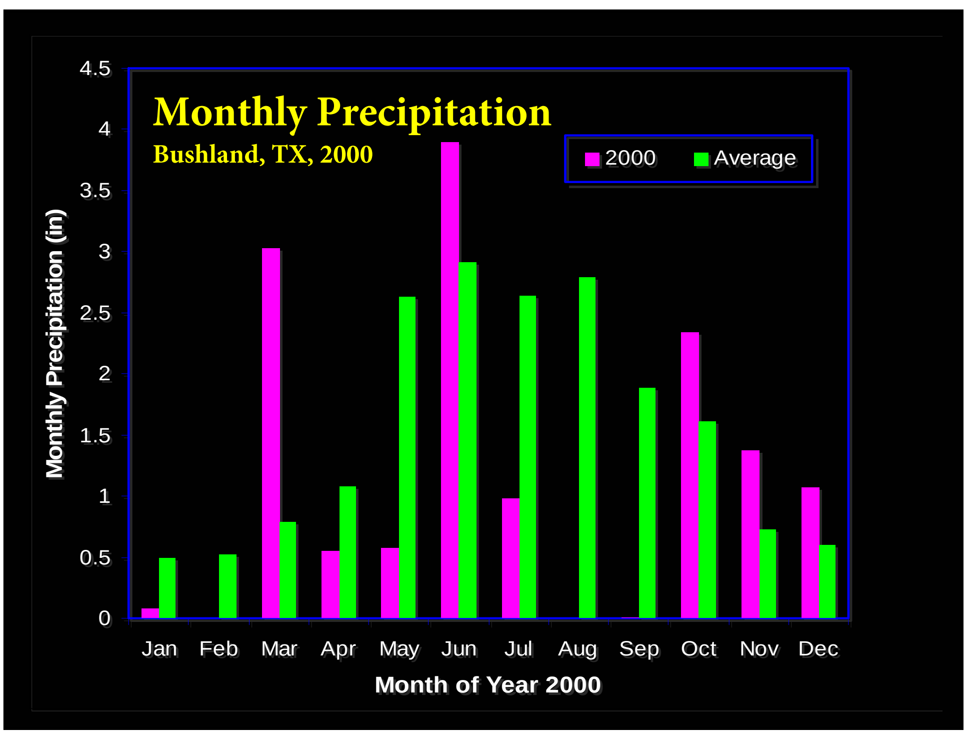

Driver #3: Corral Surface Moisture

Raising moisture content of corral surface material by 10% requires 6-9 gal/hd per 1" depth

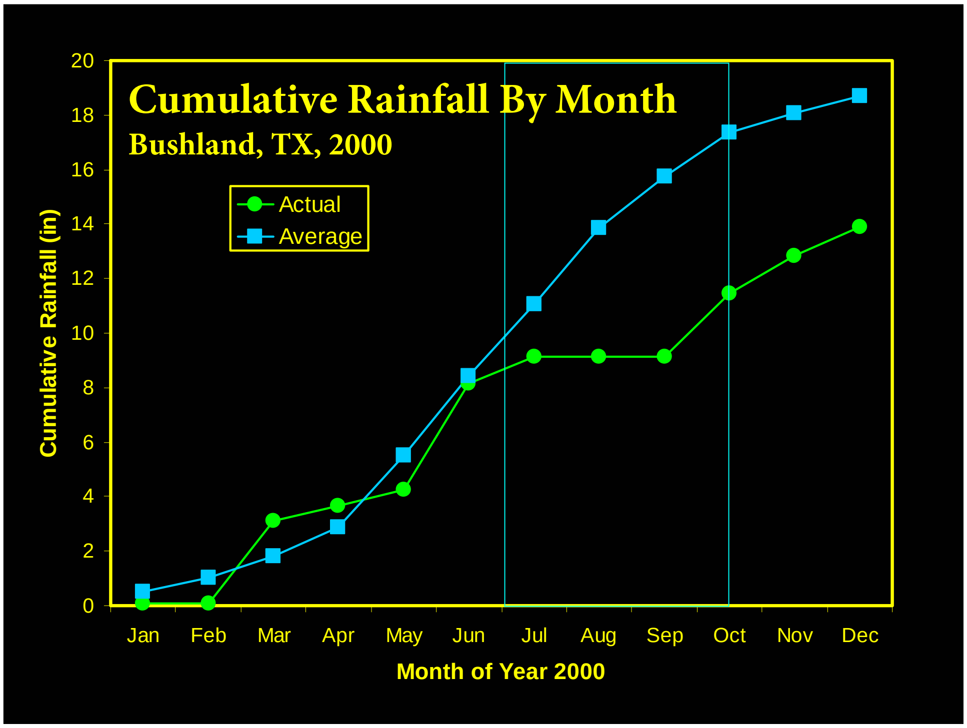
Example. Raise moisture from 10% to 35% in a 2" layer of loose manure = 7.5 x 2.5 x 2 = 39 gal/hd

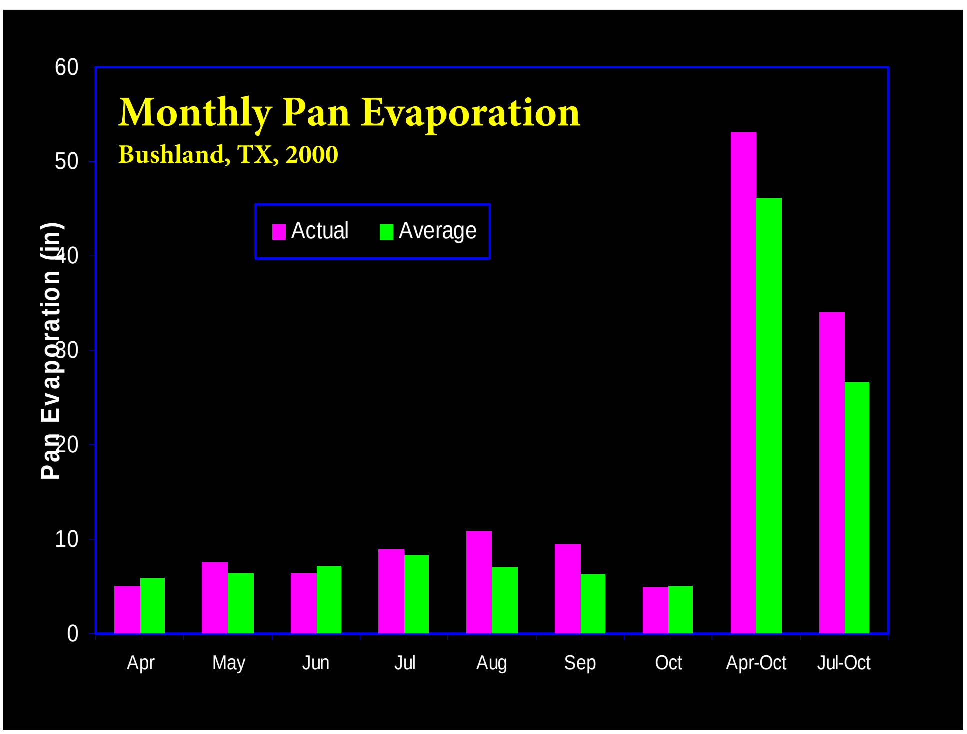
Equivalent 24-hr continuous pumping rate:
26.0 gpm per 1,000 hd

Case Studies: Fall 2000 & 2005



Monthly Precipitation
Bushland, TX, 2000
2000
Average
Monthly Precipitation (in)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month of Year 2000

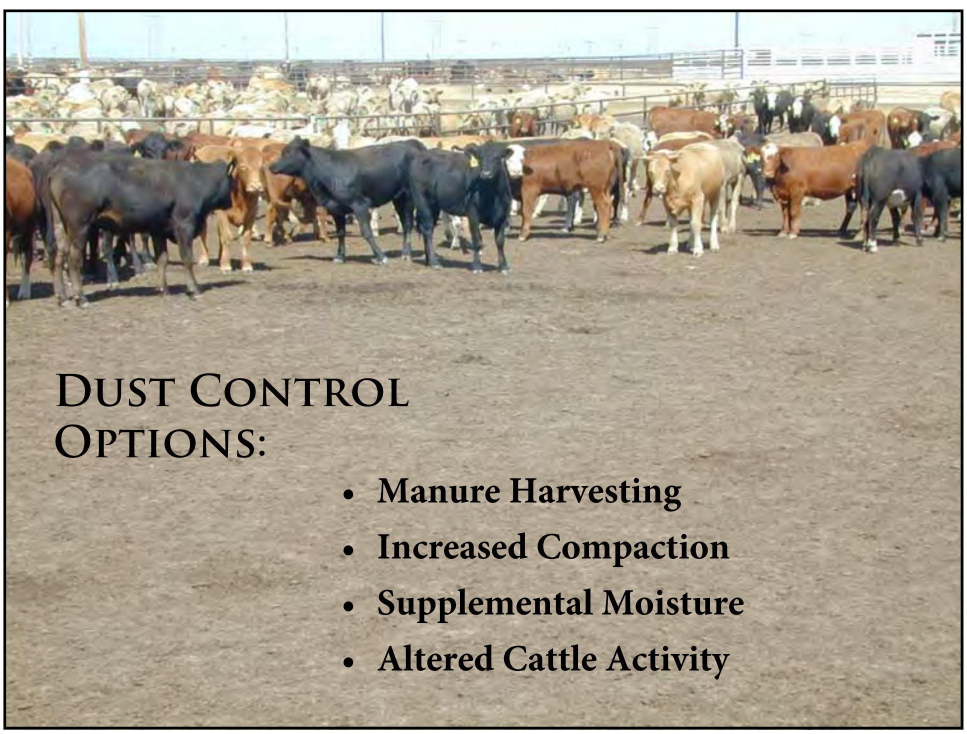

Cumulative Rainfall By Month
Bushland, TX, 2000
Actual
Average
Cumulative Rainfall (in)
0
2
4
6
8
10
12
14
16
18
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month of Year 2000

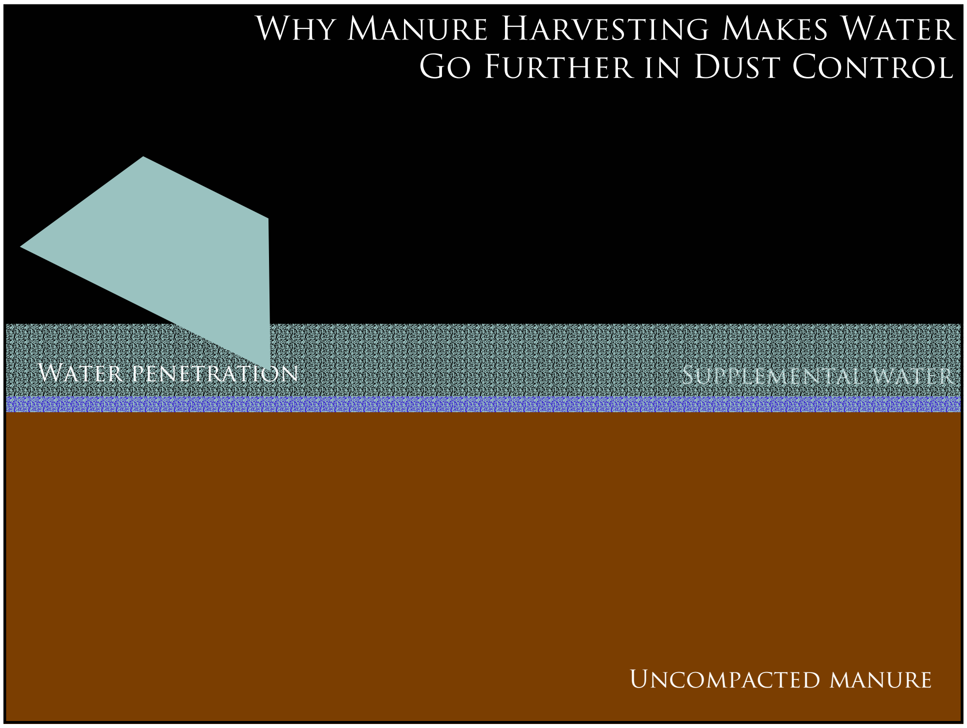

Monthly Pan Evaporation
Bushland, TX, 2000
Actual
Average
Pan Evaporation (in)
0
10
20
30
40
50
60
Apr
May
Jun
Jul
Aug
Sep
Oct
Apr-Oct
Jul-Oct

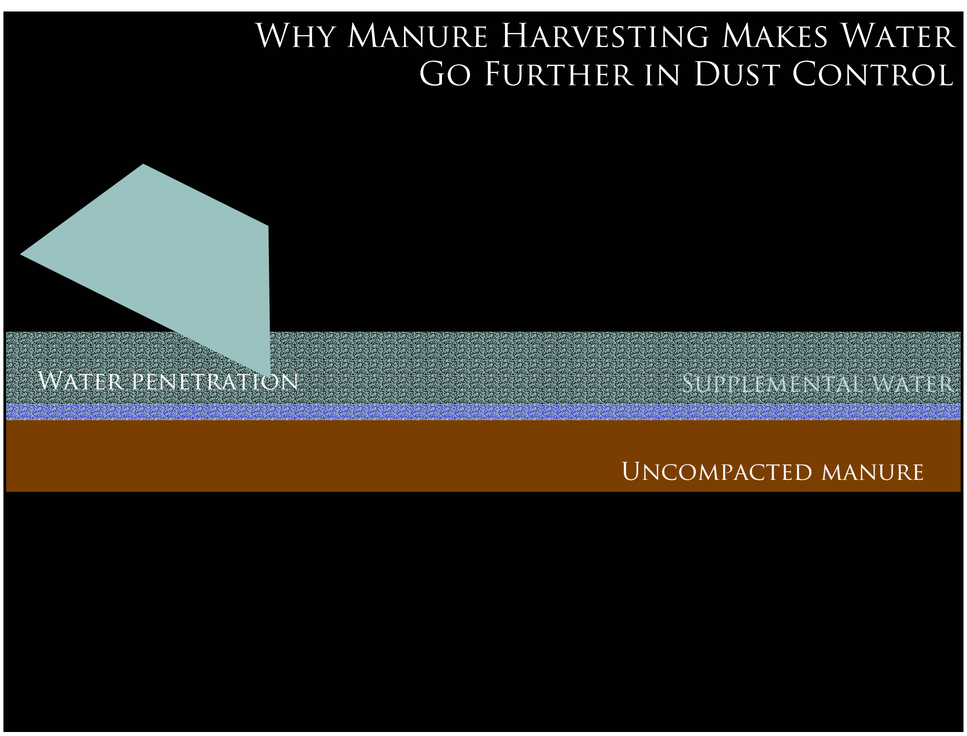
What We're Seeing This Year in the Panhandle

- Last meaningful rainfall was around 9/1/05
- Some feedyards rolled the dice:
  - Winterized sprinkler systems in September in anticipation of the October freeze (SOP)
  - Built wintertime mounds using what they had available: *dry, uncompacted manure*
  - Banked on some timely rainfall to ensure compaction
  - *Didn't get it*
  - *September diesel fuel ($$$) and labor costs ($$$) were wasted*


THIS IS TOO DEEP.


Dust Control Options:
• Manure Harvesting
• Increased Compaction
• Supplemental Moisture
• Altered Cattle Activity

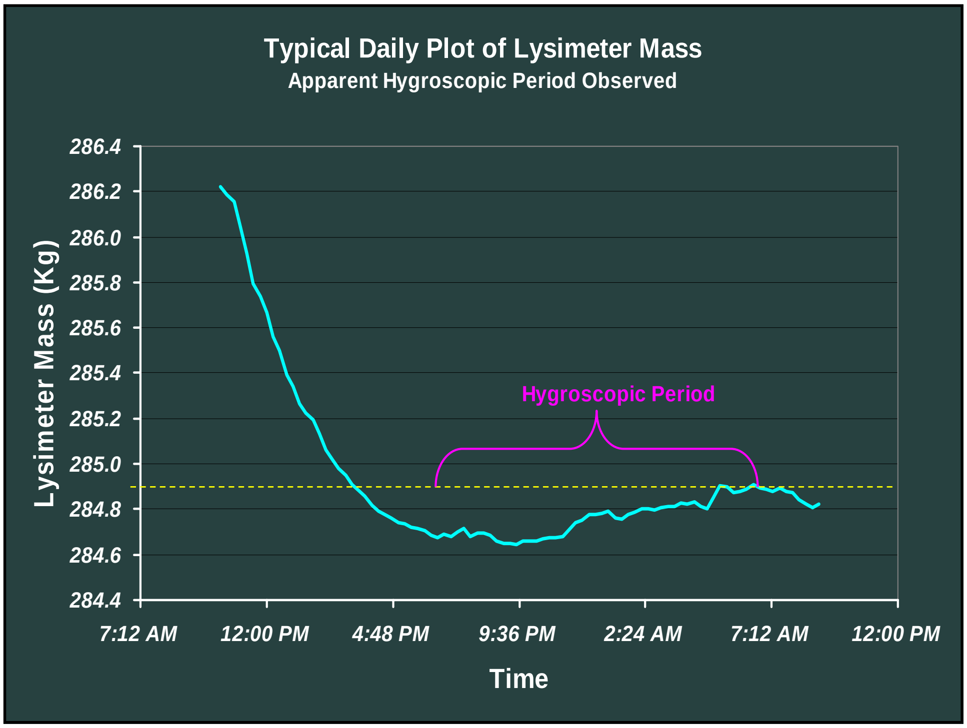

Why Manure Harvesting Makes Water
Go Further in Dust Control
Water penetration
Supplemental water
Uncompacted manure


Why Manure Harvesting Makes Water
Go Further in Dust Control
Water penetration
Supplemental water
Uncompacted manure

Take-Home Messages

- Applying water to an open-lot surface, either passively or actively, is not a cure-all
- Frequent manure harvesting (>1 per turn) will decrease water requirements and increase water effectiveness
- Use the off-season to get ready
- Prioritize within the yard *and* the corral

Determination of Feedlot Surface Evaporation Using Weighing Lysimeters



A Few Truisms

- Manure harvesting and moisture control will have a synergistic effect
- Building mounds with dry manure doesn't work; needs 25-30% moisture for compaction
- Manure harvesting makes supplemental water go further (Auvermann, 2003; Maghirang et al., 2005)

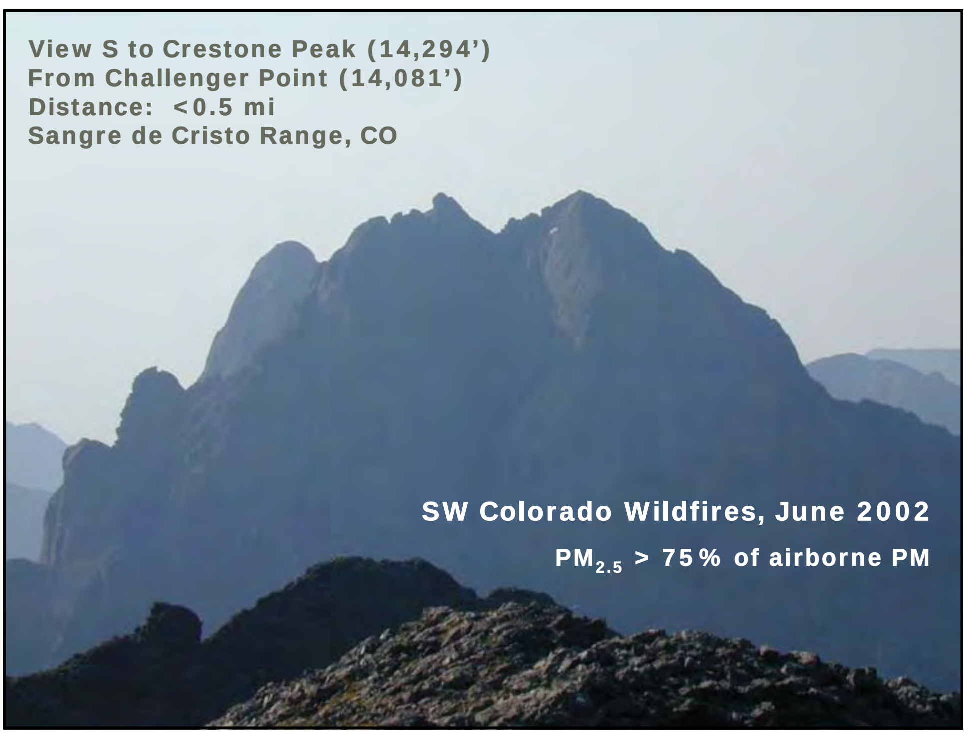
Integrated Corral Management (ICM)

- Integrates environmental protection into the day-to-day operations of a cattle feedyard
- Puts practical information technologies into the hands of the employees best suited to collect economically and environmentally significant data at the corral level
  - Global positioning systems (Bluetooth/GPS)
  - Radio-frequency identification (RFID)
  - Wireless broadband (Wi-Fi/802.11_)
  - Digital photography
  - Personal digital assistant (PDA) hardware platform

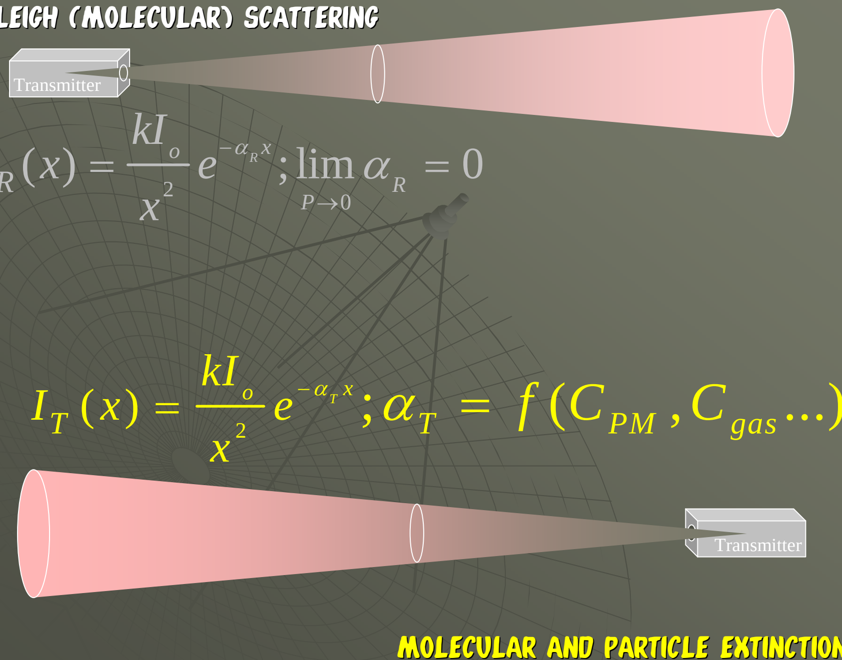
Practical Applications of ICM

- Photograph corral-surface conditions of concern
- Real-time tracking of pen riders
- Rapid cattle ID
  - Removal of mortalities
  - Treatment of sick cattle
- Sprinkler system overrides (leaks, poor performance, special conditions)
- Pipeline to feedyard database


VISIBILITY


View S to Crestone Peak (14,294’)
From Challenger Point (14,081’)
Distance: <0.5 mi
Sangre de Cristo Range, CO
SW Colorado Wildfires, June 2002
$PM_{2.5}$ > 75% of airborne PM

Rayleigh (Molecular) Scattering

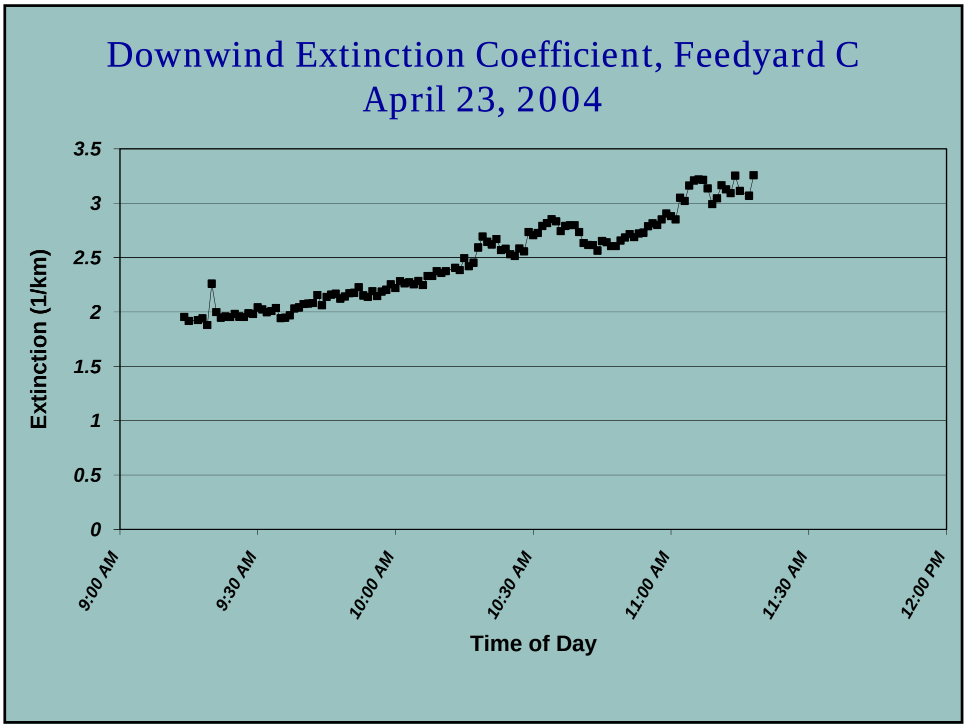


$$I_R(x) = \frac{kI_o}{x^2} e^{-\alpha_R x}; \lim_{P \to 0} \alpha_R = 0$$

$$I_T(x) = \frac{kI_o}{x^2} e^{-\alpha_T x}; \alpha_T = f(C_{PM}, C_{gas} \ldots)$$

Extinction efficiencies for ubiquitous particle types (Malm, 1999)

Particle Type	*Dry Extinction Efficiency (m^2/g)*
Sulfates	3.0
Organics	3.0
Elemental Carbon	10.0
Nitrates	3.0
Soil Dust	1.25
Coarse Particles	0.6
Feedyard Dust	***????***


Downwind Extinction Coefficient, Feedyard C
April 23, 2004
Extinction (1/km)
3.5
3
2.5
2
1.5
1
0.5
0
9:00 AM
9:30 AM
10:00 AM
10:30 AM
11:00 AM
11:30 AM
12:00 PM
Time of Day


N
500
0
500
1000
1500 Meters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