

Dust Emission Potential of Cattle Feedlots as Affected by Feedlot Surface Characteristics

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Introduction

- Particulate matter (PM) emission is a major air quality concern in open cattle feedlots.
- Need to characterize and mitigate air pollutant emissions from cattle feedlots in view of more stringent air quality standards being developed.
- Need for better understanding of the relationship between the rate of particulate emission and feedlot surface characteristics.



Objective

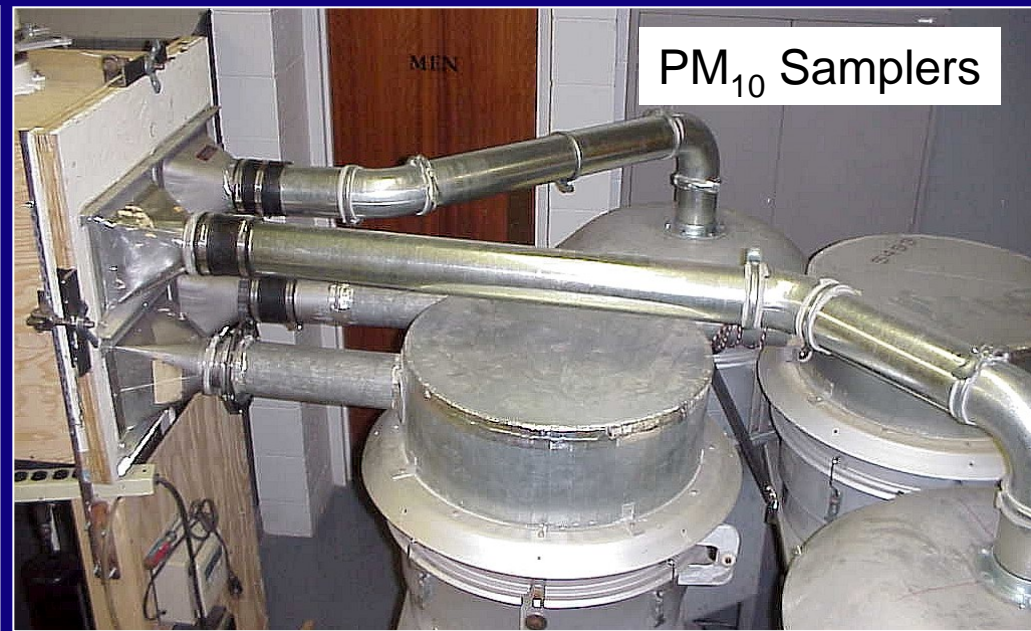
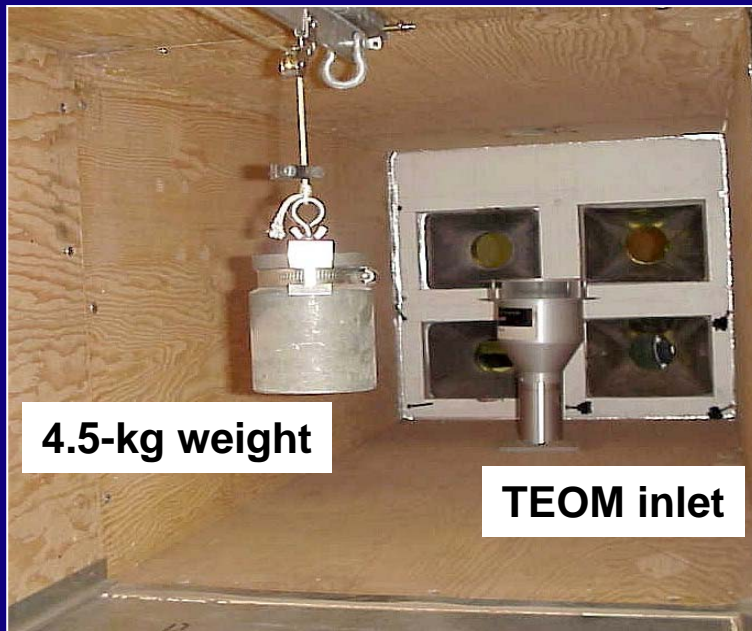
- Determine the PM_{10} emission potential caused by the hoof action on the feedlot surface as affected by:
 - Weight drop energy
 - Manure depth
 - Manure moisture content
 - Manure bulk density
 - Surface water application

Laboratory apparatus



Depth of base soil = 91 cm

Laboratory apparatus



Tapered-Element Oscillating Microbalance (TEOM)



PM₁₀ concentration – real-time monitoring



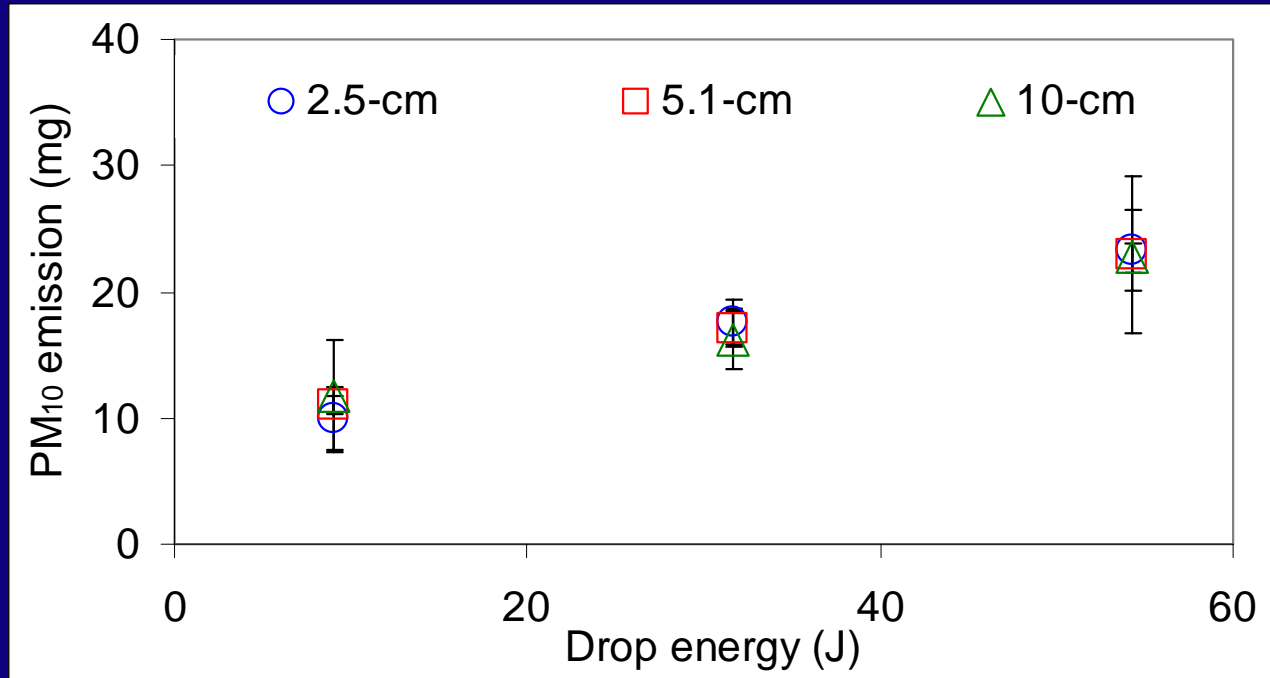
Effect of manure depth & weight drop energy

- Parameters
 - Manure depth: 2.5, 5.1, and 10 cm
 - Drop energy: 9, 32, 54 J
- The 4.5-kg weight was dropped four times from various heights. The weight was moved longitudinally over the sample tray so that the weight impacted on an undisturbed surface.



PM₁₀ Emission

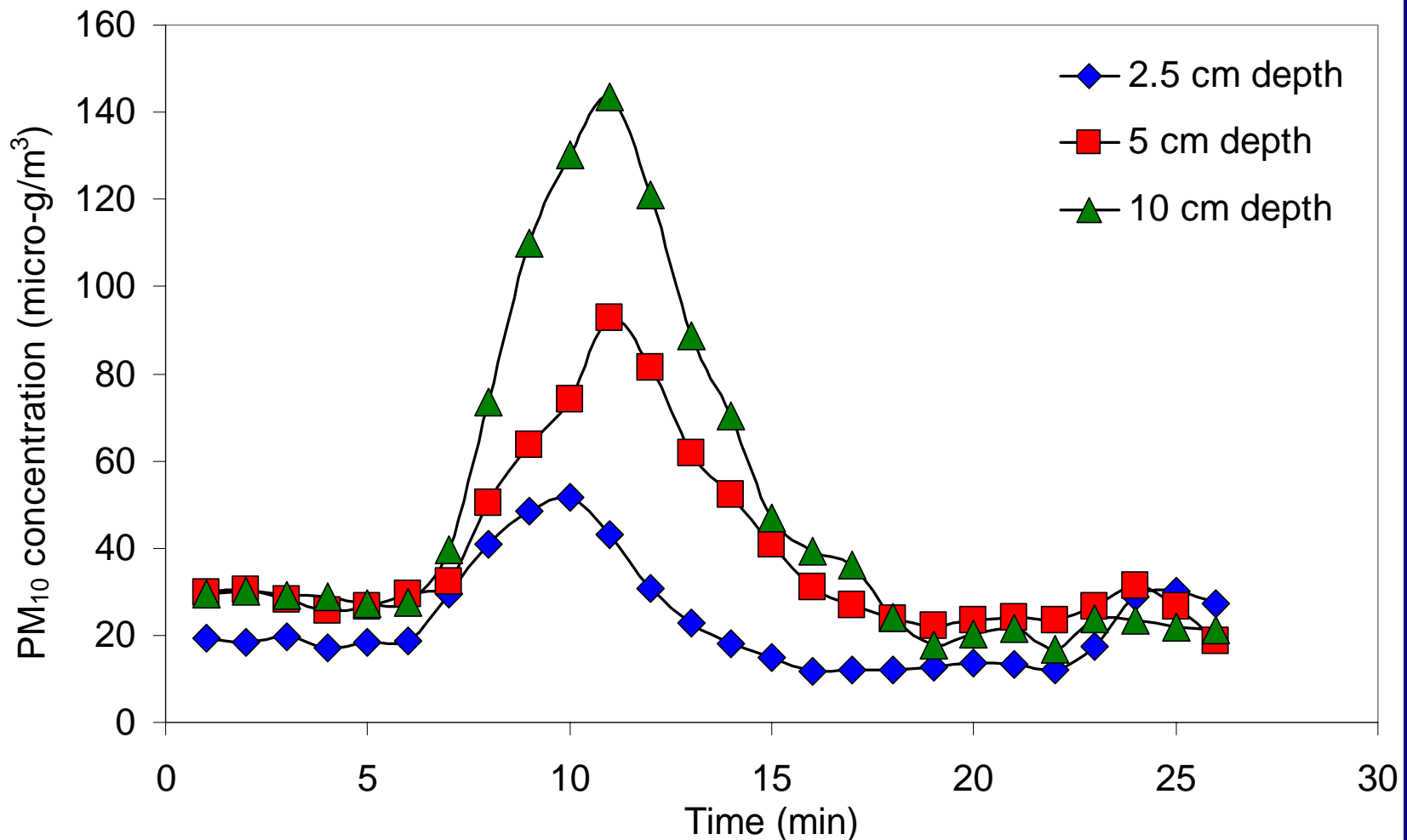
(vs. drop energy, manure depth)



- The mass of PM₁₀ emitted, as a result of vertical mode impact of a falling weight on the simulated corral surface, increased with the kinetic energy of the falling weight.
- The mass of PM₁₀ emitted increased (although not significantly) with increasing manure depth.

TEOM PM₁₀ Concentration

(at varying manure sample depth)



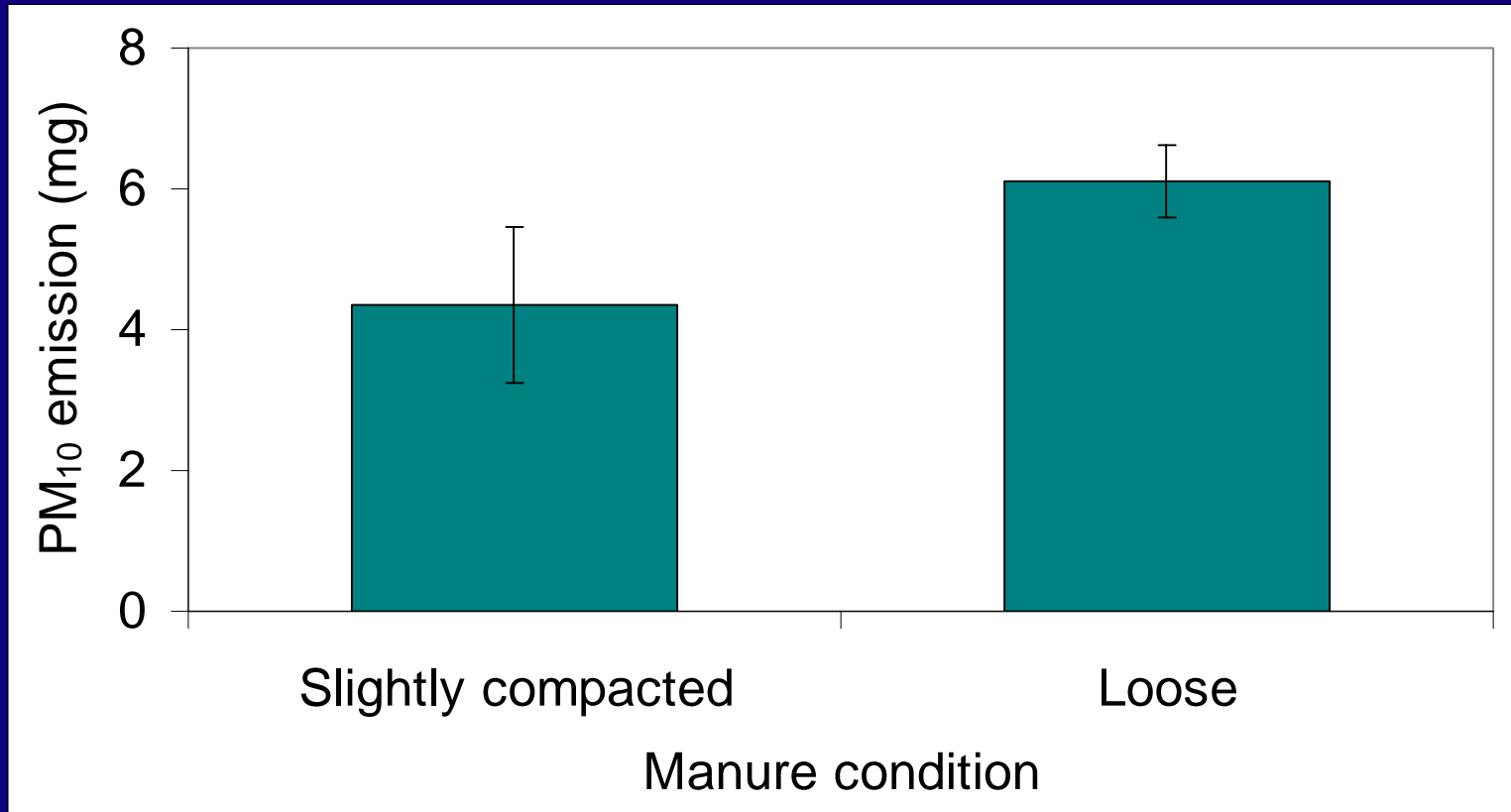
Effect of degree of compaction

- Compared loose (uncompacted) and slightly compacted manure surface.
- Prepared the slightly compacted surface by applying a uniform compaction force on the entire manure surface.



PM₁₀ Emission

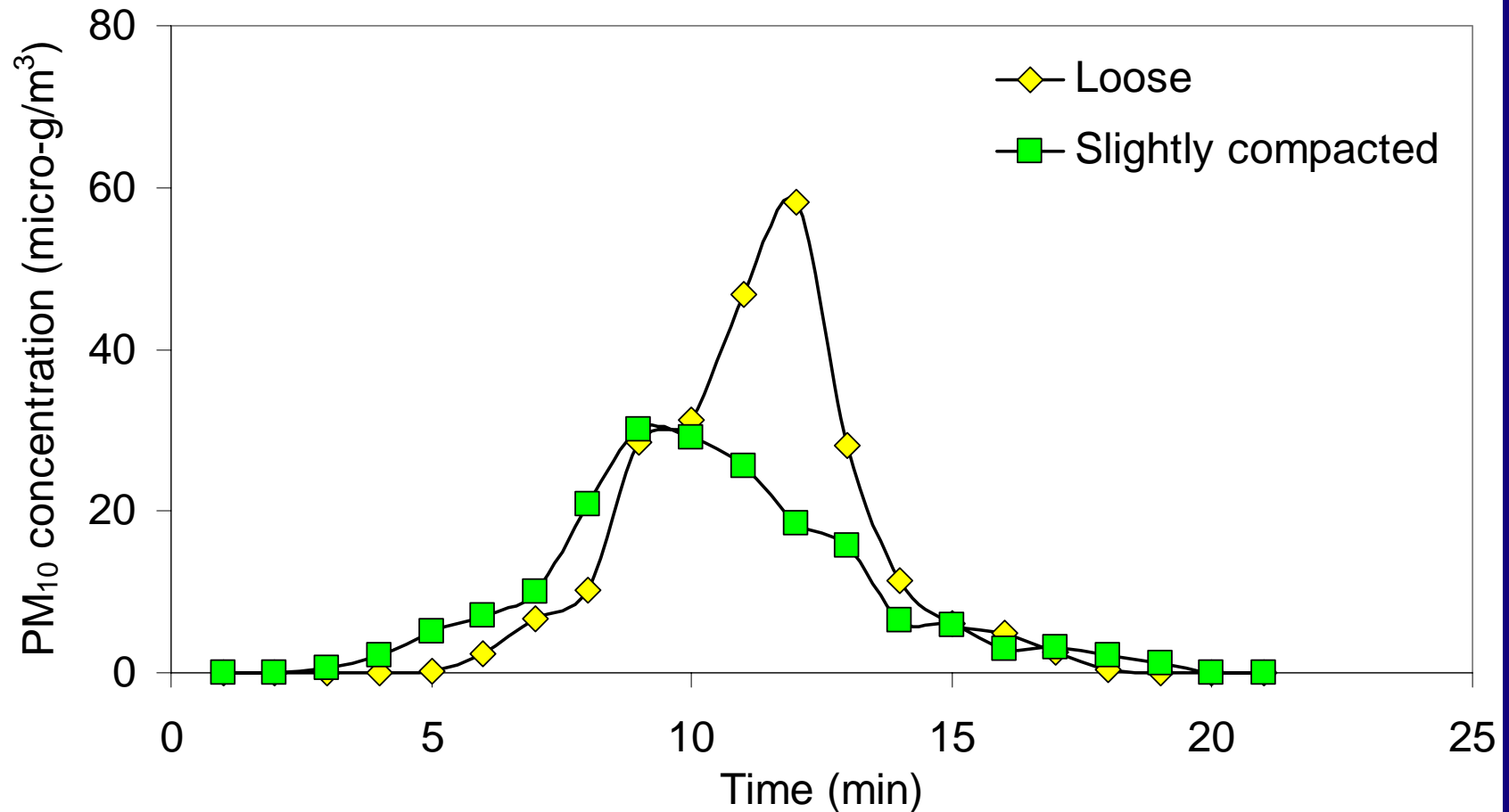
(vs. degree of compaction)



- The mass of PM₁₀ emitted due to impact of a falling weight was significantly higher for the loose, uncompacted manure than for a slightly compacted manure surface.

TEOM PM₁₀ Concentration

(vs. degree of compaction)



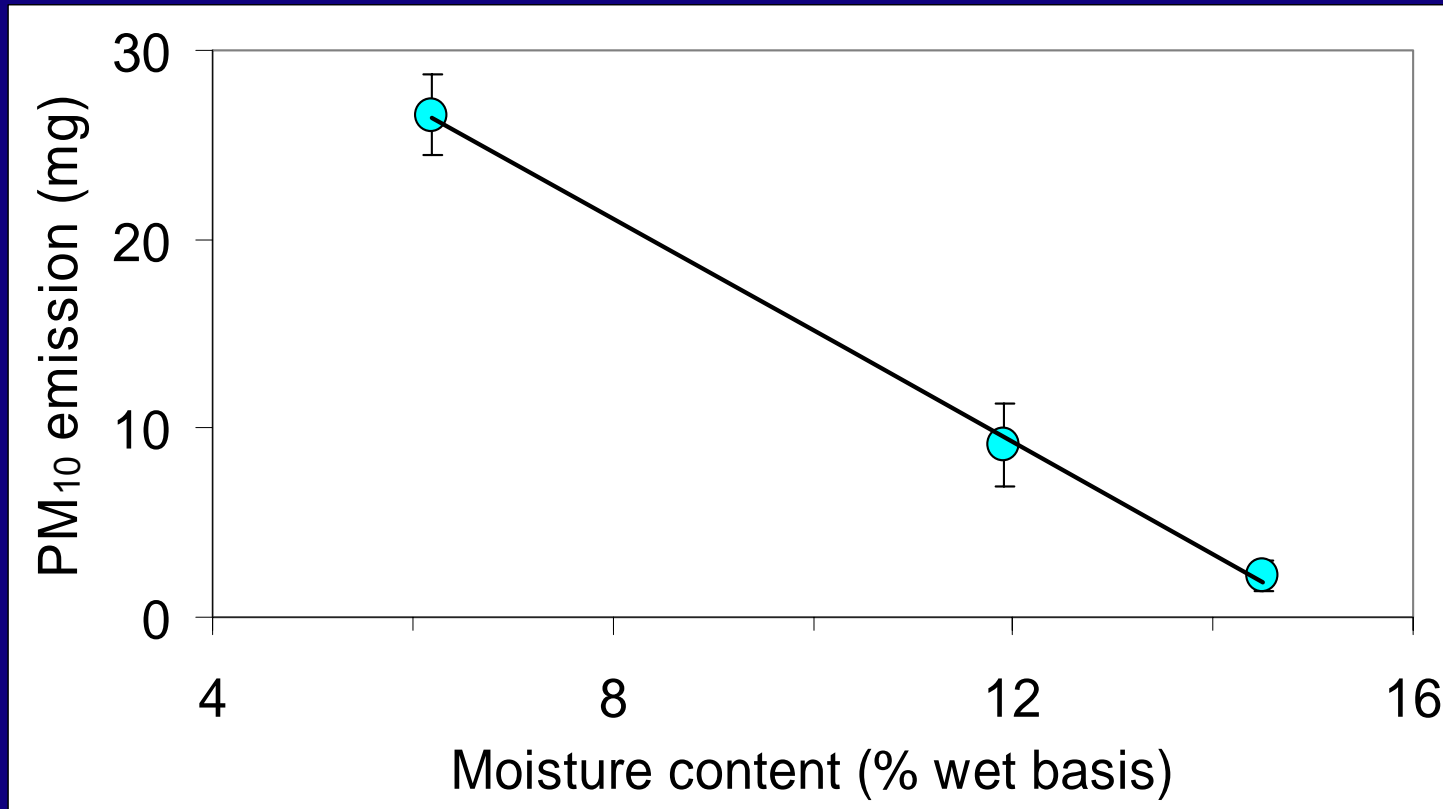
Effect of moisture content

- Increased the moisture content of the manure sample by adding a known amount of water using a high-pressure water fogging system.



PM₁₀ Emission

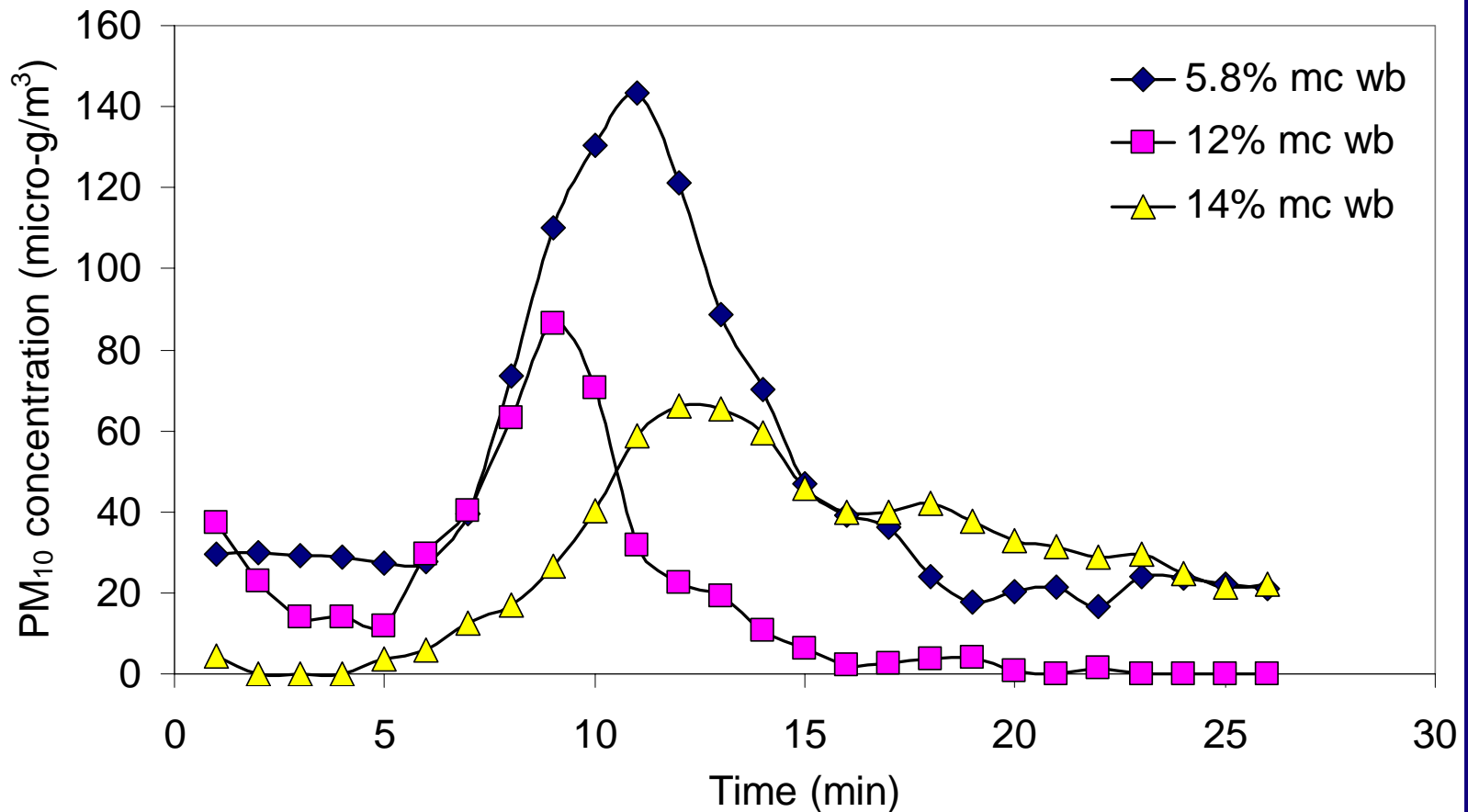
(vs. manure moisture content)



- The mass of PM₁₀ emitted due to impact of falling weight on a manure surface decreased significantly as the manure moisture content increased from 5.8 to 14%.

TEOM PM₁₀ Concentration

(at varying manure moisture content)



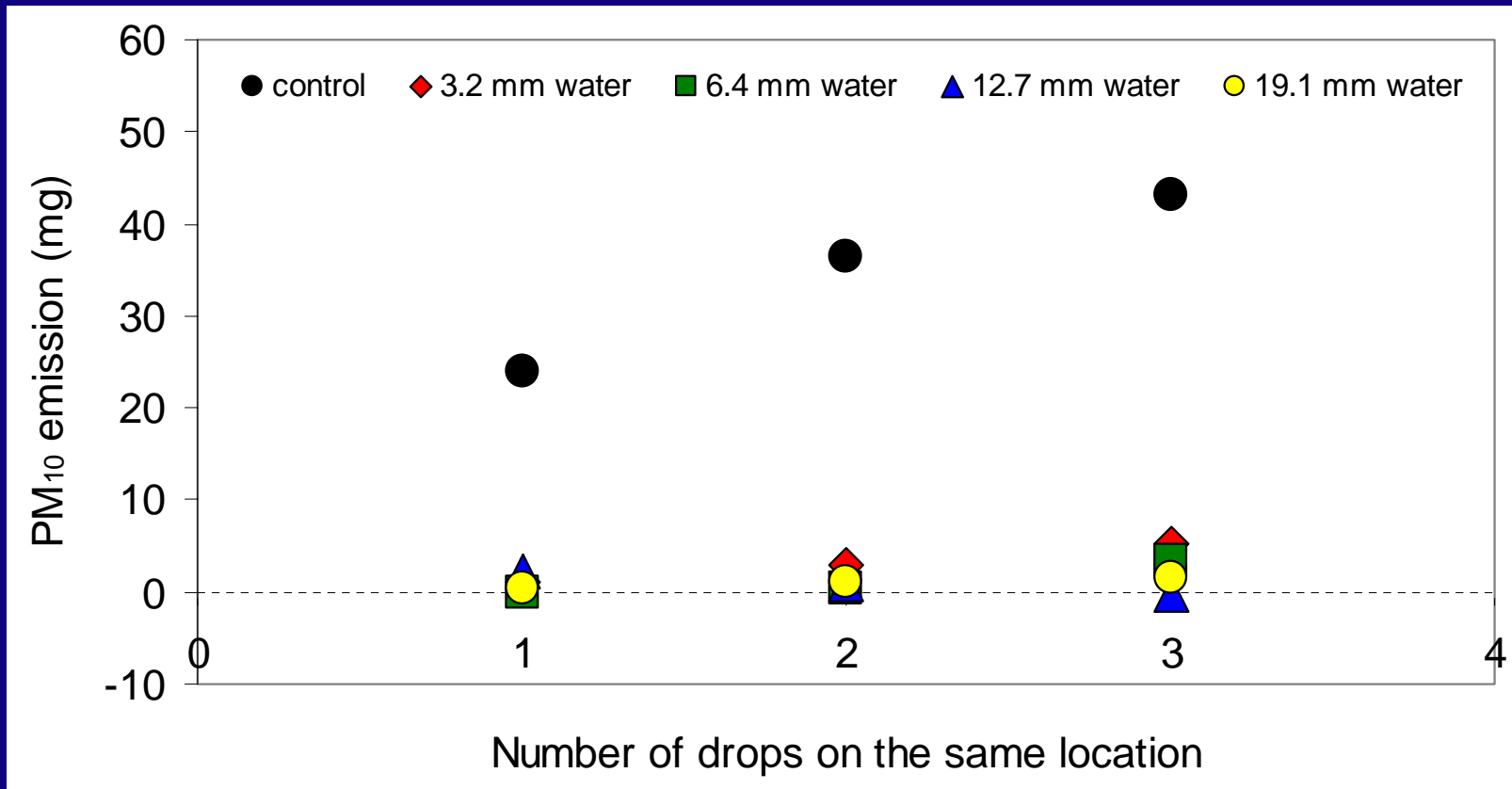
Surface water application

- Applied known amounts of water on the surface of the manure layer and measured the PM_{10} emission associated with a falling weight.



PM₁₀ Emission

(at varying surface water application rate)

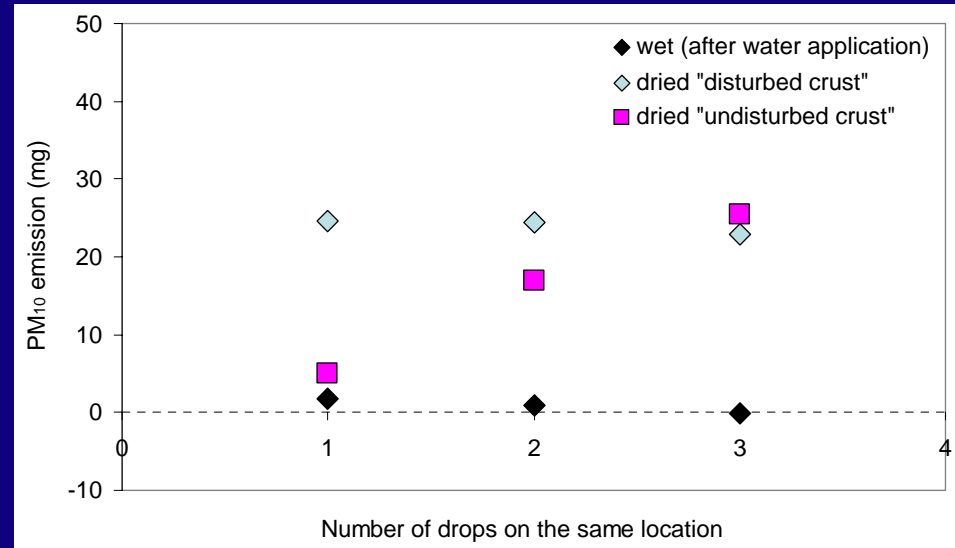


- Surface application of water on the manure surface reduced significantly the PM₁₀ emission.

PM₁₀ Emission

(disturbed vs. undisturbed crust)

- However, continuous hoof action on the surface can negate the effect of light water application that does not penetrate throughout the vertical profile of dry, uncompacted manure.



Conclusions

- PM_{10} emission from the loose manure surface due to a falling weight increased with increasing kinetic energy of the falling weight.
- PM_{10} emission potential associated with the impact of a falling weight from the loose manure surface increased (although not significantly) with increasing manure depth.
- PM_{10} emission potential was significantly higher for a loose manure surface than for a slightly compacted manure surface.

Conclusions

- PM₁₀ emission potential associated with the impact of a falling weight decreased significantly as the moisture of the manure was increased from 6 to 14% wet basis.
- Application of moisture to the dry manure surface greatly reduced PM₁₀ emission associated with the impact of a falling weight. However, penetration of the wetted layer by the falling weight increased the PM₁₀ emission potential.

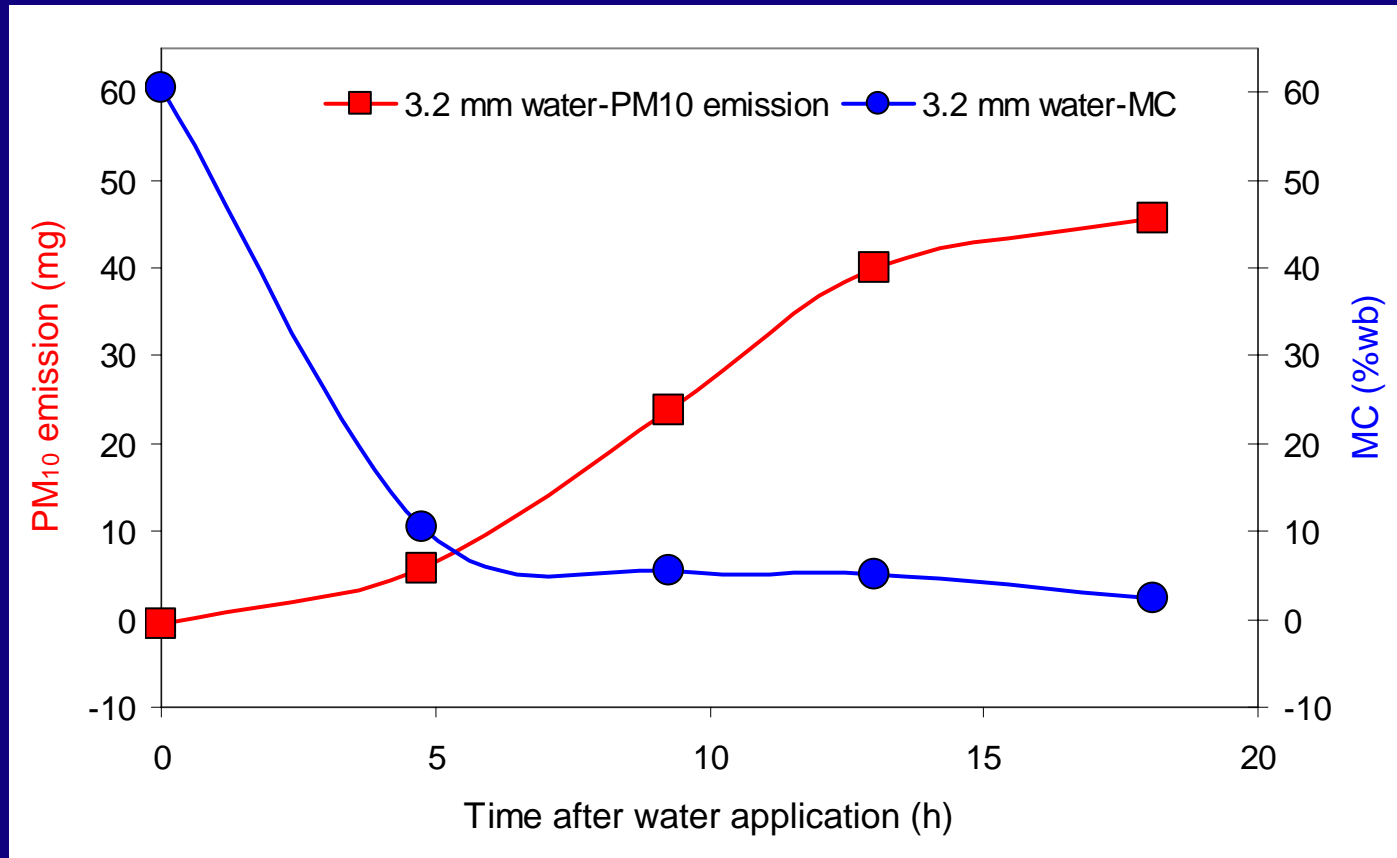
Future/Ongoing Work

- Laboratory measurement of PM_{10} emission generated by the horizontal component of the hoof action on the manure surface.
- Laboratory and field evaluation of various abatement measures in mitigating particulate emission from cattle feedlots.



PM₁₀ Emission

(at varying intervals after surface water application)



- PM₁₀ emission increased as the manure surface moisture content decreased.