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Abstract
The current drought in Iowa created unfavorable soil conditions not only for plant development and growth, but also changes in soil structure. These changes in soil structure may include fracturing and cracking of the upper 6 to 15 inches of most Iowa soils. However, continuous fracturing and cracking to depths greater than 15 to 20 inches occurs only in a few Iowa soils, primarily those soils high in clay content with expansible clay minerals. Soils that have high clay content within the soil profile, more than 45 percent clay, are generally limited to flood plains adjacent to rivers and streams and some upland landscapes in southern Iowa. These high clay content soils are a minority of the soil types that occur in Iowa.

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Dry Soil Conditions and Liquid Manure Application

By Mahdi Al-Kaisi, Department of Agronomy

The current drought in Iowa created unfavorable soil conditions not only for plant development and growth, but also changes in soil structure. These changes in soil structure may include fracturing and cracking of the upper 6 to 15 inches of most Iowa soils. However, continuous fracturing and cracking to depths greater than 15 to 20 inches occurs only in a few Iowa soils, primarily those soils high in clay content with expansible clay minerals. Soils that have high clay content within the soil profile, more than 45 percent clay, are generally limited to flood plains adjacent to rivers and streams and some upland landscapes in southern Iowa. These high clay content soils are a minority of the soil types that occur in Iowa.

The question is what is the potential for rain water or liquid manure to leach to tile drainage lines and groundwater in dry soils experiencing cracks and fractures? The short answer is that such potential is small for nearly all Iowa soils. For those few soils with continuous cracks or fractures extending to the depth of drainage tiles, the cracks and fractures would be required to be directly above the tile line.

Therefore, application of liquid manure during such dry conditions has very minimum opportunity to reach the drainage tiles. The soil moisture level has to be at field capacity for that to happen. Moisture field capacity is the maximum amount of water retained within the macro- and micro-pores of the soil. Only when field capacity is exceeded will appreciable leaching or water movement take place. Thus, manure application under such extreme dry conditions has to be in large amounts to cause two things:

1. sufficient volume to saturate the soil profile to a depth of 4 to 5 feet, which may take 10 to 12 inches of water or liquid manure and,
2. the liquid manure application has to continue after reaching field capacity for potential leaching of liquid manure to occur, that is, where water flows through macro pores or what is called “preferential flow.”

Generally, soil cracks will not reach deeper than 6 to 15 inches in most cases in Iowa soils. Under dry conditions, there is always upward water movement from the water table in response to moisture deficit and increased soil tension (or what is called matric tension or potential) at the top depths, where water movement happens by capillary action in three dimensions and not only vertical through cracks as assumed. Even if the manure flows through soil cracks, the amount has to be large enough to bring soil moisture condition as stated above at the top 4 to 5 feet to field capacity before any significant flow can take place. The dry soil has to be saturated above field capacity before we can see any significant water flow.

Liquid manure application needs to be monitored to prevent over application beyond soil moisture field capacity. In most soils in Iowa, the water storage capacity of soils for the top 5 feet is between 10 and 12 inches (2 to 2.5 inches per foot). Once field capacity is exceeded, all micro and macro pores are...
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filled with water and any additional water or liquid manure application at this point will move by gravity flow to drainage tiles, if present, or groundwater.

Liquid manure should be applied carefully under such dry conditions by using a low application rate to allow more time for liquid manure to be absorbed and infiltrate at a slow rate and to minimize surface runoff. Livestock producers and manure applicators should follow all land-application separation distances to protect water sources, consider implementing best management practices such as protecting tile inlets during manure application, and follow manure application rates identified in their manure plans. Management is a key component during land application. Take time to observe conditions and make adjustments to injection, incorporation, surface or irrigation practices to prevent potential liquid manure application mistakes.

In summary, the concern regarding liquid manure application leaching through soil cracks needs to be understood in the context of a soil’s ability to store water under dry conditions and the physical and hydraulic properties that govern water movement within the soil profile. The real concern is about over application and management of liquid manure applications regardless of the soil moisture conditions (dry or wet). Once the soil reaches its moisture field capacity, applying liquid manure will have a greater potential threat to water quality and reaching drainage tiles than applying in dry conditions, because the soil moisture at steady state and water moves faster through pores than under dry conditions.

![Figure 1. Liquid manure application after soybean harvest (Source: Angie Rieck-Hinz)](http://www.extension.iastate.edu/CropNews/2012/0815al-kaisi.htm)

![Figure 2. Liquid manure application using big-gun irrigation system](http://www.extension.iastate.edu/CropNews/2012/0815al-kaisi.htm)
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