Optimal Design Drainage Rates for Eastern South Dakota

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Subsurface drainage is a water management practice that has seen dramatic expansion in South Dakota over the past several years. While drainage can bring about significant agronomic benefits, the installation of pattern drainage (tiling) can represent a significant financial investment to the producer. Therefore, installing a drainage system designed to maximize net returns is the most efficient use of the producer's resources.

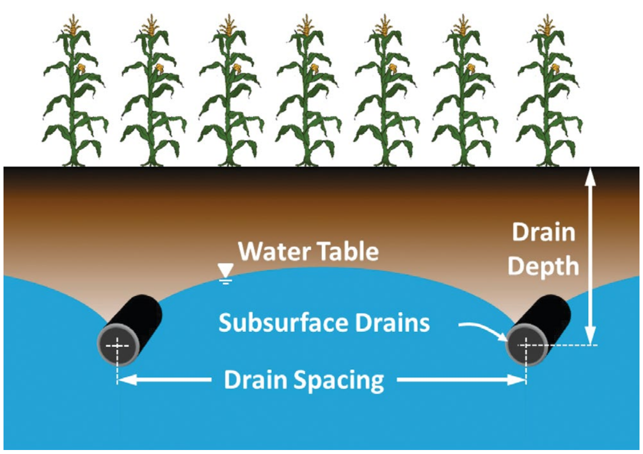

Figure 1. Depth and spacing can play a significant role in system performance and cost when considering a drainage system. Image courtesy of Gary R. Sands, University of Minnesota Extension.

The selection of drain depth and spacing, along with soil properties, determines the drainage intensity (how quickly water gets to a drain) which, in turn, influences the drainage coefficient (how quickly water leaves the field). Drain depth and spacing are also key factors in the cost of the drainage system. A wider drain spacing will cost less to install, but may not lower a high water table enough to see the desired agronomic benefits. Drains placed more closely together reach a point of diminishing returns where the benefits no longer outweigh the increased installation costs and decrease the producer's net return. Additionally, increasing drainage intensity beyond that which maximizes net returns increases the risk of nutrient losses through the drainage system. Determining the optimum site-specific depth and spacing that maximizes profitability while minimizing environmental impacts is difficult and typically relies on the use of a computer model to capture the range of climate variability along with economic assumptions.

Existing drainage design criteria for drainage intensity have been primarily developed for the more humid regions of the United States. It is unclear how well these criteria apply to regions such as eastern South Dakota, which lies in a transition zone from sub-humid to semi-arid conditions. Better information on design criteria for these regions is needed to balance production, environmental and economic goals for optimum drainage design.

In an effort to develop optimum drainage design recommendations for eastern South Dakota, an investigation was performed using the DRAINMOD simulation model for two sites with two different representative soil types at each site (Table 1). These site-specific designs provide guidance on which combination of depth and spacing is likely to produce the maximum return on investment based on soils and climate. Long-term DRAINMOD simulations were conducted for each soil type using historical climatological data (1950-2011). Three drain depths (3.0, 3.5, 4.0 feet) were used, and drain spacings varied from 16 ft (5 meters) to 328 ft (100 m).

Table 1. Soil type and location combinations used to develop drainage intensity recommendations for eastern South Dakota. DRAINMOD simulations were calibrated using drainage data from drainage sites near these locations and weather data from nearby weather stations.

Location	Flandreau, Moody County	Montrose, McCook County
Soil types	Houdek clay loam	Clamo silty clay loam
	Moody-Nora silty clay loam	Wentworth silty clay loam

Optimum Drain Spacings

The drain spacings corresponding to the maximum annual return for the four location-soil type combinations listed in Table 1 at three different depths are shown in Figure 2. These optimum spacings provide adequate drainage for high yields while minimizing investment costs. Results showed reduced relative yield at very narrow or very large drain spacings for all drain depths and soil types. Narrow drain spacings with deeper depths drained too much water and increased drought stress. Wider drain spacings did not drain enough water and increased excess water stress, reducing relative yields in the model. The optimal drainage intensities resulting from these drain depth-spacing combinations ranged from about 1/6 to just over ¼ inches per day. These results suggest that smaller drainage coefficients are likely more profitable for South Dakota producers when compared to typical values (⅜ to ½ inches per day) used in the more humid regions of the United States due to climatic differences (reduced precipitation and greater evapotranspiration).

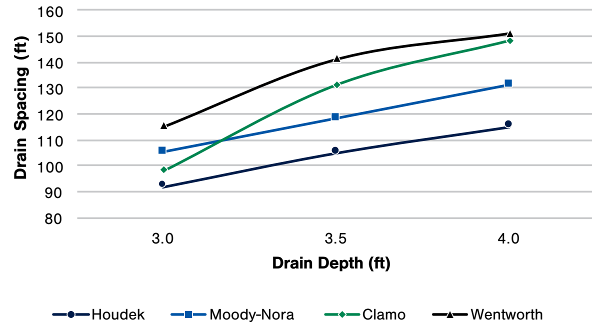

Figure 2. Optimum drain spacings for three drainage depths for four different soil types in eastern South Dakota.

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