Water Quality Implications of Playa Lake Containment of Feedlot Wastes

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Summary

Downward movement of nitrogen (N), phosphorus (P), and salts was assessed at three playas used to contain feedlot runoff/waste for several years. Analyses of soil cores to the 50-foot depth generally support the view that the clay-bottomed playas can be used for feedlot runoff/waste storage without posing a major threat to the underlying groundwater. However, caution needs to be observed around the coarser-textured playa rim because this area represents a more permeable zone where deeper leaching of soluble chemicals may occur. Most accumulations of soluble chemicals occurred in the top 5 feet of the playas’ surface.

Project Description

Background: In the Southern Great Plains, large commercial beef and dairy feedlots have often been constructed around playas to contain the runoff. Playas are natural, shallow, wet-weather lakes with no outlet, and may range in area from 1 to 100 acres. Studies by the USDA Agricultural Research Service (ARS), Bushland, Texas, at the time many lots were being established, indicated waste containment in playas was an environmentally sound practice because the playa clay bottoms were quite impermeable, and the underlying water table was generally more than 200 feet below the soil surface (Lehman et al., 1970; Lehman, 1972). Several lots have employed the practice more than 20 years, and an assessment is now needed to determine if the earlier projections, based on short-term studies, were fully correct, or whether long-term waste disposal practices need to be modified to prevent contamination of groundwater.

Methods: Annual capacities for the subject feedlots were 40,000, 300, and 200 head, located in an area of fine-textured soils in the Texas Panhandle. Randall clay (Udic Pellusterts, <0.05 in/hr infiltration rate) comprises the playa soil at all locations. In the center of the playa bed the clay may extend deeper than 14 feet, but sometimes thins to less than 1 foot at the bed’s rim.

Soil cores were collected using motorized drill rigs, to the 50-foot depth or until an impenetrable layer was reached. At each feedlot, soil cores were collected from playa beds, rims, and outside upslope watershed areas (i.e., checks). The cores were sectioned into 0.5 to 1-foot segments on site, sealed in plastic bags, and maintained at 0°F. Upon arrival at the lab, samples were divided for chemical and physical analysis. Samples for chemical analysis were air-dried, crushed to pass...
a 60-mesh screen, mixed, and stored in sealed containers. Samples for physical analysis were maintained in a field-moist state. Nitrogen and phosphorus forms, conductivity, and pH were determined using standard wet-chemistry procedures (Smith et al., 1993). Particle size analysis was determined by the hydrometer method (Day, 1965).

**Results**

Nitrogen results are summarized, on a range basis, in Table 1. They include nitrate, ammonium, and organic N (TKN). Maximum nitrate concentrations observed were about 65 ppm N, generally in the 1 to 5-foot surface layers (i.e., root zone). In the playa rim areas of the dairy and ARS lots, some higher nitrate concentrations were observed, also, in the 5 to 50-foot depths, indicating nitrate movement below the root zone. In no case, however, was there evidence that appreciable nitrate had penetrated the playa bed below the 5 to 10-foot depth (Smith et al., 1993).

Only at the beef lot were soil profile ammonium values observed >5 ppm N, with the higher values confined to the top 5 feet of soil. The highest value, 375 ppm N, occurred in the upper 2-foot layer, with ammonium concentrations decreasing sharply thereafter. Below the root zone (i.e., 5 feet), there was no evidence of ammonium penetration.

<table>
<thead>
<tr>
<th>Type feedlot</th>
<th>Core site</th>
<th>Soil Nitrate-N</th>
<th>Soil Ammonium-N</th>
<th>Soil TKN</th>
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<tr>
<td></td>
<td></td>
<td>0-5'</td>
<td>5-50'</td>
<td>0-5'</td>
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<tr>
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<td>bed</td>
<td>0-50</td>
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<td>6-375</td>
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<td>rim</td>
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<td>26-79</td>
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<td></td>
<td>outside</td>
<td>4-24</td>
<td>0-5</td>
<td>6-30</td>
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<td>bed</td>
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<td>3-19</td>
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<td>26-63</td>
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<td></td>
<td>outside</td>
<td>0-1</td>
<td>-</td>
<td>1-2</td>
</tr>
</tbody>
</table>

1 Values obtained from the array of core-depth analyses.
Highest values of organic N observed were in the order of 3,000 to 4,000 ppm, representing a several-fold increase over soil not receiving feedlot waste. However, these accumulations were observed only at the beef and dairy lots, and then just in the surface foot, where the incoming waste was being deposited. Elsewhere, organic N values were similar to soil receiving no waste.

Total P accumulations >1,000 ppm were found in the top foot of the beef bed and dairy bed/rim where incoming waste was being deposited. There was no general indication of a total P front moving below the root zone (Smith et al., 1993). In general, clay contents tended to be more than 40%, and were 55-70% in the playa bed. Relatively high sand contents, 30-35%, at the playa rim indicate a more permeable zone, and probably explain the high nitrate penetration noted above for the ARS lot. Obviously, the permeable zone is one to avoid in the storage of feedlot waste.

Technology Transfer

Our results generally support earlier views, based on short-term studies, that the “clay” playas can be used for feedlot waste/storage without posing an appreciable contamination threat to the underlying groundwater. However, caution needs to be observed around the coarser-textured playa rim because this area represents a more permeable zone where deeper leaching of soluble chemicals occurred in the playa soil surface layer. Nitrate was the chemical that leached most. Maximum concentrations in the top 5 feet of soil ranged from 50 to 80 ppm N for the three lots. At no location was there evidence that appreciable nitrate had penetrated the playa bottom proper below 10 feet. Simple storing of feedlot runoff and waste upslope or in playas, as has been practiced in the past, is not a permanent solution. Efforts to utilize the waste as an agricultural and/or commercial product should continue.

A bulletin documenting the results of this project (Smith et al., 1993) was published by the Texas Agricultural Extension Service and distributed to all county extension agents in Texas. The principal investigators have presented the main research findings at workshops in Colorado, Maryland, Minnesota, Oklahoma, Texas, and Vermont.


References


Public Affairs Activities


