Evaluating the Reuse of Swine Lagoon Effluent and Reclaimed Municipal Water for Agricultural Production

Progress Report

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This project was to further evaluate the benefits and negative impacts of 2 alternative irrigation water sources. The first is an ongoing subsurface drip irrigation system using swine effluent and the other is a surface application of treated municipal wastewater. Below are the progresses made so far for both the swine effluent subsurface drip irrigation in Stillwater and the treated wastewater reuse in Chickasha.

I. Swine effluent drip irrigation

Oklahoma State University (OSU) built a state-of-the-art swine facility about 13 years ago in order to demonstrate efficient and environmentally friendly management practices for swine production. Subsurface drip irrigation of the lagoon effluent has been used to increase water and nutrient use efficiency, reduce nutrient loss in runoff and to mitigate odor. The effluent from the two-stage anaerobic digestion lagoon has been applied to a 27-acre adjacent field through subsurface drip irrigation at 18-inch depth to produce forage, primarily bermudagrass since the construction of the facility.

1. Amount of effluent and nutrients applied

The amount of effluent and major nutrients applied to the field from 2008 to 2015 is shown in Table 1. We were unable to find the amount of effluent applications and test results of other years. The average amount of effluent applied was 61,902 gallons/acre/year. The amounts of N, P$_2$O$_5$ and K$_2$O applied were 79, 70, 18 lbs/acre/year, respectively. The amount of grass harvested and the nutrient content of the hay need to be found to calculate nutrient balance of the field.

2. Conditions of the drip irrigation tapes

The conditions and effectiveness of the irrigation tape in selected locations were exposed and evaluated by Dr. Saleh Taghvaeian, an Agricultural Engineer and Irrigation Extension Specialist. The drip tapes are in fairly good condition with some clogging emitters and visible root intrusions into the tapes in isolated locations. The drip tapes were installed 36” apart and the pattern of water distribution is visible from the grass growing in the field (Fig. 1). Based on the bermudagrass heights shown in Fig. 1, water did not seem distributed uniformly. It appears the area close to the drip tapes received more effluent, thus more water and nutrients resulting in taller grasses.
Table 1. The amount of effluent applied through the drip irrigation system to the 27 acres of bermudagrass pasture land from 2008 and 2015 and nitrogen (N), phosphorus (P) and potassium (K) calculated based on the average effluent test results. The amount of effluent applications and test results of other years could not be found.

<table>
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<tr>
<th>Year</th>
<th>Effluent Gallons</th>
<th>N</th>
<th>P</th>
<th>K</th>
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<td>345</td>
</tr>
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<td>2009</td>
<td>3430380</td>
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<td>783</td>
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<td>561</td>
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<td>878</td>
<td>341</td>
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<td>2015</td>
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<td>172</td>
<td>81</td>
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<td>1,443</td>
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Figure 1. Bermudagrass in the field with subsurface drip irrigation system to distribute anaerobically digested lagoon effluent. The strips of grass reflect the orientation of drip tapes and un-uniform water distribution.

3. **Nutrient distribution in soil profile**

Therefore, soil profile samples to 36" deep were collected between 2 drip tapes every 6" apart. Nutrients and soluble salts not accumulated due to the long-term effluent application. However, it does show nutrient and salt contents are higher close to the drip tape (Fig. 2).
Figure 2. Nitrate-N, soil test P and EC distribution in soil profile between 2 drip tapes.

Grid soil sampling to 36" was also conducted. The results are under analysis.
II. Treated wastewater irrigation using above ground sprinkler

Treated municipal wastewater was used to irrigate 2 fields at the South Central Research Station in Chickasha since 2016. Figure 3 demonstrates an aerial view of the site.

![Aerial view of the municipal wastewater reuse site near the city of Chickasha, where two sprinkler irrigation systems were installed. The straight purple line shows the location of current underground pipe that takes the municipal wastewater from the treatment facility and discharges into the Washita River.](image)

Figure 3. Aerial view of the municipal wastewater reuse site near the city of Chickasha, where two sprinkler irrigation systems were installed. The straight purple line shows the location of current underground pipe that takes the municipal wastewater from the treatment facility and discharges into the Washita River.

About 9 million gallons treated wastewater was used for irrigating those 2 fields already installed with irrigation facilities. The water was tested for irrigation quality and the results of several tests are shown in Table 2. It was considered acceptable irrigation water for most crops based on the analytes tested. It does contain some nitrogen and other nutrients. Therefore, it is recommended to give credit to those nutrients when deciding the amount of fertilizers to be applied.
Table 2. Irrigation quality of the treated wastewater.

<table>
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<tr>
<th>Sampling dates</th>
<th>pH</th>
<th>EC</th>
<th>TDS</th>
<th>Nitrate-N</th>
<th>ICP-P</th>
<th>B</th>
<th>Sulfate</th>
<th>SAR</th>
<th>Na%</th>
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<td>2.2</td>
<td>38</td>
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</table>

*sampled at the pump by the treatment plant. The rest of the samples were collected at the discharge point.

Both fields were divided into about 2-acre grids with a GPS mapping tool. One core sample was pulled from each grid to 36” before wastewater was applied. The profile samples were separated into 0-6”, 6-12”, 12-24” and 24-36” segments. The surface soil samples (0-6”) were analyzed for pH, plant available N, P, K, Ca, Mg, S, micronutrients, and electrical conductivity (EC). The subsurface samples will be analyzed for nitrate-N and EC. Results of the surface samples are shown in Table 3 and 4. There is a huge variability in nutrient contents and EC. Those values will serve as the background levels for future reference as more wastewater is continuously applied.

In collaboration with EPA Robert S. Kerr Environmental Research Center, groundwater monitoring wells were installed for both fields. For each location, one well is located above the hydraulic gradient of the field, one on or near the field, and another one below the hydraulic gradient. The locations of groundwater monitoring wells are shown in Figure 4. Water samples from the wells will be collected and analyzed periodically to monitor nutrients and salt movement.
Figure 4. The locations of groundwater monitoring wells.
Table 3. Soil samples (0-6") from the field with center pivot irrigation systems in Chickasha.

<table>
<thead>
<tr>
<th>Grid Number</th>
<th>pH</th>
<th>NO₃-N lbs A⁻¹</th>
<th>K lbs A⁻¹</th>
<th>P lbs A⁻¹</th>
<th>Ca lbs A⁻¹</th>
<th>Mg lbs A⁻¹</th>
<th>SO₄-S lbs A⁻¹</th>
<th>Cu ppm</th>
<th>Fe ppm</th>
<th>Zn ppm</th>
<th>B ppm</th>
<th>OM %</th>
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Table 4. Soil samples (0-6") from the field with lateral irrigation systems in Chickasha.

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<th>Grid Number</th>
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Acknowledgement: special thanks to Mr. Joao Antonangelo for assisting sample collection and data analysis.