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OKLAHOMA COOPERATIVE EXTENSION SERVICE

# Using Lagoon Effluent as Fertilizer

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Lagoon effluent can be a good source of nutrients for crop production if it is managed properly. Effluent contains soluble elements required to grow plants. Although nutrient concentrations in lagoon effluent tend to be low, large volumes of effluent are often available to producers. Therefore, the total potential nutrient for crop production is quite high. The steps to proper effluent management are:

1. Determine the nutrient requirements of the crop based on a realistic yield goal.
2. Determine the nutrient content of the effluent.
3. Determine the fraction of effluent nutrients available to the crop in the first year of application.
4. Calculate the total depth of irrigation for the growing season.
5. Determine approximate number of applications to achieve total irrigation depth.
6. Determine supplemental nutrients needed for maximum crop growth.

These steps will assure the proper amount of effluent is applied. Avoiding excess effluent application protects soil and water quality.

## Crop Nutrient Requirement

Lagoon effluent should not be applied to soil beyond the limits of the growing crop's nitrogen needs due to potential nitrate leaching. Applications of effluent at agronomic rates generally will not create salinity problems. Any soils scheduled for effluent application should first be tested to determine its fertility level. Periodic soil testing is recommended to monitor nutrient supplying capability of the soil. The soil test results and subsequent fertilizer recommendations for the crop to be grown are the only reliable way to obtain crop nutrient requirement.

Soil testing is available through OSU Soil, Water and Forage Analytical Laboratory in Stillwater, as well as a number of commercial laboratories. Crop nutrient needs are given in the interpretations and requirements section of the soil test report. You also can determine crop nutrient needs using Extension Facts #2225, OSU Soil Test Interpretations. Contact the local extension office for instructions and supplies for taking and submitting soil samples.

## Effluent Nutrient Content

It is difficult to give an average nutrient content for lagoon effluent. A lagoon is a living system; therefore, nutrient concentrations in the effluent depend on how living organisms digest manure solids. The major factors influencing nutrient content include type of livestock supplying manure, time of year, and the balance of water into and out of the lagoon.

See Extension Facts F-2248, Sampling Animial Manure for Analyses, for details on sampling. Sample lagoon effluent at the same time of year you plan to irrigate effluent. After a number of years, you may see a predictable pattern of nutrient concentration emerge. Table 1 gives some typical analyses

**Table 1. Nutrient Analyses of Swine Lagoon Effluent Sampled in Oklahoma.**

| *Analysis* | *LeFlore County* | *Pottawatomie County* | *Texas County* | *Texas County (nursery)* |
|---|---|---|---|---|
| Total-N (lbs/1000 gal) | 4.5 | 5.6 | 2.1 | 4.4 |
| $NH_4$-N (lbs/1000 gal) | 4.5 | 4.9 | 1.8 | 3.7 |
| Total $P_2O_5$ (lbs/1000 gal) | 1.2 | 1.3 | 0.8 | 0.7 |
| Total $K_2O$ (lbs/1000 gal) | 5.9 | 6.4 | 2.3 | 5.3 |
| EC (mmho/cm) | 5.9 | 7.3 | 3.0 | 5.6 |

of swine lagoon effluent at different locations in Oklahoma. We can make a number of general statements about the results in Table 1:

1. A large portion of the nutrients in lagoon effluent is dissolved and highly available to plants. Notice in all the samples, 80% or more of the total nitrogen appears as ammonium ($NH_4$-N). Plants can use ammonium directly from soil solution and soil exchange sites.
2. Nutrients fall into fairly predictable ratios. In this table, the ratio of Total-N to $P_2O_5$ to $K_2O$ in units of lbs/1000 gallons is approximately 4:1:5. These ratios are a reflection of the living nature of a lagoon and the water balance. Bacteria release a fairly fixed proportion of the nutrients into the liquid. Nutrients are then concentrated or diluted according to lagoon operation. Since evaporation exceeds rainfall in most parts of Oklahoma, effluent tends to become more concentrated.
3. Nutrient concentration is roughly proportional to salt content or electrical conductivity (EC). The same operational factors concentrating nutrients also concentrate soluble salts. Lagoon effluent should be analyzed for EC and sodium content, as well as major nutrients. The detrimental effect of irrigating high salt effluent must be taken into account when planning a waste management system.

## Availability of Effluent Nutrients to Crops

Nutrients in lagoon effluent cannot be substituted for those in commercial fertilizers on a pound-for-pound basis because not all the nutrients reported on a manure analysis report are readily available to a crop in the year of application. Some elements are released when organic matter is decomposed by microorganisms. Other elements can combine with soil constituents and become unavailable. Nitrogen may also be lost to the atmosphere through ammonia volatilization or denitrification depending on application methods, soil pH and soil moisture level.

Organic nitrogen in effluent must be converted (mineralized) into plant available inorganic forms (ammonium and nitrate) before it can be absorbed by roots. Although very little of the effluent N is organic, about 25% to 50% of the organic N may become available the year of application. Most effluent N is in ammonium form ($NH_4$-N). Potentially, all of the $NH_4$-N can be utilized by the plants in the first year of application. However, if manure is applied on the soil surface and not quickly incorporated, considerable $NH_4$-N can be lost to the air as ammonia ($NH_3$) gas. This decreases nitrogen available for plant growth. Ammonium worked into the soil is subject to nitrification (rapid conversion to $NO_3$-N). Nitrate-N is readily available to plants, but if excess water is present, it can be lost through leaching or denitrification (conversion of $NO_3$-N to $N_2$ gas). Combining inorganic N after ammonia volatilization losses, and N available from organic N, gives the total N available to crops. This is sometimes called plant available nitrogen, PAN. If ammonia volatilization was eliminated, almost all of the Total N in effluent is PAN. However, a rule of thumb is 50% of the Total N is available after volatilization losses. However, recent studies have shown that ammonia losses may be as high as 80% of total N.

Some studies have shown that the availability of effluent P is equal or superior to that of commercial phosphorus fertilizers; others have shown lower responses from manure than from fertilizer P. In general 90% availability has been commonly used for P calculation. Most manure K is soluble and readily available for plant use in the year of application. Ninety to 100% availability has been commonly used for K calculation.

## Total Depth of Irrigation

Producers should develop a nutrient management plan that maximizes the use of manure nutrients available. In many cases the producer may need to supplement effluent with commercial fertilizers if total crop nutrient needs are not met. Land application rates should be based on the nutrient requirements of the crop being grown to ensure efficient use of manure nutrients and minimize the chances of nitrogen volatilization and leaching. Soil testing, effluent analysis, and proper estimation of yield goal are necessary to calculate proper agronomic application rates of lagoon effluent and additional fertilizers. Follow the first four steps in the attached worksheet to calculate the seasonal application rate.

When using many irrigation systems, it is more convenient to use application depth rather than application rate. There are approximately 27,000 gallons per acre-in of application. Divide application rate in 1000 gal/acre by 27 to determine irrigation depth in inches..

## Irrigation Scheduling

You may not apply all the effluent at one time because of the limited water holding capacity and infiltration rate of your soil. A sandy loam soil, for example, can hold 0.8 to 1.4 inches of water per foot of soil when it is completely dry. It is reasonable to assume that the soil will be at half field capacity before irrigation. To bring one foot of soil up to field capacity, the most effluent you could apply would be between 0.4 to 0.7 inches. One half inch would be a reasonable irrigation depth under these conditions. So, if the total effluent irrigation needed to provide nitrogen through the growing season is three inches, you would apply six separate irrigations of 0.5 inch each.

Lagoon effluent has a high concentration of available nitrogen. Crops take up most nitrogen during the vegetative growth phase of plant development. Space irrigations throughout the vegetative growth period in order to get the most use out of the effluent nitrogen. Using the example in the last paragraph, if the vegetative growth period of the crop lasts six weeks, you will get the most use of nitrogen by irrigating 0.5 inch of effluent, once per week, for six weeks. Consult the agricultural extension educator or crop consultant in your area to find active growth periods for crops.

If applied pre-plant, effluent should be added as near to the planting dates as possible to provide starter nutrients. Effluent can also be applied post harvest to supply nutrients for winter cover crops. Lagoon effluent should not be applied to already stressed plants because the salt and ammonium in the liquid may further stress the crop. The water added with lagoon effluent will rarely be sufficient to provide the total moisture needs of a crop throughout the growing season. Use effluent to meet crop nutrient needs and irrigate with additional clean water to provide moisture needs.

# Effluent Irrigation Work Sheet

| | | Example: | Your Number: |
|---|---|---|---|
| 1. | **Nutrient needs of crop (lbs/acre)**<br>Recommendations based on soil test results and a realistic yield goal. | N= 180<br>$P_2O_5$= *95*<br>$K_2O$= *40* | N= ___<br>$P_2O_5$= ___<br>$K_2O$= ___ |
| 2. | **Total nutrient value of effluent (lbs/1000gal)**<br>Based on manure analysis of a representative sample collected close to time of application. | N= *5.2*<br>$P_2O_5$= *1.3*<br>$K_2O$= *5.9* | N= ___<br>$P_2O_5$= ___<br>$K_2O$= ___ |
| 3. | **Determine available nutrients (lbs/1000gal)**<br>Multiply the value from Step 2 by nutrient availability, 50% for N and 90% for P and K | N= *2.6*<br>$P_2O_5$= *1.2*<br>$K_2O$= *5.3* | N= ___<br>$P_2O_5$= ___<br>$K_2O$= ___ |
| 4a. | **Calculate application rates to supply N and, $P_20_5$ needs. (1000gal/acre)**<br>Divide values from Step 1 by values from Step 3. | N= *69*<br>$P_2O_5$= *79* | N= ___<br>$P_2O_5$= ___ |
| 4b. | **Choose between N or $P_2O_5$ application rate (1000gal/acre)**<br>Select the highest rate calculated in Step 4a for using effluent as a complete fertilizer. Select the lowest rate for maximizing nutrient use. | Rate = *69*<br>*(based on N for this example)* | Rate = ___ |
| 4c | **Determine total depth of irrigation (inch)**<br>Divide application rate in 1000 gal/acre from Step 4b by 27 to get irrigation depth in inches. | Depth = *2.6* | Depth = ___ |
| 5. | **Determine numbers of application needed to apply total irrigation depth.**<br>Most soils cannot accept the total irrigation depth in one application. Divide total irrigation depth in 4c by acceptable application depth for average soil conditions | *5*<br>(*based on 1/2 inch per application)* | ___ |
| 6a. | **Determine amount of nutrients applied at chosen rate (lbs/acre)**<br>Multiply the rate chosen in Step 4b, by available nutrients, Step 3. | N= *180*<br>$P_2O_5$= *83*<br>$K_2O$= *366* | N= ___<br>$P_2O_5$= ___<br>$K_2O$= ___ |
| 6b. | **Determine supplemental nutrients (lbs/acre)**<br>Subtract the nutrients applied, Step 4e, from nutrients needed, Step 1. If the difference is negative, enter 0. | N= 0<br>$P_2O_5$= 12<br>$K_2O$= *0* | N= ___<br>$P_2O_5$= ___<br>$K_2O$= ___ |

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Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

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- It is administered by the land-grant university as designated by the state legislature through an Extension director.
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