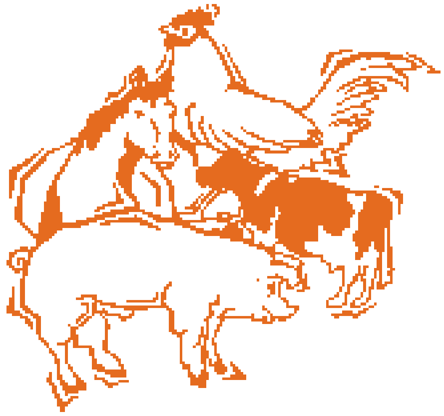

MANAGEMENT

Liquid Manure Application to Cropland no. 1.222

by M.M. Al-Kaisi, R.M. Waskom and J.G. Davis [1]

Quick Facts...

Efficient liquid manure land application requires knowledge of nutrient content, proper application rate, crop needs and field conditions.

Base application rates on soil testing for N credit, N credit from other sources, and a realistic yield goal.

Excess manure will not increase crop yields, but may lead to nutrient leaching or runoff.

Colorado State University Cooperative Extension

Liquid manure application to cropland must be managed to maximize efficiency and minimize environmental problems. Liquid manure (swine, dairy and feedlot runoff) contains macro- and micronutrients with significant fertilizer value. It also can enhance the soil's chemical and physical properties. A well-designed delivery system can improve liquid manure use.

The increase in confined animal production in Colorado in the last decade requires an effective way of handling manure as a fertilizer supplement. According to *1997 Colorado Agricultural Statistics*, there are 84,000 milk cows and 630,000 hogs in Colorado, with a total annual liquid manure production of 485 million gallons. Traditionally, fields closer to production facilities receive higher amounts of liquid manure.

System Design and Management

An application system should accomplish the following:

1. **Efficient nutrient management.** Base liquid manure application on crop needs, taking into account all other sources of nutrients (i.e., soil, irrigation water, legumes, organic matter, and previous manure applications).
2. **Efficient effluent application.** Determine when, how, and the correct amount to apply.
3. **Proper water management.** Follow efficient irrigation scheduling to minimize nitrogen (N) leaching and runoff.

To accomplish the above, consider the following factors:

- How much effluent is available annually?
- What is the nutrient content of the effluent?
- How many acres are needed to use the available effluent?
- What crop will be planted, and what are its nutrient requirements?
- What is the best time to apply liquid manure?
- What are the environmental and legal considerations for site application?
- What is the source of effluent (one- or two-stage lagoon)?
- What is the potential for salt buildup in the soil?
- How deep is the groundwater and what is the potential for contamination?
- Are well-trained individuals available to manage the system?
- What is the cost feasibility of the application system?
- Are there odor and air quality concerns during time of application?

After a careful review of these considerations, design the liquid application system to ensure suitable land application, which includes the following:

1. Proper application system to achieve efficient effluent use.
2. Proper pumping system to achieve the objectives of the application system.
3. Proper management to increase efficiency of energy, labor and nutrient application.

Design features:

1. Proper application system.

2. Proper pumping system.

3. Proper management.

Liquid Manure Composition

Liquid manure composition varies with livestock type, age and ration (Tables 1 and 2). Single-stage or primary lagoons have higher solid and nutrient concentrations than secondary lagoons. The nutrient content values in Table 1 represent swine waste content under slatted floors of hog operations. These values differ significantly from lagoon effluent contents shown in Table 2. Therefore, clogging of irrigation lines may be more common and the potential for crop burn greater when irrigating from a single-stage lagoon. Recycling lagoon effluent from a secondary lagoon back into housing operations for manure removal will further increase the solid and nutrient concentrations in the primary lagoon.

Table 1: Approximate composition of liquid manure under slatted floors from different hog operations.

Under Slats of Various Hog Types	Solids (%)	N (lb/1,000 gal)	P_2O_5 (lb/1,000 gal)	K_2O (lb/1,000 gal)
Farrow	3.5	29	34	28
Nursery	4.0	40	31	16
Grow/finish	9.0	52	52	22
Breeding/gestation	3.0	25	23	21

Table 2: Approximate nutrient composition of liquid manure at the time applied to land.

Source[a]		Dry Matter	Total N[b]	NH_4-N	P_2O_5	K_2O
		lb/1,000 gal				
Swine	Liquid Pit	4	36	26	27	22
	Lagoon[c]	1	4	3	2	7
Beef Cattle	Liquid Pit	11	40	24	27	23
	Lagoon[c]	1	4	2	9	5
Dairy Cattle	Liquid Pit	8	24	12	18	29
	Lagoon[c]	1	4	2.5	4	10
Poultry	Liquid Pit	13	80	64	36	96

a = Application conversion factors: 1,000 gal = approximately 4 tons; 27,154 gal = 1 acre-inch.
b = Ammonium N plus organic N, which is slow-releasing.
c = Includes feedlot runoff water.
Source: Colorado State University Cooperative Extension Bulletin 568A, *Best Management Practices for Manure Utilization*, 1999.

Liquid Manure Application Rates

Liquid manure should be applied at rates that match annual expected crop nutrient uptake. Manure applied in excess of crop needs will not increase yields, but will increase soil nitrogen (N) and phosphorus (P) to levels that can lead to nutrient leaching or runoff. Proper application rates depend upon actual manure analysis, soil texture, soil fertility, crop, yield goal, field slope and drainage, application method, and water resource vulnerability. If commercial N fertilizer is used in addition to manure, the total available N should not exceed the N requirements of the crop.

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The nutrient management approach is the most effective method for the beneficial use of manure. This approach requires farmers to account for all nutrient sources available from soil, water, fertilizer and manure, and balance them with the best estimate of crop needs. This method helps minimize residual nutrient leaching during the off-season and prevents excessive soil nitrate-nitrogen (NO_3-N) buildup. Consider the following in determining application rates:

Soil Testing

Soil testing is essential for determining plant nutrient needs. Yearly sampling of each field is necessary to make accurate N fertilizer recommendations. The key to good soil test results is proper sampling methods. Each sample should contain 12 to 20 cores from a 2-foot soil depth from a uniform area of approximately 40 acres. Break fields into sampling units based on crop, yield and fertilizer histories.

Realistic Yield Goals

All fertilizer N recommendations are based on the yield goal submitted with soil samples. While farmers tend to be optimistic, overestimating yield goals results in excessive N applications. This can lead to potential loss of income and potential groundwater contamination.

Establish yield expectations based on historical yield averages. The average of the five most recent yields for each field should represent an obtainable yield. Colorado State University suggests that producers add 5 percent to the five-year yield average and use this value as their yield expectation.

Steps to determine application rates:

1. Soil testing.

2. Realistic yield goals.

3. Nitrogen credits.

4. Effluent placement and timing.

5. Liquid manure testing.

6. Effluent application rate.

Nitrogen Credits

Soil organic matter, irrigation water, manure and previous legume crops all contribute N to the growing crop. These sources must be credited in order to make accurate fertilizer recommendations. Legume crops can be a significant source of N due to bacterial N fixation in root nodules. Plowing down a full stand of alfalfa releases as much as 100 lbs of N per acre in the first year after plow-down. A minimum of 30 lbs N per acre should be credited in the first year after any legume crop.

Water tests for NO_3-N should be taken annually. Multiply ppm NO_3-N by 2.7 lbs per acre-foot times the amount of water used by the crop (in acre-feet) to determine lbs N per acre applied with the irrigation water.

Effluent Placement and Timing

Proper timing and optimal fertilizer placement can greatly enhance N uptake. Incorporate all surface-applied effluent to reduce runoff, volatilization and odor. Do not apply effluent through low-efficiency furrow or flood systems due to runoff and deep percolation losses. Time effluent applications to coincide as closely as possible to the period of maximum crop uptake.

Liquid Manure Testing

Knowing the manure nutrient content is the foundation of a sound nutrient management program. Many qualified labs in Colorado provide this service.

A representative sample is the key to any good manure analysis. For proper manure sampling, you need a clean bucket and sample jar. If you apply manure daily, take many small samples over a representative period. For periodic application, agitate the liquid manure and collect samples from a variety of locations in the pit or lagoon. Alternatively, sample effluent during irrigation by placing samplers under the application system (e.g., center pivot, traveling gun, etc.). Combine the individual spot samples from a particular lot in the bucket and mix thoroughly before filling the sample jar. Keep the sample refrigerated and deliver it to the laboratory within 24 hours. In lieu of a manure analysis, use Table 2 to initially plan application rates.

Example: Effluent Application Rate

Assume a yield goal for irrigated corn of 180 bu/acre and an N requirement of 1.2 lb N/bu to produce 1 bushel. The total N credit from soil test, irrigation water, organic matter, and previous manure application is 80 lb N/acre. Liquid manure analysis shows total NH_4-N content is 88 lbs N/acre-inch.

To estimate application rate:

180 (bu/acre) x 1.2 (lb/bu) = 216 lb N/acre needed to produce 180 bu/acre corn.

216 (lb N/acre) - 80 (lb N/acre credit from above sources) = 136 lb N/acre needed from effluent.*

136 (lb N/acre) / 88 (lb N/acre-inch as NH_4-N) = 1.5 inches effluent to be applied.

**Total N application will exceed 136 lb/acre due to organic N in effluent. However, volatilization will result in loss of some NH_4-N applied. If commercial N is used in addition to liquid manure, the amount of N from commercial fertilizer also needs to be credited to the total N applied.*

For more information on calculating N credits, see Bulletin XCM-172, Best Management Practices For Nitrogen Fertilization, *Colorado State University Cooperative Extension, 1994. Also see fact sheet 0.538,* Fertilizing corn.

Effluent Application Rate

Given an accurate analysis of soil fertility and manure nutrient content, determine application rates based upon crop needs. Plant nutrient uptake depends on the type of crop, growing conditions and actual yield. It can be estimated by multiplying the average nutrient uptake of the plant by the expected yield. The application rate usually is based on the nitrogen content of liquid manure in Colorado, but this may lead to very high soil P levels over time. If the liquid manure has a high solid content, the most precise method of calculating long-term application rates requires an estimation of N mineralization over a period of three years.

P loading also must be considered in determining an acceptable long-term application rate. In general, P loading is not a primary concern because of the large capacity for P fixation of most Colorado soils. It is recommended that manure be applied on a rotational basis to fields going into a high N-use crop, such as irrigated corn or forage. Test soil annually to monitor P levels.

Long-Term Manure Management Planning

Liquid manure management requires more than just determining an application rate. It involves a long-term plan for collection, storage, use and monitoring. All confined feeding operations should develop a manure management plan.

One important component of any plan is a provision for monitoring its success. Annual soil testing is a good method for determining how well the application program is working.

Accurate records allow managers to make good decisions regarding manure and nutrient applications. Additionally, these records provide documentation that producers are complying with state and local regulations to protect Colorado’s water resources. Keep records of manure applications, laboratory analyses and crop yields for at least three years.

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