Evaluating Manure Management Systems and Infrastructure

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An important part of developing a nutrient management plan is ensuring that the appropriate management systems and infrastructure are in place. To determine if changes are needed, an assessment of the current practices and infrastructure should be made. This guide and worksheet provide information on some critical initial steps in the evaluation process..

Step 1. Determine the leaching risk of each irrigation.

A determination as to whether there is a risk of leaching needs to be made for the different irrigations on each field as the foundation of a successful nutrient management plan. The CDQAP WDR Reference Binder document 11.5 *Determining Whether Nutrients are Leaching from Your Fields* provides information and equations to assist in calculating the leaching potential of an irrigation. Use the equations provided and worksheet 1 of this guide to determine the leaching risk (yes or no) for each irrigation on a field by field basis. Once leaching risk has been determined, transfer the risk information to column A of worksheet 2.

Step 2. Develop a N application plan based on leaching risk.

Using the leaching risk assessments, develop an initial targeted nitrogen application plan "outline" to be used as a starting point for the current system evaluation. The plan "outline" can be modified as additional information is developed, however target estimates are needed to assess the current handling system. When developing the target nitrogen application "outline," consideration should be made as to the general nature of the leaching risk.

If the system is prone to frequent leaching, multiple, low-dose applications may be necessary. Nutrient applications must closely match crop uptake needs at each growth stage. Only the amount of nitrogen that the crop can utilize before the next one or two irrigations can be applied in a single application event. In these situations, manure transfer systems must allow for low-volume liquid manure applications.

In an occasional or no leaching situation, nitrogen "banking" may be possible during part of the year, allowing for liquid manure nitrogen to be applied in fewer, larger applications. These applications should be timed to avoid having excess nitrate in

the root zone during periods when leaching does occur. It is often easier to make full use of dry manure and high solids liquid manure when leaching is not severe.

Enter the target nitrogen application plan rates developed for the initial "outline" in column C (target lbs/acre available N needed).

3. Evaluate pipeline size.

Evaluating the pipeline size is a multi-step process.

a. Determine current nitrogen application rates.

In order to calculate nitrogen application rates, one must know three things:

- the **amount** applied,
- the **concentration** (lab results) of what was applied,
- the **land area** (acres) to which it was applied.

The amount applied can be measured in several different ways including flow-meter total gallons, pump gpm x run time, and acre-inches of pond drop. Use the worksheets provided in CDQAP WDR Reference Binder document 11.10 *Calculating Nutrient Application from Liquid Manure Irrigations* to calculate how much you are currently applying. Compare what you are currently applying to the target amounts generated for your "initial" nutrient management plan.

b. Determine the gpm needed to deliver your target application rate.

In order to determine the required gpm of liquid manure to be injected into fresh water to deliver the target rate, you need to know four things:

- the **target rate** you want to apply,
- the **expected concentration** of the liquid manure (lab results),
- **how long** the irrigation will take (estimate based on experience) and
- **how many acres in** the field.

The **target rate** will depend on the crop's needs at a given time, and whether or not nitrogen applied can be "banked" in the system. Use the target rates you determined in step 2 above.

The expected **available nitrogen (N) concentration** of the liquid manure needs to be calculated using lab results. The WDR General Order requires a minimum of quarterly sampling of liquid manure during land application events. These quarterly samples must be analyzed by a qualified laboratory for: **ammonium-nitrogen, total Kjeldahl nitrogen, total phosphorus, and potassium**. Your crop consultant may request additional analyses to more closely track the nutrient content of the liquid manure for the purpose of enhancing yield. At a minimum, your laboratory reports will show the total Kjeldahl nitrogen (sometimes written TKN) and ammonium-nitrogen (sometimes written NH_4^+-N). The results will be reported in either ppm or mg/L-these units are equal and either may be used in the calculations without further conversion.

Write the NH_4^+-N value in column E. Subtract the NH_4^+-N value from the TKN value to get organic nitrogen (Org-N).

total Kjeldahl nitrogen (TKN) - NH_4^+-N = Org-N

Write the Org-N value in column F in the worksheet.

Nitrogen applied versus nitrogen available

For agronomic purposes, calculations need to be made to determine the amount of nitrogen *available* to the plant. Crops can only use nitrogen in two forms- ammonium nitrogen (NH_4^+-N) and nitrate-nitrogen (NO_3-N). Organic nitrogen (Org-N) must first be mineralized by soil microbes to available forms (NH_4^+-N or NO_3-N) to be used by plants. Estimating the rate of mineralization can be complicated. The rate will vary depending on the

- soil temperature
- soil moisture content
- if solids remaining went into the soil or remained as a crust
- the time left in the crop season
- the nature of material applied

A common conservative estimate is 30-50 percent, however care should be taken not to assume too much is available and inadvertently short your crop. Once you have created an estimate appropriate for your circumstances, record the value (%) in Column G of your worksheet to allow you to calculate the expected available nitrogen to the crop.

Expected Available
Org-N Concentration = Total Org-N Concentration x (Mineralization% / 100)

Column H = Column F x (Column G/ 100)

Total Available N Concentration = Expected Available Org-N Concentration + Ammonium N concentration

Column I = Column H + Column E

Once total available N concentration has been determined, use the charts provided to look up the gpm of liquid manure to inject into the fresh irrigation water which will deliver the amount of targeted nutrients outlined in your plan. Choose the sheet which corresponds to the run times typical for the irrigation of one acre in your area and find the chart that matches your targeted application rate.

Write the gpm needed in Column K of the worksheet.

c. Determine if an appropriate rate can be delivered through the existing pump and pipeline system.

Using the target gpm you determined in the previous step, use the look up pipeline velocity chart provided to assess if you will have enough velocity in the pipeline to keep solids from settling out and plugging the pipe. Write the velocity figure from the look-up chart in column L. A minimum of 2-5 ft/sec for 4-10% suspended solids material is recommended by the USDA Natural Resource Conservation Service to prevent pipeline plugging. Compare the figure in column L with the 2-5 ft/sec range to determine if your pipeline is in danger of plugging.

Keep in mind that liquid manure concentrations may vary considerably throughout the season, especially if you add fresh water to the retention pond. Having a good understanding of the magnitude of these changes and assessing high and low concentration scenarios will help in determining the expected performance of the current or proposed manure transfer piping system. Care should be taken when considering significantly smaller pipelines. Although smaller pipelines will have a higher velocity, throughput may be limited by the length of the pipeline, the number of elbows and other obstructions, and the pump pressure.

For situations where the current pump and pipeline system does not appear to be able to deliver the needed gpm without plugging, infrastructure and management solutions will be needed. Solutions are often creative and will be based on the individual system and situation. A partial list of successful practices seen in the field includes:

- running the manure pump only during the later portion of an irrigation event,
- plumbing a freshwater source near the pond to allow the injection of fresh water into the manure transfer line resulting in higher flow rates,
- diverting a portion of the manure pump output back to the pond to protect the pump when low flow rates are needed.

Worksheet 1. Determining the Leaching Potential of ALL Irrigations by Field

Field Name: _____

	days between irrigations	ET this period	inches water used	Inches water applied	inches excees	Can this irrigation leach?
Winter crop						
preirrig						
winter rain						
1st irrig						
2nd irrig						
3rd irrig						
Corn						
pre irrig						
1st irrig						
2nd irrig						
3rd irrig						
4th irrig						
5th irrig						
6th irrig						
7th irrig						
8th irrig						
9th irrig						
Triple crop						
pre irrig						
1st irrig						
2nd irrig						
3rd irrig						

Worksheet 2. Evaluating Pipleine Size

Field Name: _____

Acres: _____ manure pipeline diameter (inches) _____

Soil Type: _____

Date: _____

	B	C	D	E	F	G	H	I	J	K	L
	can this irrigation leach	Target lbs/acre av N ne	total N applied	liquid manure ammonium concen-tration (	liquid manure organ concen- (m	% of Org-N tha availa	expected availab Org-N conc (m	Total available concentrat (mg/L	irrig run tin (hrs)	GPM needed for this applicati	velocity in pip (feet/sec
information source	y/n		C ÷ I	lab	lab	estimate	F * (G ÷ 100)	E + H	your records	chart	chart
Winter crop											
N from soil											
dry manure											
preirrig											
winter rain											
1st irrig											
2nd irrig											
3rd irrig											
Corn											
N from soil											
dry manure											
pre irrig											
1st irrig											
2nd irrig											
3rd irrig											
4th irrig											
5th irrig											
6th irrig											
7th irrig											
8th irrig											
9th irrig											
Triple crop											
N from soil											
dry manure											
pre irrig											
1st irrig											
2nd irrig											
3rd irrig											