How to Apply a Target Rate of Lagoon Nitrogen by using Flow Rate (GPM) and Irrigation Run Time

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You will be injecting a specific amount of lagoon nutrients into the fresh irrigation water. The following steps will help you to determine how much nitrogen your pump or gravity flow pond is putting out, how long to run the pump to decrease the application rate, if necessary, and how to calculate how much nitrogen was applied.

1. Decide what rate of nitrogen (N) you need to apply, in pounds per acre (lbs/ac).

> *Example:*
> *You would like to apply 50 lbs of available N/acre*

2. Determine the concentration of nitrogen in the lagoon water that will be used for this application. Although there are two main types of nitrogen in liquid manure, the ammonium form and the organic form, you need to make your application based on a single nitrogen concentration value. If you base your application only on the ammonium form nitrogen concentration, you will likely over-apply nitrogen because the amount of nitrogen in the organic form is ignored. TKN, or Total Kjeldahl Nitrogen is a laboratory analytical procedure that determines the concentration of the combined ammonium and organic forms of nitrogen. Basing your application on the total of both forms may result in yield loss because the organic form nitrogen may not be broken down to plant-available nitrogen quickly enough for the crop to be able to use it. Usually you will want to count all of the ammonium form nitrogen and a portion of the organic form nitrogen as crop available.

> *Example:*
> *TKN (total Kjeldahl N) is 630 mg/L**
> *ammonium N is 300 mg/L.*
> **mg/L (milligrams per liter) and ppm (parts per million) are the same*
>
> *TKN minus ammonium N = organic N*
> *630 TKN – 300 ammonium N = 330 mg/L organic N*
>
> *If we assume that 30% of the organic form nitrogen will become available to crop over the next few weeks (this rate will vary), multiply the organic N by that percentage expressed as a decimal:*
> *330 mg/L organic N x .3 = 100 mg/L available organic N*

Add this rapidly available organic-N concentration to the ammonium-N concentration and use the combined value as the available N concentration.

300 mg/L ammonium N + 100 mg/L organic N = 400 mg/L available N

3. How many acres will be irrigated in each field or check?
   Multiply the number of acres by the target application rate to find the pounds of nitrogen you want to apply to this area.

Example:
If the field is 30 acres and we want 50 lbs/A of N
30 acres x 50 lbs avaiable N/ acre = 1500 lbs N total

4. How many hours do you expect the irrigation to take?

Example:
Based on experience, it will take 15 hours to irrigate this 30 acres

5. What will the pump gpm (gallons per minute) be during the irrigation?
   Pump output declines as the pond level drops. You will be more accurate in your applications if you adjust your estimates of the pump output according what you anticipate the level of the pond will be during the irrigation. Methods for measuring pump output at varying pond levels are discussed in the publication Measuring Liquid Manure Application Rates, available on the manure.ucdavis.edu website.

Example:
The pond level is expected to be about 2 feet below full during the irrigation of this field and the pump output at that level is around 1000 gpm.

6. Use the "Pounds of Nitrogen per Hour" table (Table 1) to look up how much nitrogen your pump is putting out based on the concentration you determined in step 2.

Pounds of Nitrogen per Hour

concentration of N in lagoon

lbs per thsnd gal	lbs/ac-in	mg/L or ppm	gallons per minute (GPM) 250	500	750	1000	1250	1500	1750	20
1.7	45	**200**	25	50	75	100	125	150	175	20
2.5	68	**300**	38	75	113	150	188	225	263	30
3.3	91	**400**	50	100	150	200	250	300	350	40
4.2	113	**500**	63	125	188	250	313	376	438	50
5.0	136	**600**	75	150	225	300	376	451	526	60
5.8	159	**700**	88	175	263	350	438	526	613	70
6.7	181	**800**	100	200	300	401	501	601	701	80
7.5	204	**900**	113	225	338	451	563	676	789	90

Table 1. Complete tables are available at manure.ucdavis.edu.

Example:
The pump is putting out 1000 gpm. At a concentration of 400 mg/L of available N, the pump will apply 200 lbs of available N per hour.

Multiply the pounds of N per hour by the number of hours it will take to irrigate the field. Compare this amount with the pounds you wanted to apply. Is this amount close enough to your planned application rate to be acceptable?

Example:
The pump will apply 200 lbs available nitrogen per hour and the irrigation will run 15 hours. 200 lbs available N/hr x 15 hrs = 3000 lbs of available N applied in 15 hours, or 100 lbs of available N/acre. This is twice the 50 lbs of available N/acre that you wanted.

7. One way to apply less is to run the lagoon pump during only the last portion of each check or irrigation set. If it is run at the beginning or too early in the set, the nitrogen will not be well distributed. Calculate how many pounds of nitrogen you want to apply to each check or set, then use Table 2 to look up how long to run the lagoon pump on each area based on the pounds of nitrogen per hour the pump is putting out.

Run time for lagoon pump to achieve a target nitrogen application

total lbs N needed	pond output in lbs of N per hour: 100	200	300	400	500	600
250	2 h 30 m	1 h 15 m	0 h 50 m	0 h 38 m	0 h 30 m	0 h 25 m
500	5 h 0 m	2 h 30 m	1 h 40 m	1 h 15 m	1 h 0 m	0 h 50 m
750	7 h 30 m	3 h 45 m	2 h 30 m	1 h 53 m	1 h 30 m	1 h 15 m
1250	12 h 30 m	6 h 15 m	4 h 10 m	3 h 8 m	2 h 30 m	2 h 5 m
1500	15 h 0 m	7 h 30 m	5 h 0 m	3 h 45 m	3 h 0 m	2 h 30 m
1750	17 h 30 m	8 h 45 m	5 h 50 m	4 h 23 m	3 h 30 m	2 h 55 m

Table 2. Complete charts are available at manure.ucdavis.edu.

Example:
Each check is 5 acres. You want to apply 50 lbs available N/acre x 5 acres.
50 lbs N/acre x 5 acres = 250 lbs of available N applied to each check.
If the pump is putting out 200 lbs of N per hour, according to table 2 you will want to apply the lagoon water during the last 1 hr 15 minutes of the irrigation for that check.

8. Write the target lagoon pump run time on the irrigator sheet along with the target flow rate and the assumptions used to determine the run time. This additional information will be useful for

making in-field adjustments if the irrigation does not take the time expected or the pond concentration is noticeably different than anticipated.

Irrigation Record Sheet

Name of Facility: *My Dairy*

Date: *7/1/2011*

Source lagoon: *main lagoon*

Record weather conditions for day before, day(s) of and day after irrigation

date					
weather					
expected concentrations	total N *633*	NH_4-N *300*	Org-N *333*	% avail *30%*	Avail N *400*

s = sunny
o = overcast
c = cloudy
lr = light rain
sr = steady rain
hr = heavy rain
w = windy

Location	acres	Irrigation number	Target lbs N per acre	Expected total run time	Lagoon only hours or %	Expected gpm	Location Start Date/Time	Location End Date/Time	Starting Pond Level	Ending Pond Level	Estimated gpm	Fresh Water Source(s)	irrigator initials & notes
Home Place	*30*	*1*	*50*	*15 hrs*	*1 hr 15 min/ck*	*1000*							

9. The lagoon pump will be run during only the last portion of each set or check. Decide when the irrigation on that area will end, and then subtract from that time the length of time that you determined that the pump needs to run. Also subtract enough time to compensate for the travel time of the blended water from the mixing point to the field outlet.

Example:
It will take 2 ½ hours to irrigate a 5 acre check. The lagoon pump needs to run 1 hr 15 minutes.
It takes 20 minutes for the blended water to travel from the mixing point to the check.
The irrigation will start at 3 pm.

3 pm plus 2 hrs 30 minutes total run time = 5:30 pm finish time
5:30 pm minus 1 hr 15 minutes run time for the pump = 4:15 pm. This is the time the lagoon water should begin entering the field. But since it takes 20 minutes for the water to travel from the mixing point to the field, the pump needs to be turned on at 4:15 minus 20 minutes or 3:55 pm and turned off 1 hour 15 minutes later, at 4:10 pm so that the line will be clear as the irrigation begins on the next check.

The on and off times have to be determined for each irrigation set.

10. Record the start and end date and time for each field or area, and the weather conditions the day before, day(s) of, and day after the irrigation. Since the pump output will change as the pond level goes down, record the approximate pond level during the irrigation so that the calculated application amounts can be adjusted accordingly.

Irrigation Record Sheet

Name of Facility: *My Dairy*

Date: *7/1/2011*

Source lagoon: *main lagoon*

Record weather conditions for day before, day(s) of and day after irrigation

date	6/30/10	7/1/10	7/2/10		
weather	s	s	s		
expected concentrations	total N 630	NH_4-N 300	Org-N 330	% avail 30%	Avail N 400

s = sunny
o = overcast
c = cloudy
lr = light rain
sr = steady rain
hr = heavy rain
w = windy

Location	acres	Irrigation number	Target lbs N per acre	Expected total run time	Lagoon only hours or %	Expected gpm	Location Start Date/Time	Location End Date/Time	Starting Pond Level	Ending Pond Level	Estimated gpm	Fresh Water Source(s)	irrigator initials & notes
Home Place	30	1	50	15 hrs	1 hr 15 min/ck	1000	7/1/10 4 am	7/1/10 7 pm	1 ft 4 in	1 ft 10 in	1000	Canal	

11. Calculate the amount of nitrogen applied.

You may prefer to use a worksheet or an Excel spreadsheet to record data and calculate results. Both of these are available at manure.ucdavis.edu.

A. Calculate the volume of liquid manure applied to each field, expressed as thousand gallons:

Observed gpm (adjusted for the level of the pond) x minutes = gallons applied

Gallons applied ÷ 1000 = thousand gallons applied

Example:

Although it took 15 hours to irrigate the field, the lagoon pump only ran a total of 7 hr 30 minutes on all six 5-acre checks.

The lagoon flow rate is estimated to be 1000 gpm

(7 hrs x 60 minute/hr) + 30 minutes = 450 minutes run time

450 minutes x 1000 gallons/minute = 450,000 gallons

We need this amount expressed as thousand gallons

450,000 ÷ 1000 = 450 thousand gallons

B. How many pounds of nitrogen were in that volume

You will need to know the concentration of the liquid manure that you applied. Agitation, freshwater additions and position of the sludge layer with respect to the pump intake can all greatly affect the variability of the material being applied.

Calculate the pounds applied using this equation:

mg/L* nitrogen x thousand gallons x .008345 = pounds nitrogen applied

*mg/L (milligrams per liter) is the same as ppm (parts per million)

Example:
TKN (total Kjeldahl nitrogen) is 633 mg/L
ammonium nitrogen is 300 mg/L.
organic nitrogen is 333 mg/L (TKN includes both ammonium and organic nitrogen so subtract the ammonium from the TKN to get the concentration of organic N).

<u>Total nitrogen</u>
633 mg/L TKN x 450 thousand gallons X .008345 = 2377 lbs TKN

<u>Ammonium nitrogen</u>
300 mg/L ammonium N x 450 thousand gallons X .008345 = 1126 lbs ammonium N

<u>Organic nitrogen</u>
333 mg/L organic N x 450 thousand gallons X .008345 = 1250 lbs organic N

a. How much nitrogen was applied to each acre
   pounds nitrogen applied ÷ number of acres = pounds nitrogen applied per acre

Example:

2377 lbs TKN ÷ 30 acres = 79 lbs Total nitrogen/acre
1126 lbs ammonium N ÷ 30 acres = 37 lbs/acre ammonium N
1250 lbs organic N / 30 acres = 42 lbs/acre organic N (of which only 30% was assumed to be available to the plants in the next few weeks)
Available nitrogen per acre applied = (.3 x 42)lbs organic N + 37 lbs ammonium N = 12 + 37 = 50 lbs available N per acre

The amount of organic nitrogen that will become available to this crop depends on many factors, including the amount that remains in a crust, how rapidly the particles break down, the temperature and the time remaining until harvest. For this example, it was assumed that 30% would become available within the next few weeks after application.

12. If the application was significantly above or below the target, the nitrogen amount in subsequent irrigations may have to be adjusted. Adjust application rates in subsequent irrigations as needed.