Calculating Nutrient Application from Liquid Manure Irrigations Using Flow Meter Measurements (Worksheet 1)

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As part of an effective nutrient management plan, it is important to document the nutrients applied to *each* land application area to maximize efficiency (water and nutrient management) and yield. Additionally, the Central Valley Regional Water Quality Control Board's Waste Discharge Requirement General Order for Existing Milk Cow Dairies restricts nutrient application and requires documentation of total nutrients applied to each land application area.

An important part of documenting nutrient application is keeping good field records during liquid manure applications. Tools available to assist with field record-keeping can be found in the CDQAP WDR Reference Binder, at http://www.cdqa.org and at http://manure.ucdavis.edu. With good records, calculating the nutrients applied to each field is a simple, 3-step procedure:

1. Determine how much liquid manure was applied
2. Find out the nutrient content of the material
3. Calculate the total nutrients applied

Written descriptions of the basic steps are provided below to assist the user in completing the accompanied worksheets. Excel-based worksheets with automatic calculations can also be found at the above mentioned websites.

Step 1: Determine How Much Liquid Manure Was Applied

The volume of liquid manure applied can be measured using three different methods. This guide supplies spreadsheets for calculating applied nutrients using flow meter measurements.

When using the worksheets supplied in this guide, it is recommended that one worksheet be used for each field each cropping year so that you can keep a running total of the nutrients applied to allow for in-season comparisons and adjustments.

Flow Meter Measurements (Worksheet 1):

There is only one calculation required if you have flow meters on your liquid manure application system:

Reading at end – Reading at beginning = 1000 Gallons* applied

*Most meters give a x1000 or Kgal reading, and this is exactly the number you need in order to do the final calculation, don't add the zeros to get unit gallons. You may prefer to set your meter to read in hundred gallons. Divide 100 gallons (hgal) by 10 to get 1000 gallons.

In *Worksheet 1. Calculating nitrogen applied using flow meter readings*, transfer the meter start reading to column I and the meter end reading to column J. Then, calculate:

Column J – Column I = Column K

This is the total volume of liquid manure applied in gallons times 1000. The following nutrient application calculations take into account the x1000 gallons unit, so don't change that.

Step 2: Find Out the Nutrient Content of the Material Applied

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. The more samples that were taken, the more information will be available to assist you in calculating accurate results. Evaluating all the samples that were collected, choose the sample which best represents each liquid manure application

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.

Use your worksheet. Write the NH_4^+-N value in column N. 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 O in the worksheet.

Step 3: Calculating the Amount of Nutrients Applied

<u>Calculations for Nitrogen</u>

We have all the information we need to calculate the total nitrogen applied to the field, but we need to make several calculations to get there:

1. NH_4^+-N applied (lbs) = NH_4^+-N (ppm or mg/L) x Volume applied (gal x1000) x 0.008345

    Column P = Column N x Column K x 0.008345

    (Note: 0.008345 is the conversion factor for the x1000 gallons unit insisted upon earlier.)

2. Org-N applied (lbs) = Org-N (ppm or mg/L) x Volume applied (gal x1000) x 0.008345

    Column Q = Column O x Column K x 0.008345

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 T of your worksheet to allow you to calculate the total nitrogen that was available to the crop. Comparing the amount available to the amount needed will help you to decide whether you need to apply additional nutrients mid-season to meet crop needs. Remember that, if you need to exceed the 1.4x crop removal limit, you must test the plant tissue for total nitrogen prior to any nutrient application.

Calculating the available nitrogen is completing in the worksheet by using the following four steps.

1. Total NH_4^+-N (lbs/acre) = Total NH_4^+-N applied (lbs) / Acres

    Column R = Column P / Column C

2. Total Org-N applied (lbs/acre) = Total Org-N applied / Acres

    Column S = Column Q / Column C

3. Available Org-N (lbs/acre) = Total Org-N applied (lbs/acre) x Mineralization%

    Column U = Column S x (Column T / 100)

4. Available N (lbs/acre) = Total NH_4^+-N (lbs/acre) + Available Org-N (lbs/acre)

    Column V = Column R + Column U

5. Total Nitrogen applied (lbs/acre) = NH_4^+-N applied (lbs/acre) + Org-N applied (lbs/acre)

    Column W = Column R + Column S

Information in this document was compiled by UCCE and CDQAP to assist dairy producers in understanding and complying with the General Order Waste Discharge Requirements for Existing Milk Cow Dairies (Central Valley Regional Water Board Order R5-2007-0035). Effort has been made to ensure accuracy, but these summaries are not official regulatory guidance and are not legal advice. Producers are advised that these summaries are not intended to be a substitute for producers reading the complete order and consulting their own legal counsel to ensure compliance with the waste discharge requirements. Should any information here conflict with the General Order and/or official information provided by the Regional Board, Board-provided information takes precedence.