Checklist for Using Liquid Manure for Crop Production

Marsha Campbell Mathews
Farm Advisor, University of California Cooperative Extension

Managing dairy nutrients to maintain yields while protecting water quality requires having the infrastructure and management tools in place that will enable the nutrients to be land applied at appropriate rates. Will your system allow you to successfully use dairy liquid manure as the primary nutrient source for your crop? Use this checklist to ensure that you have all the necessary parts of the system in place.

☐ **Liquid manure access** to crop acreage to utilize the nutrients. If application is through an irrigation system, the distribution system must be designed in such a way that liquid manure can be applied to the required amount of acreage at appropriate rates.

☐ **Sufficient storage capacity** so that the liquid manure can be applied during or just prior to periods of crop uptake, and not applied when crop nutrients are not needed. Your soil type, climate, and irrigation practices will influence how far in advance of expected crop uptake you can safely apply liquid manure nitrogen. Liquid manure storage pond sizing considerations include:

- Rainfall & stormwater runoff (up to and including the 24-hour, 25-year storm event)
- Freeboard
- Stockpiling of nutrients to cover peak use periods
- Additions of fresh water to prevent the pond from becoming too concentrated
- Evaporation losses
- Tailwater return flow (if returned to pond)
- Minimum operating levels needed for flushing and floating pumps

☐ A source of **fresh water for dilution.** In many cases, applying undiluted liquid manure to a field will result in over-application of nitrogen, phosphorus and salts. The speed of the irrigation, concentration of nutrients in the pond, and desired application rate determine the dilution required. Required dilution rates vary greatly, but a dilution of 10% liquid manure in the mixed water is typical for an application rate of 50 lbs/A available N. Winter irrigations usually have lower dilution rates -- on the order of 25% - 35% liquid manure because it is often possible to apply higher rates of nitrogen in a single application than in the summer due to lower potential for leaching from spring rainfall than with summer irrigations..

☐ **Adequate mixing** of fresh water and liquid manure. Liquid manure usually must be diluted prior to application. If flows of fresh water and liquid manure come from opposite directions in a pipeline, they will probably not mix, even if both streams are put through one valve, and one side of the irrigated area will receive more nutrients than the other side. Liquid manure has a high electrical conductivity (EC) and an EC meter can be used to verify adequate mixing under your conditions.

☐ **Correctly sized pumps and pipelines** are necessary to allow application of both high and low rates of liquid manure without plugging. Your nutrient management plan will establish target rates throughout the year. Target rates on soils that do not retain nitrate nitrogen when water is applied can vary as widely as 30 to 150 lbs of crop-available nitrogen. Low rates may be needed to prevent

salt injury on pre- and first irrigations, while higher rates may be used in mid-winter applications. On these soils, a typical mid-season summer application is usually around 50 lbs/A of crop-available nitrogen. When liquid manure is concentrated and irrigation run times are slow, achieving these low application rates without plugging pipelines may be difficult. Where nitrogen losses under irrigation are minimal, less frequent applications of rates can be applied.

☐ **Uninterrupted applications** during irrigations**.** Some flush pumps are also used to apply pond liquids through the irrigation system. Problems can occur when a flush is called for during an irrigation set when manure is being applied. These manure flow interruptions will result in non-uniformity of nutrients applied to the field. Dedicated pond irrigation pumps provide timing flexibility.

☐ **A solids removal system** will be needed in most cases to remove all but the fine manure particles to accommodate agronomic applications. Solid removal systems help in several areas by:

- Minimizing solids build-up at the head of fields,
- Keeping pipelines clear,
- Providing a more uniform product for nutrient application,
- Preventing solids build-up in the pond,
- Reducing the organic nitrogen fraction of lagoon nutrients,
- Allowing additional nutrients to be moved offsite if necessary.

☐ Creation of a **uniform fertilizer product**. In many cases, the lagoon nutrients will be the only nutrients applied to a crop. It is essential that the liquid manure be consistent throughout the irrigation so that one part of the field does not have more nutrients applied than other parts. Agitating the pond prior to and during irrigation may improve uniformity, but the mixed liquid manure will often have too much organic-form nitrogen to meet the requirements of a nutrient management plan. Agitators also risk damaging the integrity of the bottom seal. Slugs of sludge that occur when a stand pump is first turned on or when a floating pump digs into the sludge layer can overfertilize crops and contaminate groundwater and need to be avoided. For stand pumps, consider recirculating the first water pumped back into the pond until the pumped water stabilizes. For floating pumps, avoid sucking up sludge and optimize usable pond capacity by using a floating pump with a shallow draft. Sampling and testing flows from pond multiple times throughout irrigation events (at least during the early "learning" stages) can provide feedback to the operator on how infrastructure and management adjustments might be made to achieve uniform applications.

☐ A means of handling **sludge build-up in the pond** is essential for long-term nutrient management and balance. Sludge build-up can be extremely high in nutrients and in most systems it is advantageous to prevent situations where sludge accumulations from multiple seasons must be applied at one time as these applications often result in the over application of nutrients. Three potential methods include:

- Preventing build-up through regular agitation or freshwater flushing resulting in annual cleanout.
- Preventing build-up through removal from the liquid manure stream prior to entering the storage pond.
- Utilizing the first of a 2 or 3 pond system to capture sludge for periodic removal and potential exportation.

The use of agitators, movable floating pumps or flushing of ponds with fresh water can minimize sludge build-up by promoting regular application to crop land through liquid manure irrigations. However, these methods can result in a liquid manure product with too much nitrogen in the organic (slowly available) form. Maintaining yields without applying excess nitrogen when more than 30-50% of the nitrogen is in the organic-nitrogen form can be difficult under frequent leaching conditions because in order to provide enough available form nitrogen to meet crop needs, an excessive amount of total nitrogen must be applied.

Another way to minimize buildup of solids in ponds is to keep them from entering in the first place. Traditional mechanical separators take out course particles but generally won't prevent sludge buildup. Functional settling basins or very fine screen separation equipment in conjunction with a process pit are better options. A process pit collects and stores water from the milk barn to use for flush water, which then drains back to the process pit. The process pit water is sent over a low-throughput, high efficiency separator prior to transfer to the long term storage pond. Well-designed and maintained settling basins are another good option for solids separation.

An alternative method to land applying all nutrients generated in a year is to deliberately allow sludge to accumulate in the first pond of a two or three pond system, keeping the last longer- term retention pond relatively clear. Periodically the sludge from the first pond(s) would be pumped and land applied at agronomic rates or dewatered and exported. Technology to economically accomplish the dewatering process remains to be demonstrated in California.

☐ **Uniform distribution of irrigation water** down the furrow or check. With furrow or border irrigation more water tends to infiltrate at the top of the field than in the middle or near the end. On sandy soils this difference can be extreme. Because liquid manure nutrients are being applied with water, more nutrients will be applied in parts of the field where more water infiltrates. Non-uniform distribution results in over-fertilization in some areas and under-fertilization in others. In some cases, injecting the liquid manure into the fresh water during only the last portion of the irrigation may improve uniformity of surface water nutrient applications. Modifying field lengths, check widths, flow rates or the irrigation system itself can improve irrigation uniformity.

☐ **A method of measuring how much liquid manure is being applied**. There are several methods for doing this. They include:

- Installing flow meters
- Measuring pond drop
- Calculating gallons applied from pump output times pump run time

The easiest way to measure application is to install a flow meter on the pond outlet. This method, when coupled with a control valve, allows specific amounts of liquid manure to be applied and measures the total gallons applied to each field. In many cases, the cost of the flow meter can quickly be recovered in savings on commercial fertilizer. Construction of a metering run may be necessary to ensure the meter reads correctly. When liquid manure is being applied to more than one field at a time, separate flow meters will be necessary to measure each stream independently.

The pond drop method can be used accurately only if

- inflows to the pond and non-irrigation outflows are stopped or measured the during the entire irrigation

- The dimensions of the pond are accurately measured and the changes in dimension with water depth due to side slope are accounted for and
- There is a way to accurately reading the amount of drop, such as a staff gauge or depth sensor.

When using the pump output calculation method, thought should be given in determining the most accurate pump output gpm. The correct gpm of liquid manure pumps can be difficult to determine as standard pump testing equipment usually cannot be used for liquid manure pumps. In addition, pump outputs will vary depending on the water level in the pond, amount of sludge, debris on the impeller and pump wear.

☐ **A method of measuring the concentration** of crop nutrients in the liquid manure. The amount and forms of nitrogen in the liquid manure storage pond can vary throughout the season and sometimes even over the course of an irrigation. Laboratory analysis offers the most accurate and complete information on a sample, while in-field rapid testing procedures make it possible for the application to be adjusted in response to changing concentrations. Thoughtful placement of the sampling spigot or other method of obtaining a sample for will make sampling liquid manure easier for those taking liquid manure samples.

☐ A way to **control the amount** of liquid manure that is applied to the field by varying the proportion of liquid manure to fresh water. A valve or variable frequency controller on the pump will allow the liquid manure flows to be regulated. Some valve designs are better at throttling flow than others, especially if it is sometimes necessary to apply very small amounts. A V-notch gate valve is preferred by most users for this purpose because it is less prone to clogging when throttled down to low flow rates and can be more accurately adjusted when nearly completely closed. Valves chosen should be made from a material that is resistant to corrosion.

☐ A **tailwater return system** to prevent discharge of nutrients off the property is a necessity if irrigation runoff occurs and it may contain nutrients. Consider how to measure the amount of nutrients in the tailwater leaving the field so that you are not having to account for nutrients that were not actually applied to the crop.

☐ **Backflow prevention devices** are required to prevent wastewater from contaminating freshwater sources. An air gap between the discharge of the freshwater source and the standpipe containing manure liquids is the most common and simple method of backflow prevention.

☐ **A method of record keeping**. The best infrastructure is of little value for nutrient management without a functional recordkeeping system. You will need to record the volume and concentration of each source of nutrients applied to each field. Sources include liquid manure, fresh water, solid manure, commercial fertilizer, and legume crop plowdown. Yield and nutrient concentration of the harvested crop also needs to be recorded. A record keeping system that allows you to calculate the amount of crop nutrients shortly after they are applied to each field during each irrigation will enable you to make informed decisions about subsequent applications.