Checklist for Using Liquid Manure for Crop Production

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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 to match crop uptake needs. 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
- Minimum operating levels needed for flushing and floating pumps

☐ **A source of fresh water for dilution** will usually be needed to apply liquid manure at agronomic rates. The speed of the irrigation, concentration of nutrients in the pond, and desired application rate are factors that determine the amount of dilution needed. Required dilution rates vary greatly, but a dilution range of 10 - 35% of liquid manure in the mixed water across the cropping year is common.

☐ **An adequate system of mixing** fresh water and liquid manure is important in cases where fresh water is used to dilute liquid manure prior to application. Certain equipment and/or structures may be necessary. If flows of fresh water and liquid manure come from opposite directions in a pipeline, they will probably not mix effectively, even if both streams are put through one field valve. Without proper mixing, one side of the irrigated area may receive more nutrients than the other side. Liquid manure has a high electrical conductivity (EC) and an EC meter is one way to verify adequate mixing under your conditions.

☐ **Correctly sized pumps and pipelines** 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 can vary as widely as 30 to 150 lbs of crop-available nitrogen in a single irrigation. Low rates may be needed in some cases to prevent salt injury (such as in pre- and first irrigations) ,while higher rates may be needed for mid-season or winter applications.

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

☐ **A solids removal system** may be needed to accommodate agronomic applications. If needed, solids removal systems can provide help in several areas:

- Minimize solids build-up at the head of fields,
- Keep pipelines clear,
- Provide a more uniform product for nutrient application,
- Prevent solids build-up in the pond,
- Reduce the organic nitrogen fraction of lagoon nutrients,
- Allow additional nutrients to be moved offsite if necessary.

☐ A means to create a **uniform fertilizer product**. In many cases, the liquid manure 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 receive 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. In addition, slugs of sludge that may occur when a stand pump is first turned on or when a floating pump digs into the sludge layer can overfertilize crops 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 pond flows multiple times throughout the irrigation events (at least during the early “learning” stages) can be helpful in providing feedback to the dairyman on how infrastructure and management adjustments might be made to achieve uniform applications.

☐ A means of handling eventual **sludge build-up in the pond** is essential for long-term nutrient management and balance. Three potential methods include:

- Prevent build-up through regular agitation or use freshwater flushing to accomplish annual cleanout.
- Prevent build-up through removal of solids 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..

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 may result in the over application of nutrients.

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 much of the nitrogen is in the organic-nitrogen form can be difficult.

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 the 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 removed and then can be either 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** within the furrow or check. Because liquid manure nutrients are being applied with water, more nutrients will be applied in parts of the field where more water infiltrates (for example the head or tail end of a surface irrigated field). Non-uniform distribution results in over-fertilization in some areas and under-fertilization in others. Management or system infrastructure changes may be necessary to improve distribution uniformity.

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

- Installing flow meters

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

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.

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.

If using the pond drop method, inflows to the pond and non-irrigation outflows need to be stopped or measured during the entire irrigation. The slope of the sides needs to be accounted for, and a provision for accurately reading the amount of drop needs to be made.

☐ **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 can allow the application to be rapidly adjusted in response to changing concentrations or unanticipated run times. Thoughtful placement of the sampling spigot will make sampling liquid manure easier for those taking liquid manure samples.

☐ **A means of controlling 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 valuable addition in many locations. 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 returned to the storage system and not applied to the crop.

☐ **Backflow prevention devices** are required to prevent wastewater from contaminating freshwater sources. An air gap between the discharge of the liquid

manure and the standpipe is the most common method of backflow prevention when liquid manure is injected into a pipeline or standpipe.

☐ **A method of record keeping**. The best infrastructure is of little value for nutrient management without a functional recordkeeping system. A method to record the volume and concentration of each source of nutrients applied to each field will be needed. 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 track the amount of crop nutrients as soon as they are applied to each field during each irrigation will enable you to make informed decisions about subsequent applications.

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