Provisional Guidance: Using Surplus Milk as Fertilizer Due to the COVID-19 Emergency

- for safety, the environment, and farm viability -

Given the current market disruptions created by the COVID-19 emergency, farms may play important roles in the safe and environmentally sound recycling of surplus milk. This document is intended to offer agronomic and environmentally protective guidance for recycling milk and manure and milk mixtures as a fertilizer for crops. The guidance is based on scientific principles and extensive research on fertilizing crops with manure, but there is very little information in the scientific literature on use of milk as fertilizer, so this guidance may need to be updated as more is learned.

The provisional guidance was developed by the NYS Department of Agriculture and Markets, in partnership with the NYS Department of Environmental Conservation (NYS DEC) and the Cornell University Nutrient Management Spear Program, Department of Animal Science, and PRO-DAIRY Program, and in coordination with the NYS DEC's enforcement discretion memo regarding Part 360 regulations (specifically Part 361-2.3(b) and (c)) and the milk surplus caused by COVID-19.

Nutrient Content and Other Attributes of Milk

Milk contains N, P, K and other nutrients, similar to dairy manure, but typically at somewhat higher levels. Thus, milk that is land applied should be valued for the nutrients it can supply to crops. One critical difference between nutrients in manure and those in milk, is that nutrients in cow milk are essentially 100% readily available, unlike manure where much of the nutrient content is bound in bits of undigested feed.

The N content of milk can be derived from the percent crude protein (CP) it contains. Milk crude protein includes about 5% of N in the inorganic (urea) form and 95% in the organic form (whey protein and casein). The organic N in milk will be rapidly mineralized and nitrified by microbes when land applied especially as microbes become more active with increasing soil temperature. As such, the N value of milk is expected to be similar to that of N fertilizer.

Raw milk has a high biochemical oxygen demand (BOD) in aerobic conditions and high chemical oxygen demand (COD) in anaerobic conditions (about 2x that of raw manure). Milk is readily biodegradable and under anaerobic conditions, like in manure storages, the microbes that degrade milk and manure and milk mixtures produce offensive odors relative to odors from manure alone. Fresh milk (milk that is kept cold) can be land applied with less of an odor issue, but great care needs to be taken to keep milk out of water courses; its high BOD levels can quickly deplete receiving water bodies of free oxygen resulting in losses of aquatic life (including fish and macroinvertebrates).

Selection decisions for land application sites should factor the nutrient needs of the crops that will be growing, impact on neighbors in terms of odor and flies, as well as potential to harm aquatic systems with offsite movement. Consult with an AEM Certified Planner, Soil and Water Conservation District staff, or other local agricultural conservation professionals to help identify lower risk fields for application (see the Additional Environmental Considerations section, below).

Land Application of Surplus Milk as Fertilizer

Given the fairly high N content of milk, it makes sense to apply it to crops that have a high N need such as corn, grass hay or pasture, wheat or spring grains. Alfalfa or soybeans are also candidates, but with lower priority because of the ability of legumes to supply N through N fixation from the atmosphere. If looking to get the most fertilizer value from milk, alfalfa or soybean fields are not the best places to apply milk. However, the N will be taken up favorably by legumes, so these are acceptable places to land apply milk given other considerations mentioned here. Grass hay fields could use a readily available source of N to promote early spring growth or after cuttings, so if surface applications can be made safely on such fields, these fields may be good candidates for recycling surplus milk. In general, avoid application of milk on fields where nutrients have already been applied to meet the crop guideline and limit or avoid application on first-year corn fields after hay, due to the ample N supplied by the rotated hay field. To estimate how much N, P_2O_5 and K_2O is being applied with a given application rate, use Table 1. Rate selection should be based on crop nutrient needs and acknowledge any P Index requirements for CAFOs. Notice that milk has a higher N content than most liquid dairy manure samples, but given the forms of N in milk, the pH of milk, and expected infiltration of milk into the soil, we do not expect significant N volatilization loss from surface application of milk, even if not incorporated.

Table 1: Estimated application rates of total N, P_2O_5 and K_2O for land application of milk. Manure and milk mixtures will likely have lower N, P_2O_5 and K_2O content than listed here.

gallons/acre*	Total N**	P_2O_5	K_2O
	lbs/acre	lbs/acre	lbs/acre
1000	44	18	17
2000	89	35	33
3000	133	53	50
4000	178	71	67
5000	222	89	83
6000	267	106	100

* The pH of milk is roughly neutral and the chloride content is modest such that the rates, above, will not result in soil acidification or salt limits. ** Assumes 3.3% crude protein.

For spring applications before corn or sorghum planting, the N rate applied should be multiplied by 0.65 to reflect that not all N applied is crop available. Applications to hay fields should be made at green-up or soon after cuttings and should be credited with the entire N content of milk summarized in Table 1. Applications to growing crops, such as small grains may cause injury or leave unacceptable residue, and/or result in excess N and possibly lodging.

Additional Environmental Considerations

Milk added to manure storage in modest amounts will increase odor potential but should not appreciably change overall nutrient content of the manure. However, if milk added to storage starts to exceed 5-10% of the volume of manure in the storage, it can have an impact on overall nutrient content and resampling and adjustments for rates should be considered. While encouraged for all farms, CAFO-permitted farms must record the quantity of milk accepted into storage, even if the only addition to storage is the farm's own milk. When spreading milk or manure and milk mixtures on a neighbor's land, CAFOs should use the same precautions and provide the same documentation as if manure alone was being applied (refer to "Transfer of manure, litter, food processing waste, digestate, and process wastewater to other persons" requirements in the CAFO permit).

Depending on storage capacity across dairies and the duration of the milk surplus situation, some milk may need to be directly land applied. Unlike manure, milk has an extremely narrow range of N, P, K content, so the book values provided in Table 1, above, can be used to determine nutrient value. Avoid spray application of anaerobically stored milk or manure and milk mixtures with tankers if possible to manage odors; applying close to ground level will be less odorous.

Dairies and other farms with high soil test P levels should be careful about rates and overall quantities of milk being recycled as a fertilizer source. Relocating milk to land with low to moderate soil test P is desirable when possible, assuming limited runoff potential when it is surface applied. Most CAFO permitted farms with an adequate land base should be able to recycle some milk with their manure without major adjustments to the nutrient management plan. Consult with your AEM Certified Planner on this topic to make sure that you are following the CAFO permit requirements.

Further considerations for reduced-risk applications of surplus milk have been summarized, below, drawing from the CAFO permits, the NRCS-NY 590 Nutrient Management Standard, and the other guidance from the Agricultural Environmental Management (AEM) Partnership referenced at the end of this document.

- Near-term weather: time applications when little or no rainfall is forecast in the next 48 hours (note, in an emergency response, this may not always be possible for smaller dairy farms without storage).
- Actual field conditions: look for fields that are fairly dry (ready to plow) and don't apply on saturated soils or without tillage on surface compacted soils. If runoff, ponding (beyond small, infrequent puddles), or discolored tile flow is observed during application, stop spreading.
- Lower risk fields (whether on your farm or neighboring farms) are those with:
    - no history of runoff, groundwater, or flooding issues;
    - limited surface connection to streams/ditches (fields or portions of fields are set back from streams);
    - flat or mild slopes;
    - high crop residue or surface roughness (like hayfields).

- Avoid fields with:
    - shallow soils over bedrock or in the drainage area to a sinkhole in karst areas;
    - locations with subsurface drain tiles in well-structured silty clay loam soils unless tilled with application to break-up macropores;
    - significant concentrated flow paths.

- Manage applications to further reduce leaching and runoff risk by:
    - injecting or incorporating the milk or manure and milk mixture (may be especially important as temperatures rise to reduce odors) or tilling in advance of application to encourage infiltration;
    - applying to fields well away from neighboring homes and/or with significant air current disruption such as woods to reduce odors;
    - considering recent applications of manure and fertilizer to the field;
    - maintaining a 100-foot application setback from streams, surface inlets, and wells;

Additional logistics may be relevant for smaller dairy farms and crop farms (i.e., non-CAFO permitted farms) working to help recycle surplus milk. For farms without manure storages, consider the following options for managing surplus milk:

- avoid sending raw milk to existing milkhouse waste systems used for milkhouse wash water, unless it's the type built to transfer milkhouse waste to a liquid-tight spreader;
- farms may need to pump milk from their bulk tanks to spreaders if gravity transfer isn't an option;
- work with a neighbor if they have storage capacity for your farm's milk;
- check with your co-op if your milk hauler can take milk to another farm's storage;
- if your spreader can haul and apply liquids, land apply directly based on the guidance provided in this document;
- if your spreader can't handle liquids without leaking and there's no option to store the milk, consider these alternatives for applying the milk to fields:
    - borrow a neighbor's liquid-tight spreader;
    - repurpose a tank or other equipment on your farm for hauling and applying milk to fields (water wagons, sap tanks on trailers, nurse tanks, etc. with a valve and spreader plate or bar; may require more frequent cleaning to avoid clogging with milk fats);
    - load your spreader with absorbent materials (bedding, waste feed, dry manure, etc.) and top dress with milk.

Local Resource Professionals Near You

The following local Ag conservation professionals may be available to help on the nutrient management considerations outlined in this document in a safe manner according to COVID-19 guidelines:

- AEM Certified Planners: https://agriculture.ny.gov/system/files/documents/2019/12/aemcertifiedplannerdirectory.pdf
- Soil and Water Conservation Districts: https://agriculture.ny.gov/soil-and-water/soil-water-conservation-district-offices
- Cornell Cooperative Extension Regional Ag Teams: https://cce.cornell.edu/page/areateams
- Certified Crop Advisors (CCA): www.certifiedcropadviser.org/certifications/professional-search
- 4R Nutrient Stewardship Certified Businesses: www.nysaba.com/4r-ny
- USDA-NRCS Field Offices: https://offices.sc.egov.usda.gov/locator/app?state=NY

If not already working with one or more of these partners, consider contacting them for help during the COVID-19 response or with other conservation and farm management interests once we're beyond these challenging times. Please be safe and stay healthy.

Reference Information

- Agricultural Environmental Management (AEM). NYS Department of Agriculture and Markets and the NYS Soil and Water Conservation Committee. https://agriculture.ny.gov/soil-and-water/agricultural-environmental-management
- Agronomy Factsheet Series. Cornell University Nutrient Management Spear Program. http://nmsp.cals.cornell.edu/guidelines/factsheets.html
- Field Crop Nutrient Guidelines. Cornell University Nutrient Management Spear Program. http://nmsp.cals.cornell.edu/guidelines/nutrientguide.html
- Manure Management Guidelines for Limestone Bedrock/Karst Areas of Genesee County, New York: Practices for Risk Reduction. Cornell University Nutrient Management Spear Program. http://nmsp.cals.cornell.edu/publications/files/Karst_2_15_2011.pdf
- NRCS Nutrient Management Conservation Practice Standard (NRCS-NY 590). USDA-NRCS. https://efotg.sc.egov.usda.gov
- NYS DEC CAFO Permits. NYS DEC. www.dec.ny.gov/permits/6285.html
- PRO-DAIRY Program Resources. Cornell University PRO-DAIRY Program. https://prodairy.cals.cornell.edu
- Winter and Wet Weather Manure Application Guidelines. Cornell University Nutrient Management Spear Program. http://nmsp.cals.cornell.edu/publications/files/WinterSpreadingGuidelines2015.pdf