Supply chain disruptions in the dairy industry

How do I manage excess raw milk on my farm from an agronomic and environmental perspective?

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This spring, consequences of the COVID-19 pandemic have resulted in temporary milk processing plant disruptions, school closures, and decreased ability for producers to ship milk off their farm for further processing. In some cases, this has led to the need for farms to manage their excess raw milk.

Diverting and Reducing Milk Production

Key Points for Feeding Milk:

- Dairies could potentially feed up to 25% (as-fed) raw bulk tank milk in lactation diets if the ration is dry to start with.
- The biggest concern is feed stability, including potential residual spoilage in the feed alley concrete. Push out refused feed daily.
- Dairies should work with their nutritionists to come up with a strategy that will maintain ration dry matter above 45%, keep feed fresh, and save money by pulling out some other feeds to account for the nutrients supplied by the milk.
- Dairies should also consider bovine disease transmission risk in consultation with their veterinarian.
- If a dairy is currently using milk replacer for calves, this would be a time to consider switching to milk. Although pasteurization can reduce bacterial load, feeding raw milk is not likely to be a problem if fresh milk is used consistently. If you do switch from milk replacer to fresh, raw milk, this should be a transitional process. Alternatively, milk can be acidified for longer “shelf life”. For more information, check out the following link from Penn State Extension: https://extension.psu.edu/feeding-acidified-milk-to-calves.

Reducing Milk Supply:

- Generally, the most economical way to decrease milk production is to remove less efficient cows from the herd. However, this strategy may be constrained by a current lack of slaughter capacity. Herd managers may want to consider whether low-cost pasture is available to hold non-lactating cull cows for weeks until processing capacity returns.
- Be sure to engage with your milk cooperative before choosing to reduce production. As wasteful and illogical as it is to produce milk that will be discarded, if you will be paid for discarded milk but not milk that is not produced, you may have no choice but to continue with your current management framework.

Non-Permitted vs. Permitted Farms

According to EGLE, during the COVID-19 pandemic response, **permitted** farms (Concentrated Animal Feeding Operations – CAFOs) are expected to maintain compliance with environmental regulations and permit requirements. EGLE understands that disruptions to standard operations may create challenges for regulated farms to meet some legal obligations. To address these challenges, EGLE has established an email box (EGLE-EnforcementDiscretion@mi.gov) to accept requests for regulatory flexibility from entities who face unavoidable noncompliance directly due to the COVID-19 pandemic, for example overpopulation. In response to those requests, EGLE may consider extending reporting deadlines, waiving late fees, and otherwise exercising enforcement discretion. Additional information and requirements for the request can be found at https://www.michigan.gov/egle/0,9429,7-135--523592--,00.html

Requests must include:

- The specific regulatory requirement in question, including identification of any permit, order, or agreement that applies to the entity's obligations.
- A concise statement describing the circumstances preventing compliance and how the compliance issue is impacted by the COVID-19 pandemic response.
- The steps taken to avoid the compliance issue, including whether you contacted EGLE for assistance and why the compliance issue was not reasonably avoidable.
- The anticipated duration of the compliance issue and whether it may create an acute risk or imminent threat to human health or the environment (but emergency situations should be reported to the PEAS Hotline at 800-292-4706).
- Mitigative measures planned to protect Michigan's environment and public health during the period in which the requirement cannot be met.
- A central point of contact for the regulated entity (your farm), including an email address and phone number.

Permitted farms will **not** be allowed to put milk into manure storages. The following are acceptable according to EGLE guidance:

1) Send raw milk to wastewater treatment plants (WWTP) that have potential capacity to treat excess raw milk. If interested in this option, contact Charlie Hill at hillc@michigan.gov or Phil Argiroff at argiroffp@michigan.gov (EGLE – Water Resources Division). Farms can also call a WWTP directly for additional information and potential authorization.
2) In an official state of emergency, alternative options may be allowed. Contact EGLE-EnforcementDiscretion@mi.gov for enforcement discretion requests.

Non-permitted farms can store and apply agricultural wastes under the Michigan Right to Farm Act and Generally Accepted Agricultural and Management Practices (GAAMPs). GAAMPs are guidelines for good farm management, and farmers following these practices are afforded a certain level of protection if a nuisance complaint is filed against them.

GAAMPs define raw milk as an agricultural waste. Raw milk can be added to manure storages, but manure storage should still meet criteria in the GAAMPs for Manure Management and Utilization (Manure GAAMPs) including design criteria and minimum freeboard.

Many of the guidelines for land application of raw milk are summarized in the MDARD Guidance for Emergency Management of Raw Milk. Comingled milk and manure should be applied following the Manure GAAMPs, while land application of just raw milk should follow the GAAMPs for Nutrient Utilization. Raw milk is unique from many other agricultural wastes, and so many of the guidelines in this document will be helpful in achieving the performance standards described in GAAMPs.

Land Application of Raw Milk

While raw milk is typically not land applied as a fertilizer source, certain circumstances may lead to the need to appropriately land apply. You may need to consider the sale of milk as a fertilizer. Environmental concerns are also important as milk has five times more Biological Oxygen Demand (BOD) than manure.

What is BOD?

BOD is the amount of oxygen that is required by microbes to breakdown organic materials, like milk or manure. High amounts of BOD that leave the land and end up in surface water as runoff can lead to low dissolved oxygen and therefore, fish kills. For instance, if one pint of milk is added to water, the bacteria will consume the oxygen in 1,600 gallons of that water.

Based on limited research, it is unlikely metal mobilization will be a concern:

- Consider that one gallon of milk/acre is equal to one pound of BOD/acre (BOD concentration in milk is 120,000 mg/L according to Wang et al. (2006)
    - 120,000 mg/L * 3.785 L/gal * 1 g/1,000 mg * 1 lb./454 g = 1 lb./gal
- A study done by Safferman et al., 2011 utilized a 4 ft. deep soil column receiving 500 lb. BOD/acre/day leach Mn after 200 days (200 applications)
- Therefore, one application of milk at 500 lb. BOD/acre/day, or higher, is not likely to leach metals even if the anoxic environment changes the soil ecology to favor metal reducing microorganisms (unlikely the metals would migrate to tiles drains and groundwater very quickly (this has not been demonstrated, however)

Unlike manure, 100% of the N, P_2O_5, K_2O, and S in raw milk is considered plant available.

Application Guidance:

Milk should be applied to fields as a fertilizer to meet growing crop nutrient needs. The average nutrient values in 1,000 gallons of raw milk: N = 46 lb, P_2O_5 = 26 lb, K_2O = 17 lb, S = 2 lb.

To calculate the amount of N in milk using milk tests:

% protein x 13.48 = lb N/1,000 gal

Like manure, if milk is applied to meet crop N needs, P will be overapplied. The **total** nutrients a field needs should not only include milk, but other nutrients that have been or will be applied. If a field had previously applied manure on it the summer before, it may not be a good field for land application of milk. Consider N credits that may exist from alfalfa or forage legumes that were terminated the previous fall as they may not be ideal fields for application.

- When comparing Milk vs. Dairy Manure (<4% DM), milk has six times more available Nitrogen (N) and nine times more available Phosphate (P_2O_5)

When discussing the appropriate application of manure, it is natural to refer to the 4Rs: right source, right rate, right time, and right place. The same principles should be followed for land application of milk.

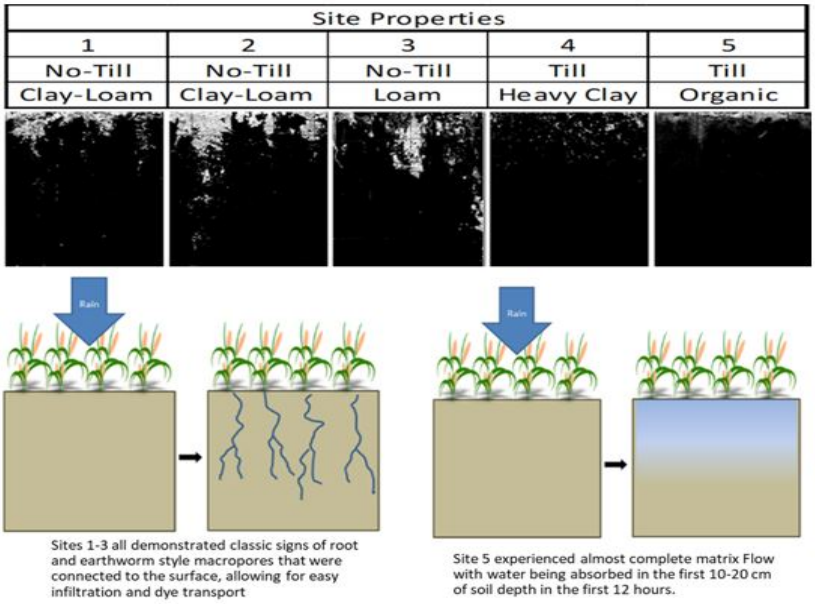

Figure 1. Representative Images from Five Sites using Dye Tracer Study (Safferman et al. 2019)

- Utilize the MI EnviroImpact tool to determine proper timing of application
- Incorporate or inject milk to prevent potential runoff
- Consider the location of wells and surface water
- Avoid:
  - Heavily sloped fields
  - Sandy or loamy sand soils
  - Fields with shallow groundwater
  - Tiled fields, and
  - Soils with macropores where possible
- Macropores have the potential to act as a direct conduit to tile drains with both manure and milk (See Figure 1)

The fat portion of the milk may be a concern:

- Consider multiple applications at lower rates to avoid surface ponding; however, clogging of soil pores is unlikely. Research by (Dong et al., 2017) showed the total amount the fat applied is the limiting factor in total application, but more research is needed to see potential long-term impacts
- The social aspect of raw milk being applied to land should also be contemplated.
- Odor will be great when milk is surface applied to fields: Consider the location of neighbors and public places near the field on which you choose to apply and incorporate or inject milk to reduce odor.

Agronomic Considerations for Application:

- Corn, sorghum-sudan, and other warm season grasses
  - Potentially sidedress to reduce potential early season N loss
  - Apply before planting on moderately well and well-drained soils (avoid excessively drained soils)
  - Avoid application over top plants (potential for milk to stick to plant and runoff during rain event)
- Small grains – all uses
  - Application rate should not exceed crop N need
  - After harvest (consider a cover crop to capture N)
- Legumes
  - Topdress alfalfa and clover shortly after harvest to minimize crown damage
  - If apply to soybeans, may see increase in lush vegetation growth creating potential increased risk of white mold infection
- Pastures
  - Apply shortly after grazing or harvest
  - Unsure if alterations will occur in forage palatability ensiling and/or quality
  - For grass, split into 2-3 applications with final application in mid-August
  - Any manure deposited by livestock on pasture MUST be counted in total nutrient application to the pasture along with the milk
  - Give time between grazing/harvest days and application

Other Considerations:

- Monitor forage potassium levels specifically when feeding to dry cows or springing heifers
- Milk sugars may promote fungi growth (ID fungi before applying a fungicide as it may not be needed)
- Soil sample fields where looking to apply milk if have not sampled recently
- Soil sample fields where milk is applied before the next growing season

Utilization and Disposal of Raw Milk

When land application is not immediately possible, raw milk may be stored in manure storages, taken to an anaerobic digester, or a municipal wastewater treatment plant. Do NOT put milk into septic tanks. The fats in milk can cause clogging of pipes and drainfields. Do not put milk into recycle water, as it could cause pipe clogging.

Manure Storage

- Do not transfer milk to manure storage through other systems/transfer systems due to the fats in milk; Send the milk directly to manure storage to prevent clogging.
- Avoid milk going into sand separation systems since milk components will adhere to the bedding.
    - If you do have milk going into sand separation, you will need to store the sand longer to decrease levels.
- Mix storage evenly when adding milk.
- Milk has a lot of readily degradable materials, which can increase gas production.
    - Risk of carbon dioxide, and methane asphyxiation and well as explosion risks increase.
    - Hydrogen sulfide production may increase, more concern as temperatures increases.
    - Michigan Farm Bureau offers these tips to stay safe.
- The odor in your manure storage WILL increase when adding milk.
    - Additives may not work as they increase decomposition, which will actually increase odor.
    - Minimize the number of people exposed to the odor.
    - In the case of complaints, MDARD will review whether the farm is following the Site Selection GAAMPs.
- If adding milk into a manure storage, get a nutrient analysis before application to have a better idea of the milk-manure mixture

Anaerobic Digesters

Milk and various milk-derived products can be utilized in anaerobic digesters to generate biogas and stabilize it for land application as a fertilizer. The high fat and protein content of milk results in relatively high biogas potential, in the range of 11.5 (skim) to 14.5 (whole) cubic feet of biogas per pound of volatile solids added to a digester. In comparison, manures and biosolids generate biogas in the range of 5 to 8 cubic feet of biogas per pound of volatile solids added. To maintain a healthy digester, operators should allow their systems to acclimate to new feedstocks by starting slow and ramping up the volume over the course of several weeks. New feedstocks should be sampled and evaluated for solids and chemical oxygen demand (COD) at a minimum. Understanding the basic composition will allow operators to calculate the organic load from milk and check the organic loading rate (OLR) of the digester to make sure the system is not overfed. In addition, operators should use the composition to estimate biogas production and make sure the utilization system is not overwhelmed. Balancing biogas production and utilization is important to make sure there is a net benefit to adding milk or other organic wastes. Producing biogas at a rate that exceeds utilization can result in flaring excess biogas or direct venting to the atmosphere which negates the benefits of adding the material.

Digester operators need to consider several factors when adding milk products to their system. Raw milk is 87.5% water. Water is not impacted during digestion and will require management and storage space post

digester. The simple carbon compounds in milk are highly degradable and will be converted to biogas quickly in a healthy digester. Proper metering of milk products into the system is important for maintaining biological health and balancing biogas production and utilization. Slug feeding can result in a rapid increase in gas production (in a matter of hours) followed by a relatively rapid drop off (few days). This rapid change in gas production could overwhelm the biogas utilization system and potentially damage equipment or result in gas releases. Rapid generation of gas can also result in foaming which can cause mechanical issues with digester systems if not managed. Milk products due contain sulfur which can contribute to increases in the hydrogen sulfide (H2S) concentration of biogas, requiring additional treatment before utilization. regulatory agencies to ensure compliance with regulations such as National Pollution Discharge Elimination System Permits (NPDES), Air Permits, and Liquid Industrial By-product transportation. Operators also need to consider the impact on energy sales. Adding new feedstocks will change or could eliminate credits generated by selling biogas derived renewable natural gas under the Renewable Fuel Standard or California Low Carbon Fuel Standard. Changing or losing credits under these programs can have profound impacts on system financials.

Considering all factors before taking in milk or other organic feedstocks is important to determining the acceptability of a product and the value of the product to an individual digester system.

Municipal Wastewater Treatment Plants

Several engineers and public works directors were contacted in April 2020 concerning the willingness of publicly owned treatment works (POTW) wastewater treatment plants to take milk in their treatment process and biosolid's anaerobic digesters. There was a willingness, notably from those with anaerobic digesters in their treatment systems.

Some POTW have capacity and/or ability to take raw milk. Many POTW do not have capacity due to the high BOD of milk or the type of system the POTW used to process pollutants.

- Farmers and/or co-ops can contact the public works director in communities near their routes to check for availability.
    - Interested POTWs have been included on a contact list available through your MSU Extension Dairy Team representative. Here is a contact list of all POTWs in Michigan.
- Some POTWs work with septage haulers that routinely deliver to the plants. Consider one of these haulers to haul milk to municipalities.

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