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By Curt Gooch and Peter Wright

Manure Treatment. Is it in your future?

Manure treatment provides a number of benefits to improve its characteristics for on or off farm use. Treatment can help address regulatory concerns, reduce handling costs, add economic value, and improve neighbor relations and environmental stewardship. Manure (urine plus feces) as excreted is a high moisture, high volume material, with potential pathogen and odor concerns. In its raw form manure has value but less than when processed. Processing can increase its value as an organic fertilizer, harvest its bio-energy potential, and/or result in a product that can be used as a stall bedding or soil amendment.

Manure manipulation: Is there a benefit to taking a systematic approach to manure treatment?

Composting is a viable manure treatment option particularly if there is a market for the finished product. Composting requires oxygen (therefore mixing or forced air) and moisture content below 70%. Requisite moisture content can be achieved by adding chopped straw, hay or other dry material, or by pre-processing with a solid-liquid separator. The high temperatures developed kill pathogens and the anaerobic process converts the nutrients to a more organic form for a slow release to the environment. Some nitrogen will be lost to the atmosphere, but adding more carbon-based dry matter to the mix can minimize this loss.

Storage of manure, when storages are sized appropriately, and in warmer climates, is a passive treatment process many farms have adopted. Because of short summers and long winters, storage in the Northeast cannot be designed as a treatment. Typical liquid storage increases the moisture content of the manure, increases the odor through partial decomposition, and increases the total volume with the addition of precipitation. The advantage, of course, is it allows for more appropriate spreading environmentally, efficiently and agronomically. Storage also reduces pathogen viability.

Storage with impermeable covers is a step that will prevent the addition of precipitation and preserve some nitrogen in the manure. As the gases emitted from the manure are contained and then flared, the greenhouse gas (GHG) potential from the manure is reduced, as well as the odor from the storage. These benefits need to be weighed against the capital cost of the cover. Generally without sufficient economic credit for the GHG reduction, the cost of the cover is greater than the continued hauling cost of the uncovered manure from storage.

The January 2015 issue of *The Manager* focused on Managing Manure, and featured a cost survey of manure covers in NYS. This article "Covered manure storage systems: Tangible and non-tangible benefits" is featured on PRO-DAIRY's website.

Solid separation is an important treatment step if a covered storage is used. Agitation under the cover is generally limited unless the storage is specifically designed to accommodate agitation, and a cover and equipment cannot enter the storage to remove built up solids. Many farms have benefited from a basic solid-liquid separation system to remove some of the fiber from manure and to re-use it as bedding. The savings in bedding costs can offset the cost of treatment, but farms need to be good managers to make recycled manure solids work well. Added advantages include the increased pumpability of the liquid fraction. Typically 20% of the

mass is removed in the form of separated solids, so there is less manure to store and spread. However, separated liquids are much more likely to cause water quality impairments if rainfall events happen soon after application, or if over-application happens on inclined fields. Typically 20% of the nutrients are removed with the solids separated. If used on the farm for bedding they are retained in the manure system.

Sand-manure separation. Many farmers who use sand to bed their cows realize the benefits of sand bedding. Historically, the mixture of used sand bedding and manure, known as sand-laden dairy manure (SLDM), was a challenge to farmers when it came to conveying, storing and spreading this material. Today, farmer-ready solutions exist that address these challenges, along with technology to reclaim bedding sand from manure, commonly known as sand-manure separation.

Sand-manure separation (SMS) requires just a few basic but KEY items to be effective - proper flow rates of SLDM and dilution water, consistent dilution water quality, time - needed for separated sand to settle, and a means of harvesting the separated sand. Commercial equipment is available as part of a SMS system to develop the required dilution water. Separation efficiencies can be over 95% when using recycled concrete sand for bedding and 80% when using mason sand.

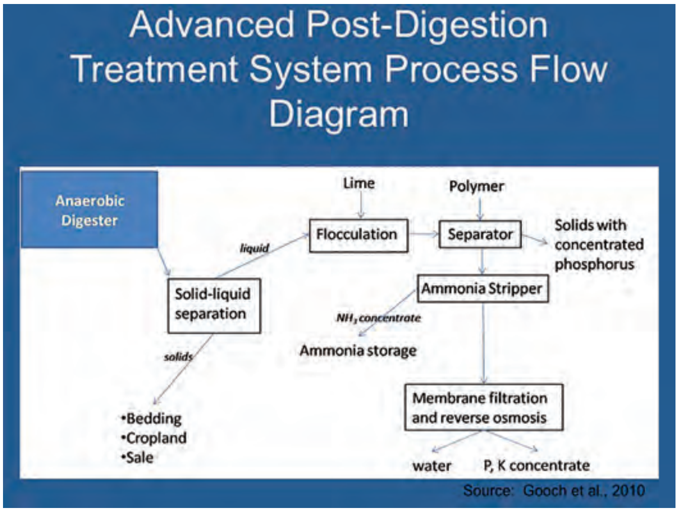
Like solid-liquid separation, SMS is normally part of an overall manure treatment system.

Advanced solid separation, using either more sophisticated physical separation and chemical additions to precipitate minerals or flocculate colloidal solids, can be used to partition nutrients for export or application further from the farmstead with less mass. Manure is typically chemically treated first, and then mechanically treated.

Equipment, including screw presses, roll presses, sloped screens and centrifuges separately or in series can remove more solids. Without the addition of chemicals the typical results can be around 40% of the solids removed, but still only around 20% of the phosphorus. It is the smaller colloidal particles that contain the phosphorus (P). A centrifuge can remove more solids and can get up to 50% of the P removed even without chemical additions.

With chemical additions, the removal of solids can increase to 70%, with 70% of the P removed as well. The addition of more sophisticated physical removal equipment comes with an increased capital cost. The chemical additives needed bring an additional expense. The amounts needed vary, so either the management of the chemical addition is complex, or extra is used increasing the costs.

This augmented removal of solids is a precursor to even more treatment with **ultrafiltration (UF)** or UF followed by **reverse osmosis (RO)**. Fairly good quality, potable, permeate water is produced, along with a concentrate that contain the nutrients remaining. Both of these processes come with higher capital and operating costs making their applicability limited to farms with specific goals and objectives.



Nitrogen recovery by gas stripping and then absorption after removal of the suspended solids is facilitated by lowering the pH and increasing the temperature. Gas stripping requires energy to increase the temperature and an acid to lower the pH. Ammonium sulfate is produced and can be used as a commercial fertilizer replacement. Having the nutrients portioned for export from the farm would be an advantage for a farm with a small landbase struggling to comply with the Comprehensive Nutrient Management Plan (CNMP). The energy for this operation could be obtained from anaerobic digestion as there is often waste heat.

Anaerobic digestion is a high capital cost treatment option that reduces odor, GHG emissions, and pathogens, while producing energy. Energy in the form of biogas (typically 40% CO_2 and 60% CH_4) can be useful in a generator for electricity for on-farm use or export or for direct combustion for heat. Technologies to clean, and compress the biogas for transportation fuel, or additions to the natural gas system require large amounts to be efficient. The monetary benefits of anaerobic digestion increase dramatically if tipping fees for food waste to also be digested are included in the system. If the additional biogas can be put to productive use as excess electric or used as heat, the additional food waste is an even greater addition. The nutrients from the food waste imports do need to be included in the farm's nutrient balance.

Struvite production ($MgNH_4PO_4(H_20)_6$) again after most of the solids are removed has the potential to concentrate nutrients in a crystal that could be easily transported and marketed off the farm. This potential treatment so far has not been successfully developed.

Additional references are available at: **manuremanagement.cornell.edu/Pages/Popular_Pages/Fact_Sheets.html.** ❐

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