

Technologies on the Horizon

This section features a few examples of technologies that are still in development, but that are promising and worth looking out for in the future.

XI. Aquatic Cropping Systems

One promising future alternative to land application of manure is to concentrate manure nutrients in algal biomass by cultivating algae in engineered ponds or raceways. Converting the nitrogen and phosphorus in manure into algal biomass increases the value and manageability of the nutrients. Laboratory-scale research of benthic algae growth chambers to recover nitrogen and phosphorus from raw and anaerobically digested dairy manure has demonstrated great potential. Nutrient balance results showed that most of the manure nitrogen and nearly all of the manure phosphorus was taken up by the algae.

In comparison to a conventional corn-rye rotation, benthic algae production rates would require just 26% of the land area requirements for equivalent nitrogen-uptake rates and 23% of the land area requirements on a phosphorus-uptake basis. The algal biomass had a crude protein content of 44%, compared to 7% for typical corn silage protein content.

The dried algal biomass resulting from the treatment offers a valuable slow-release fertilizer that could substitute for commercial fertilizers used for potting systems, as well as a potential high-grade protein feed

that could be used to replace a portion of the protein content of animal feed imported onto the farm.

The high productivity and nutrient removal capability of aquatic plants suggest that floating aquatic macrophyte-based treatment systems (FAMTS) also have potential for removing and recovering nutrients in wastewaters from livestock operations. The harvested biomass of floating aquatic plants, such as water hyacinth, water lettuce and pennywort, can potentially be used for composting, soil amendments, anaerobic digestion with methane production, and processing for animal feed. Since anaerobic digestion reduces the organic content and increases the bioavailability of manure nutrients, a combination of anaerobic digestion and FAMTS for dairy manure treatment may provide an effective integrated waste management system.

Use of aquatic cropping systems to concentrate manure nutrients is still in the research phase. Additional farm-scale research and economic evaluation are needed before aquatic cropping systems offer a viable manure treatment option for producers.

Additional Resources

Sooknah, R.D. and Wilkie, A.C. (2004). Nutrient removal by floating aquatic macrophytes cultured in anaerobically digested flushed dairy manure wastewater. Ecol. Eng. 22(1):27-42. doi: 10.1016/j.ecoleng.2004.01.004 available online at <http://dx.doi.org>

Wilkie, A.C. and Mulbry, W.W. (2002). Recovery of dairy manure nutrients by benthic freshwater algae. Bio-resour. Technol. 84(1):81-91. doi: 10.1016/S0960-8524(02)00003-2 available online at <http://dx.doi.org>



XII. Waste-to-Energy Technologies

The processes of pyrolysis and gasification can convert biomass into fuels for use in internal combustion engines or turbines. Conventional direct combustion produces steam, which then is converted to mechanical energy via a steam turbine. These processes can be used to produce fuel, while reducing the volume of dairy manure and concentrating nutrients.

A number of challenges must be resolved first for this option to be ready for widespread adoption. Researchers are currently working to address performance issues related to the high moisture content of dairy manure, variability in manure quality, the need for a consistent and large supply of feedstock manure, the low fuel density and flame temperature of manure compared to coal, and the high capital and operating costs.

Despite these challenges, these waste-to-energy technologies may offer a future solution to waste management issues. Engineers at Texas A&M have developed an approach in which feedlot manure is

co-fired with coal. This co-firing research showed that partially-composted, fine-ground cattle feedlot manure mixed with pulverized Wyoming PRB coal (10:90 fuel blend) overcame the variability problems encountered in earlier 100% feedlot manure fuel combustion tests.

Preliminary investigations of gasification combined with anaerobic digestion of dairy manure shows the potential to use manure solids for energy production on dairy farms. By integrating the gasification and microturbine system with anaerobic digestion, producers may be able to solve water quality and manure odor problems while providing a net benefit to the farm in energy production. A preliminary feasibility study on a dairy farm in New York showed that the gasifier/microturbine and anaerobic digestion combination should be able to almost double the current electrical power generation capacity of the farm compared to the digester alone. Further tests are needed to provide verification of performance and costs.

XIII. Alternative Herd Management

Cows and heifers can spend considerable time in outside areas, such as pastures, 'dirt lots', feed bunk areas, and barnyards. On average, 30-40% of the manure mass produced from a dairy operation is produced by non-lactating cows that do not need to be confined. Substantial gains in manure nitrogen recycling through crops can be achieved by corralling non-lactating dairy cows and heifers on cropland.

A research trial at the U.S. Dairy Forage Center in Wisconsin showed that crop nitrogen uptake in plots where heifers were corralled were higher than where barn manure was applied. This increase in crop nitrogen uptake in corralled plots continued for two complete corn silage-rye rotations indicating that the positive effects of winter corralling on crop nitrogen uptake may last for more than two years.

Next steps in evaluating the alternative herd management approach include collecting additional crop data on corn silage yields and nitrogen uptake and launching large-scale on-farm trials and economic analysis of manure management practices.

