

## Benefits of Anaerobic Digestion on Farms

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There are many interrelated attributes of farm-based anaerobic digestion (AD) systems that benefit farmers and non-farmers alike, providing sustainability to the animal agriculture industry by: increasing renewable energy production, increasing the potential for off farm sales of by-products and recycling of nutrients, and improving water and air quality. The potential benefits include:

- **Reduction of Greenhouse Gas Emissions (GHG)** – Cornell applied research has shown that on average for every two cows' worth of manure digested annually, one US car's worth of GHG emissions are removed. Obtainable GHG reduction from an AD system producing electricity from biogas is 2.94 Metric Tons (MT) per cow/year. There are additional GHG reductions when AD is combined with heat production replacing fossil fuel derived energy. GHG can be further reduced when other waste organics are co-digested and their nutrients recycled instead of sent to landfills.
- **Odor Reduction** – Manure is commonly stored long-term (6 months or more) to reduce the chance of pollution to water bodies. Long-term storage of raw (untreated) manure releases offensive odor emissions, especially when the storage is agitated prior to emptying and when applied to a farm's cropland. However, digested manure can be stored and recycled to the farm's land base with far less odorous emissions allowing a farmer to be more flexible in how manure is stored and recycled to the land base.
- **Improvement of Water Quality** – Application of AD treated manure can be readily made in the late spring and in the summer on hay fields in compliance with Concentrated Nutrient Management Plan requirements and without causing neighbor relations issues. These growing crops are perfectly suited to utilize the additional nutrients, while water quality is protected as the risk of water run-off and leaching is low. There are a number of watersheds under TMDL regulations that include N and P load reductions. To reduce nutrient loading in sensitive watersheds partitioning nutrients to specific products is needed. These products would then be available for easier transport and more desirable to crop farms. AD is an important precursor to obtain nutrient partitioning from manure and co-digested organics.
- **Generation of Renewable Fuel/Energy** – Biogas can be used to generate electricity and utilize heat as hot water and/or dry materials such as corn and cow bedding, or used in a number of other potential alternative uses that can be used on- or off-farm, including liquid fossil fuel replacement. This distributed renewable energy can be produced at a much steadier rate than both wind and solar or stored as a cleaned and pressurized gas. The additional utilization of the energy potential from waste organics significantly increases the energy available during AD.

- **Conservation and Utilization of Crop Nutrients** – The AD process does not consume the manure or co-digested organic nutrients, nitrogen (N), phosphorus (P), or potassium (K), all of which are important for crop production. Recycling of these nutrients appropriately to a land base of growing crops, is more efficient than fertilizer purchase. Effluent from AD can be stored long-term without significant odor problems allowing farmers to apply nutrients to even sensitive cropland in an agronomic, timely fashion, thus reducing the potential for surface water and/or groundwater contamination. Odor issues often prevent stored manure from being applied to fields near residences. Additionally, the specific forms of the crop nutrients N and P are more available for use by planted crops than raw manure, increasing potential nutrient recapture when managed properly. Precision feeding for production requires quality forage production. Precision fertilizer application from digested effluent can achieve high quality forage and higher production per acre. The ratio of N, P, and K to meet crop nutrient demand is often different than digester effluent, however AD provides for the opportunity to further process manure to partition the nutrients and the moisture contents for more efficient application of fertilizer to both farm and non-farm land.
- **Revenue Potential** – Besides reducing on-farm purchased energy costs for electricity and/or heat, the digester may facilitate other enterprises such as digested manure solids sale as compost or bedding, excess electricity sales, or co-digestion of food waste for a tipping fee. Both green energy and GHG credits are potential revenue sources. Utilizing the methane for resale in a natural gas pipeline or as a transportation fuel are also possibilities.
- **Pathogen Reduction** – Cornell research has shown a 99.9 percent reduction of indicator organisms. The importance of food safety, the need for hazard reduction procedures and the potential for trace back of pathogen contamination make this an important factor. Complete pathogen reduction by pasteurization of portions of the AD effluent is also possible.
- **Pre-treatment** – AD produces a consistent effluent material (same temperature and pH) that is in a useful form for further treatment including solid, ammonia nitrogen and phosphorus separation into discrete, usable forms for sale or on-farm use.
- **Co-digestion** – The performance of farm-based AD is enhanced by adding off-farm substrates. Many of these substrates are costly to dispose of by other means and are not fully utilized for their energy and nutrient values. Society's goal to eliminate organics from landfills will create a need for organic treatment and recycling. Treating these organics with the stability of a manure stream and then recycling the nutrients to the land is a much better alternative than separate compost operations or incorporation into sewage treatment plants.