ON-FARM ANAEROBIC DIGESTION: MESSAGES AND METHODS TO EDUCATE A LAY AUDIENCE

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INTRODUCTION

Farm-based anaerobic digestion (AD) technology has been gaining in popularity over the past 15 years in the United States and has seen more rapid rates of implementation in European countries like Germany and Denmark. This manure treatment strategy that incorporates concurrent renewable energy generation is well known to the constituents of applicable industries, namely, dairy and swine. However, it remains a poorly understood technology by the public and is normally absent from dialogue on renewable energy. Anaerobic digestion is rarely, if ever, called out as a strategy to generate renewable energy, as are wind and solar; if 'biomass' is included at all, it is assumed to encompass AD.

Since AD technology has proven to be an effective manure management strategy and one of the most reliable and efficient ways to generate renewable electricity, it is essential to educate the public and increase awareness of the benefits of this technology. If more people are aware of the technology and the multitude of benefits it offers, legislative and funding support mechanisms are likely to emerge, and consequently, expanded adoption opportunities.

This paper provides the main concepts to be publicized in order to 1) increase awareness of the role anaerobic digestion plays in a dairy farm setting, 2) educate people on the ability of AD to generate renewable energy, and 3) foster legislation that supports different aspects of on-farm AD and associated renewable energy generation. The paper also outlines several proven methods for encouraging positive public perceptions of on-farm AD, beginning with effectively educating a lay audience.

Relevant background

Anaerobic digestion technology has not caught on as quickly for the United States as it has elsewhere, for example in Europe, specifically in Denmark and Germany. There, government policies as well as high electricity pay-back prices have encouraged adoption of the technology, whereas the United States has relatively low prices for small electricity-generators that sell power back to the grid. The technology however, is proven effective at reducing manure-related odors and capturing the mainly methane-based biogas produced from the anaerobic breakdown of manure and other substrates. It is important to demonstrate the reasons for low rates of adoption thus far in the U.S., so this is not construed as inadequacies of the technology.

It is important that producers and their advisors be prepared and confident to discuss technical aspects of on-farm AD. This paper includes information and techniques to be used by producers and their advisors when interacting with the public, media and law makers and when discussing on-farm AD. Foremost, they should be well versed in demonstrating the advantages AD has for the farm compared with conventional manure management.

It is important that not only producers, but also extension educators and others, be aware of the positive aspects of on-farm AD, and be able to disseminate this information to different audiences with varying knowledge levels.

MESSAGES FOR EDUCATING A LAY AUDIENCE

There are many positive messages to convey regarding on-farm use of AD technology both from the standpoint of treating manure and of generating renewable energy. Messages directed to the public need to be made audience-appropriate; additional details on this are discussed later in the paper. Brief overviews of the major benefits attributed to AD are provided below.

- *Odor reduction:* Incorporating dairy manure to an anaerobic digester significantly decreases the odor causing compounds in the manure, and allows farmers the flexibility of how and where to store the digested manure and how and when to apply it on cropland.

- *Greenhouse gas mitigation:* An anaerobic digester system on a farm captures the methane that is produced from anaerobically degraded manure and combusts it to reduce it to carbon dioxide, which is 23 times less potent as a greenhouse gas in the atmosphere.

- *Water quality improvement:* Contamination of local bodies of water is significantly reduced when digested manure can be applied at the agronomically optimal time, minimizing runoff and leaching.

- *Renewable energy generation:* Biogas that is produced from manure degrading anaerobically is captured and can be used to generate heat and electricity. Anaerobic digesters used to generate renewable electricity also have much higher capacity factors than other forms of renewable energy generation, since manure is consistently available and biogas is continually produced, fueling energy generation.

- *Nutrient availability:* The nutrients contained in manure are conserved through the anaerobic digestion process. Applying digested manure to cropland at the agronomically optimal time means that a growing crop is readily able to uptake and utilize nutrients.

- *Pathogen reduction:* Research at Cornell University has demonstrated a 99.9 percent reduction of indicator organisms (those that are commonly used to evaluate the success of a system's performance relative to killing other pathogens) in manure. Johnes disease, a disease found in dairy cows, is reduced 99 percent by anaerobic digestion of manure.

- *On-farm financial savings:* Utilizing certain by-products from the digestion process can lead to a reduction in purchase costs for electricity, heat and bedding.

- *Improved neighbor and community relations:* By reducing odors from storing manure long-term and applying manure to cropland, it has been shown that neighbor complaints decrease, and fewer complaints to be mediated means overall improved community relations.

In addition to the direct benefits listed above that anaerobic digester systems provide to the immediate farm and surrounding lands, there are also by-products of the digestion process that can be sold to generate revenue on the farm. Electricity generated by combusting biogas in an engine-generator set can be first used to offset purchased electricity on the farm and excess can be sold back to the utility grid. In most states there are laws that regulate the sale of electricity back to the grid, for example, in New York, electricity may be sold back under the provisions of the New York State Net Metering Law. Post-digestion, the effluent can be separated and the solids can be sold as-is or can be further treated by composting them, and then sold as bedding to other farms or as a soil amendment. Receiving food waste for inclusion to the anaerobic digester also generates revenue through tipping fees paid to deliver food waste to the farm. Incorporating food waste substrates to the anaerobic digester also significantly enhances biogas production by 3-5 times that of manure alone.

There are many original revenue generation schemes that can be integrated with an on-farm anaerobic digester system. Secondary to using the by-products of the system to offset costs on-farm, excess heat, manure solids and biogas can be used for several innovative, synergistic enterprises. Presenting these potential scenarios further demonstrates the opportunities AD technology presents to the farm and community.

There is a company in Connecticut that manufactures a product called CowPots™ - a biodegradable alternative to plastic seedling pots - which are made by molding digested manure solids into seed-starting pots that biodegrade when placed in the ground with a growing seedling. Manufacturing potting plants is a step beyond simply composting manure solids – but simply selling cured compost is another revenue generation strategy. There is a farm in New York that currently bags and sells composted manure solids as a soil amendment to commercial and residential consumers, which have actually been approved for organic food production.

Many options exist for generating revenue with the excess heat produced by the combined heat and power system (CHP) when generating electricity. While there are

no examples in operation in New York State, heat-intensive and potential synergistic applications include: a car wash, a grain dryer, a maple sugaring operation, a greenhouse, or an aquaculture operation.

AD systems reduce the greenhouse gas emissions associated with manure stored long-term, and farms normally opt to trade these carbon credits and receive payment for them when the credits are retired. However, rather than trade them, they could potentially be used to offset the carbon emissions from the production of fluid milk. The resulting added-value product could be sold as 'carbon-neutral' or 'green milk'. Selling carbon-neutral milk has not been attempted thus far, but with the recent spike in interest towards greenhouse gas reductions, it is a product that would likely have higher value than conventional milk.

Many times, an opportunity to connect with an audience will be brief, and messages aimed at providing educational insight will need to be short and focused. Realizing the need for short, accurate, anaerobic digestion-related facts prompted the development of the following list, organized by topic. These facts are great for use in visual resources as well as for media articles and outreach materials.

Renewable energy

- Digesting the manure from half of the dairy cows in New York State would produce over 70-MW annually.

- Digesting the manure from half of the dairy cows in New York State, in addition to the food waste from all active food and beverage manufacturers would produce enough energy to allow the city of Rochester to take its coal-fired power plant (Russell Station, 253-MW) out of service.

- If the manure from half of the dairy cows in New York State was digested, it would offset 2,250 railcars full of coal destined to be burned in coal-fired power plants annually.

- If the manure from half of the dairy cows in New York State was digested in addition to the food waste from all active food and beverage manufacturers, it would offset more than 8,000 railcars full of coal destined to be burned in coal-fired power plants annually.

- Assuming the manure from half of the dairy cows in New York State was digested, enough power could be produced to power 45,000 residences per year.

Greenhouse gases

- New York State contributes 1% of global greenhouse gas emissions

- The reduction in greenhouse gas emissions by 16 of the 20 operating digesters in New York State is equivalent to removing 7,775 cars from the road per year

- The 20 operating digesters in New York State yield a total greenhouse gas reduction of 155,000 TCO_2e/year, which, at $6.00 per ton, is equivalent to a potential revenue of $930,700.

- If half of the cows' manure in New York State were digested, it would yield a total greenhouse gas reduction of 2.5 million TCO_2e/year, which, at $6.00 per ton, is equivalent to a potential revenue of $14,858,000.

Transportation

- 1 car is removed from the road for every 2 cows' worth of manure digested

- If 40% of the manure in New York State was digested, it would be equivalent to removing 215,000 cars from the road

Solid waste and nutrients

- One on-farm digester co-digesting manure and food waste could displace the average food waste deposited in a landfill by more than 8,000 people per year.

- One centralized AD accepting dairy manure from 25 farms and several food waste substrates has the ability to offset 11 million gallons per year of synthetic fertilizer, after meeting the fertilizer needs of all participating farms.

- One centralized AD accepting dairy manure from 25 farms and several food waste substrates has the potential to generate $226,000 per year in revenue from the sale of AD effluent to be used in place of synthetic fertilizer.

METHODS TO EDUCATE A LAY AUDIENCE

There are several ways to encourage positive publicity for on-farm applications of AD. Effectively educating a lay audience is foremost in increasing the knowledgebase the public has with regards to this technology. Additionally, presenting information in a manner that is engaging will attract attention and enhance education efforts. These efforts are important in order to reach an audience that includes potential funding organizations and legislative entities that have the potential to create legislation in support of different aspects of on-farm AD.

In order to increase awareness of AD, a group must first have the knowledgebase to understand the topic and related issues. The first step in educating the public on AD technology, is to synthesize the information to be concise, jargon-free, easy to understand, and easy to relate to. Making information concise, jargon-free and easy to understand are common methods of translating technical information to make it easier for a lay audience to understand. However, it is also important to create an aspect of audience-specific content that will make the audience able to relate to the information. Several parties involved with the implementation of on-farm AD have the responsibility

to disseminate information to the public, including: extension educators, producers and research groups.

In addition, local media outlets have an interest in serving their audiences and presenting information in a way that is meaningful and useful to their viewers/readers. Since milk and other dairy foods are an important part of most families' diets, stories about dairy farming easily fit into this category. Although this may be contrary to commonly-held public perception, reporters are looking for positive stories to tell; with increased interest in both how food is produced and the generation of renewable energy; AD makes a well-suited candidate.

There are various materials that can be designed to effectively provide information at a basic level, including: case studies, websites, posters, articles and videos, among many other visual formats. Another way to directly present introductory material on the topic of on-farm AD is being pursued by the PRO-DAIRY Dairy Environmental Systems group at Cornell University, who are currently offering one-day workshops that target a lay audience and local media outlets. The workshop begins with a classroom-based instruction session in the morning and concludes with a tour of an existing on-farm anaerobic digestion operation in the afternoon. This format exposes participants to information in a lecture-style format for half a day, presented in both printed and visual formats (i.e., use of a workbook and slide presentation) and also exposes participants to a hands-on learning experience by viewing an actual operation, the second half of the day.

Extension educators can provide tools to producers in order for them to be able to reach the public and when they do have a public audience present on the farm, to be able to distribute concise information in a positive light. Simply equipping producers with materials for a lay audience can greatly improve the education of a public group when visiting a farm. In addition, workshops can be designed to teach producers, first, the complete set of benefits AD technology has to offer the farm and the community, and second, how to effectively present farm visitors with this information.

It is also important to have advanced research information available in a lay format. More importantly than educating the general public on current research issues, research groups should realize the benefit of making technical information available to both legislators and potential funding sources.

Many times simply making a document non-technical is not enough to accurately convey scientific information to a lay audience. There are some terms that incorrectly convey an idea to the public, as is shown in Figure 1. Using better word choices with clear intentions can more effectively communicate concepts.

Figure 1. Terms that have different meanings for scientists and the public (Somerville, 2011)

Terms that have different meanings for scientists and the public

Scientific term	Public meaning	Better choice
enhance	improve	intensify, increase
aerosol	spray can	tiny atmospheric particle
positive trend	good trend	upward trend
positive feedback	good response, praise	vicious cycle, self-reinforcing cycle
theory	hunch, speculation	scientific understanding
uncertainty	ignorance	range
error	mistake, wrong, incorrect	difference from exact true number
bias	distortion, political motive	offset from an observation
sign	indication, astrological sign	plus or minus sign
values	ethics, monetary value	numbers, quantity
manipulation	illicit tampering	scientific data processing
scheme	devious plot	systematic plan
anomaly	abnormal occurrence	change from long-term average

After preparing the actual information and messages to be conveyed following the methods described above, the materials should be presented in a format that is easily accessible, appealing, and entertaining.

When developing materials to educate the public, there are several keys to making the information you are presenting not only easier to understand, but easier to retain as well (List adapted from (AAAS, 2012):

- *Do not use jargon:* Do not use acronyms (i.e., CAFO, NCRS) or jargon that is specific only to a select industry.

- *Focus on a few points:* Think about what is important for a specific audience and accordingly what the major points are to highlight; do not attempt to explain everything beyond what the target audience is concerned with.

- *Use numbers sparingly:* Numbers can be very effective at making a point, but do not overuse numbers; when using number values be sure to provide a context (i.e., “This 1,000 cow dairy can generate enough energy to heat all the homes in Liverpool for the entire winter”).

- *Anticipate questions:* Attempt to formulate the questions you think the target audience will ask and focus on the answers in the outreach materials.

- *Provide visuals:* Include visuals where appropriate in all outreach materials; visuals help in explaining processes and make points easier for people to relate to (i.e.; show images of dairy cows when discussing manure generation).

- *Fact sheets:* Provide people with a fact sheet for a particular case study and if possible, include a glossary of terms.

A great way to publicize information about AD technology or a particular project is to involve the media, with the goal of developing positive and informative news articles. Working with the media can provide accurate, informative updates about your research or project to stakeholders. Specifically, taking the time to work with the media can help to:

- *Reach a wider audience:* Journalists can help to reach the broader public, legislators, and funding organizations, not just those actively seeking information.

- *Raise awareness:* Consistent and accurate news coverage could increase public awareness of a project.

- *Create positive attitudes:* Bringing current successes and future goals of dairy farming to the attention of the public could help generate enthusiasm for research and for funding support.

Holding farm tours to see firsthand how anaerobic digester technology operates on a farm helps people connect with the processes involved with treating manure, producing biogas and generating renewable energy. It is advisable to keep tour groups to a very specific audience so that material can be targeted toward one knowledge level and so that the needs of each group can be met effectively. Offering tours and/or a press conference to announce the ground breaking of a new project can be appealing to media and legislators as well as the general public. Tours can also be held to showcase new and unique designs or changes to standard uses of the technology. Legislators might view a farm tour of an operating anaerobic digester as an opportunity to demonstrate their support for dairy farming, renewable energy or other AD-associated issues. Legislators and politicians are also prime audiences to target when seeking funding or regulatory support for a certain issue. Offering tours and educational materials for school-age children helps increase awareness of renewable energy, dairy farming and responsible manure management, and over time undoubtedly increases the number of people interested in pursuing these fields. Other children's groups and organizations (i.e., Boy and Girl Scouts of America) may be interested in farm tours to use as the basis for a specific project or learning initiative.

An unconventional method of promoting on-farm anaerobic digestion in the past has included the use of sculptures to depict anaerobic digestion technology on a farm. In 2010, the famous butter sculpture at the New York State Fair featured a farm with an anaerobic digester as well as a poster highlighting the process. In 2012, the butter

sculpture from the Pennsylvania State Fair was donated to a local dairy farm with an operating anaerobic digester to be co-digested with the farm's manure. This made for a great example of a sustainable full circle where the products used to make the sculpture were returned to the farm for a beneficial use (in this case, heating the farm).

Participating in state fairs, environmental and agriculture focused fairs, provides an outlet to educate many attenders with quick fun facts about dairy farming and renewable energy generation. Visuals for this type of event should be light on textual information and heavy on images that attract attention and are easy to understand. Technical information is best presented verbally in this context to especially interested individuals.

CONCLUSION

In order to make AD and biogas consistently present on the list of major renewable energy technologies, alongside wind and solar, public awareness of the technology needs to be increased, and positive, informative news stories need to be encouraged. Producers are constantly in contact with audiences in the community that stand to benefit from an education on the use of farm-based AD and the ways it improves aspects of dairy farming both on and off the farm. Extension educators and others involved in supporting on-farm manure treatment strategies like AD can greatly support farmers in their mission to educate community members.

With the recent increase in attention to sustainable management of organic waste from industrial, commercial and residential sources, anaerobic digestion is likely to be mentioned more frequently. Education efforts aimed at stakeholders in these industries can improve understanding of the technology and increase adoption rates.

Overall, anaerobic digestion technology stands to benefit farms, agriculture communities, and the general public through responsible manure management techniques and the generation of high-efficiency renewable energy. Reaching the public with the messages contained in this paper and pursuing effective methods for communicating those ideas will lead to increased public awareness and an improved knowledgebase for understanding the technology.

REFERENCES

American Association for the Advancement of Science (AAAS). 2012. *Communicating Science: Tools for Scientists and Engineers. "Why work with reporters?"*

Somerville, Richard C.J. and Susan Joy Hassol. October 2011. *Communicating the Science of Climate Change.* Physics Today p. 48. Web address: http://blogs.agu.org/mountainbeltway/2011/10/17/words-matter/ visited February 1, 2012.