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ANAEROBIC DIGESTER IMPLEMENTATION ISSUES

Phase I - A Survey of U.S. Farmers (Farm Bill Section 9006)

PIER FINAL PROJECT REPORT

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Abstract

This study includes two reports summarizing personal interviews with individuals who took concrete steps to install an anaerobic digestion (AD) facility and documentation of the factors that contributed to the current implementation status of their AD project. It was undertaken in two phases:

Phase I. A survey of 64 US farmers who received federal Farm Bill funding in 2003 and 2004 for an AD system (CEC-500-2006-115A).
Phase II. A survey of 10 California farmers who received state funding under the California Dairy Power Production Program for an AD system, and a comparison of their experiences with those reported by farmers in Phase I (CEC-500-2006-115B).

The two phases are covered in separate reports. The first report presents the national sample and the second presents the California sample and the comparison.

Farmers in both samples chose AD technology because of the advantages it offers in manure management and environmental protection. Farmers in the national sample were also motivated by being able to reduce odor and use the digested solids as animal bedding. Neither of these factors was a motivator for the California sample—they were more interested in producing renewable energy.

Both groups rated negotiating an acceptable agreement with the local utility as their greatest challenge. Financing also proved to be difficult for many in the national group and obtaining permits was more difficult for the California group. Despite all of the problems they encountered, farmers in both samples are overwhelmingly in favor of AD technology.

Keywords
Anaerobic digester, biogas, electricity production, manure management

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Executive Summary

As farms grow in size, manure management becomes more important, and more challenging. Installing an anaerobic digester (AD) can help farmers, particularly those with sizeable operations of at least 500 dairy cows, develop efficient manure management practices. In addition, using the waste to generate electricity produces a renewable source of energy that can help offset the farm's electrical bills, and in some cases, may add income from sales of excess electricity.

There are approximately 100 digesters that are operational or under construction on farms across the United States. But this represents merely 1% of the farms on which a digester could be installed.

In order to provide a better understanding of the implementation issues associated with planning and installing digesters, a sample of 64 farmers who received Farm Bill grants for anaerobic digester systems in 2003 and 2004 were asked to describe their motivations and challenges.

Motivation

Being a good neighbor and being able to expand their herd are two driving forces for these farmers. Thus, it is not surprising that the primary motivations for installing a digester are odor reduction, environmental protection, and solid waste disposal. This is consistently the case, even though the sample used for this study was farmers who received Farm Bill grants to implement an anaerobic digester specifically to produce renewable energy. In fact, producing electricity to sell or to offset electrical bills was one of the lowest priorities of this group.

Challenges

Although producing electricity was a low priority, it was a requirement under the Farm Bill grant. But, negotiating an acceptable agreement with the local utility for meeting electrical interconnection requirements and obtaining an energy contract for selling their renewable energy was reported to be a major challenge for the farmers. Difficulties and delays in the negotiation process itself often resulted in cost overruns and increased payments on loan interest.

As a group, the farmers also expressed dissatisfaction with the relatively low rate they are paid for the electricity they generate compared to the higher rate they pay electricity they use. Many are under the impression that selling additional electricity will enable them to recover some of the high cost of implementing a digester, and are disappointed when this is not the case. They are also bothered by the long-term contracts the utilities offer that lock them into a fixed rate even if the purchase price of electricity increases.

Finally, they are dismayed by the high cost of electrical upgrades that are often required in order to interconnect with the electrical grid. In particular, they view as unfair the policy that they must pay for installation of interconnection infrastructure

that will belong to the utility—such as poles, transformers, and switches—and that is not on their property.

In order to investigate how other challenges affected the ability to follow through and actually implement an anaerobic digester, the 64 projects represented in this sample were divided into three groups according to their current status: discontinued, delayed, or developed.

Discontinued Projects
The group who discontinued their projects typically did so because they were unable to find a satisfactory digester design that would give them ease of operation and serviceability. They are more interested in waiting until the technology improves.

Delayed Projects
The majority of farmers whose projects are delayed encountered the greatest difficulty trying to negotiate an equitable agreement with their local utility. In many cases, these negotiations are the cause of the delay.

Financing is a secondary challenge for the farmers with delayed projects, who often run into difficulty obtaining a bank loan. This is particularly the case if they are proposing a new operation and do not have equity in an existing farm.

Except California, obtaining the required permits was not a challenge in any of the 12 states represented in this sample. Changes in water quality regulations that have gone into effect since some of the California farmers applied for permits, have complicated the process and delayed projects in that state.

Local opposition was not a challenge in any state except Minnesota. A national activist group opposed to large farms, particularly confined animal feeding operations, has equated them with anaerobic digesters and mounted opposition to digester installation. This is keeping at least one farmer tied up in legal proceedings and unable to move forward with his digester project.

Developed Projects
The majority of farmers who have developed an operational digester also said that dealing with the electrical utility was their greatest challenge. On the other hand, it did not keep them from moving forward with their project. They often had the necessary electrical upgrades already installed on the farm, and had a good working relationship with their local utility. However, most of them were unhappy with the price they were being paid for their electricity.

The farmers in this group typically did not report financing or digester technology to be impediments. On the contrary, they were more likely to exhibit creativity in exploiting the technology to help pay for the digester operations by doing things such as selling the digested solids for bedding or compost, or charging a tipping fee for adding food waste to the digester.

Conclusions

Farmers are interested in installing anaerobic digesters to handle their animal manure for the benefits it can provide to their farming operations by reducing odor and improving air and water quality. These two factors do not have a financial return, but farmers seem to accept them as best business practices and recognize their value in good neighbor relations.

Farmers view the production of electricity as a secondary benefit that can allow them to recoup some of the capital expense or operating costs of the digester. But they find negotiating with the local utility to be such a challenge that many of them do not move forward with their digester projects.

In some cases, a number of issues—negotiating with the utility, financing, selecting an AD technology—arise that, taken together, result in a delay in project development. In other cases, a single factor—a change in permitting regulations, for example, or the formation of an opposition group—is sufficient to impede implementation progress.

Because so many factors affect the successful implementation of an anaerobic digester, farmers who do move forward seem to approach their projects differently. This persistent group anticipated that there would be difficulties and delays, yet found a means to manage them in order to still move forward.

Recommendations

Farmers are interested in installing anaerobic digesters because it contributes to good business practices for manure management; it is not necessarily a cost recovery endeavor. Yet the expense of AD technology means that initial financial support is critically important for many farmers. When this support is tied to the generation of electricity, the program would benefit from a dedicated, transparent process of negotiation between the farmer and the utility.

The farmers expressed a desire for financial assistance that is not tied to a specific form of renewable energy, but offers them the flexibility to market their biogas or electricity as a commodity in a manner similar to how they manage the production and sale of milk. As experienced business people, they are accustomed to making their own decisions, and do not want to be limited in that regard.

I. Introduction

Effective management of animal manure is one of the most pressing challenges facing the agricultural industry and is a particular concern for dairy farmers as herd size has increased over the years. Anaerobic digestion (AD) is a waste treatment technology that can "help to solve some of the environmental problems associated with manure disposal."[1] Processing manure through an anaerobic digester prevents methane release into the atmosphere, controls odor, and reduces the amount of manure in runoff entering streams. AD is also an energy-producing technology. The methane that is captured can be used to generate electricity. Thus, farmers "can be a part of the solution for a long-term, comprehensive energy plan for the US."[2]

Rationale

Despite its promise as a source of renewable energy and a solution to manure management, AD technology has been relatively slow to catch on in the US. Over time, numerous conjectures have been made about the role of several factors—AD system technology, financing, electric utility negotiation, local opposition, and permitting—in creating a positive outcome for AD implementation, but no one has reported on the farmers perspective.

The motivation for this project was to gather data from primary sources—personal interviews with individuals who took concrete steps to initiate an AD facility—in order to document the factors that contributed to their current AD project implementation status. It was undertaken in two phases:

Phase I. An investigation of a sample of 64 US farmers who received federal Farm Bill[3] funding in 2003 and 2004 for an AD system.
Phase II. An investigation of a sample of 10 California farmers who received state funding under the California Dairy Power Production Program[4] for an AD system, and a comparison of their experiences with those reported by farmers in the first phase of this project.

This is the report of Phase I; the results from Phase II are summarized in a separate report.

Background

The AD process involves biochemical degradation in which naturally occurring anaerobic bacteria convert complex organic material, such as animal manure, into

[1] No blackouts for dairyman who converts manure to energy. *American Farm Bureau News*. 2001. June 25 80(12).
[2] Ibid.
[3] *Farm Security and Rural Investment Act of 2002 (PL 107-171),* also known as the Farm Bill.
[4] The Dairy Power Production Program was initiated by the California Energy Commission Public Interest Energy Research program in response to the enactment in 2001 of *Senate Bill 5X*.

biogas and digested solids. The biogas, about 60% methane, can be used in an engine to produce electricity, or burned in a suitably modified hot water heater. The solids can be de-watered and used for compost or animal bedding. An anaerobic digester is a mechanism that promotes this decomposition of the organic products in manure.

Long used in Europe, AD began to find favor as a viable means of manure management in the US with the introduction of better-designed systems in the 1990s. In the past few years, rising energy costs, expanded environmental regulations, and increased competition in the marketplace have accelerated interest among farmers and enhanced governmental efforts to promote implementation of AD systems; nevertheless, the market potential is much greater than is being realized.

The most recent AgSTAR Digest[5] listed 82 operating digesters in the US, and 19 in the start-up or construction stage (see Figure 1). An AgSTAR feasibility study, however, based on factors such as number of animals and waste handling method, determined that there are approximately 7,000 candidate dairy and hog farms in the United States that could use an anaerobic digester cost effectively.[6] This means approximately 1% of the on-farm AD market has been developed, leaving a substantial untapped resource for generating electricity and a potential business opportunity for increasing farm income.

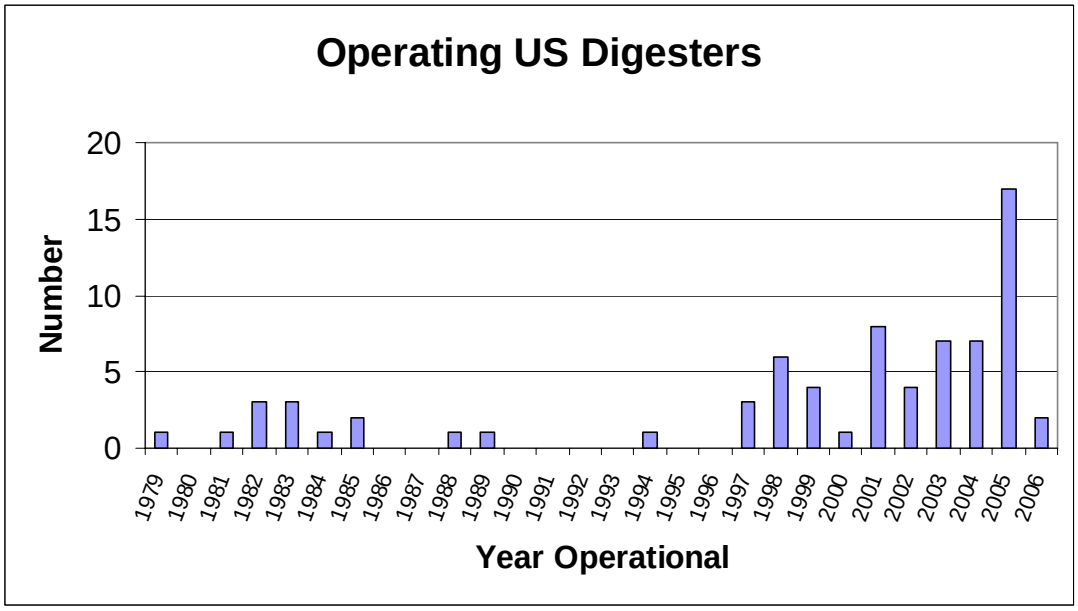

Figure 1. Data available for 73 operating US anaerobic digesters, from 1979 through early 2006.

[5] USEPA. 2006. *AgSTAR Digest*. Office of Air and Radiation, Washington, DC.
[6] USEPA. 2006. *Market Opportunities for Biogas Recovery Systems*. Report No. 430-8-06-004. AgSTAR, Washington, DC.

Objective

The goal of this project was to provide a better understanding of the implementation issues associated with planning and installing AD systems at US livestock operations. By collecting data from the farmers themselves we are able to report on their experiences—both difficulties and successes.

It is important to note that this report is not limited to operating AD systems. Doing so would have eliminated the opportunity to investigate the reasons why some AD plans fail or why some grant recipients decide not to proceed with their AD projects. Including all grant recipients, regardless of the status of their AD project, allowed us to gain a clearer picture of the implementation issues farmers face when considering an AD system.

II. Method

Sample

The sample for this study consisted of 64 US farmers[7] who were recipients of federal funding for AD systems in 2003 and 2004 under the *Farm Security and Rural Investment Act of 2002 (PL 107-171)* (i.e., the Farm Bill), which was the first farm bill to include an Energy Title, Title IX, that in Section 9006 provided grants and loans to assist farmers with purchasing renewable energy systems. Signed into law in May 2002, there were 37 grant recipients in 2003 and 30 in 2004 who proposed to implement AD systems.[8] This sample was selected for several reasons:

- It was a convenient, focused sample.
- It offered a manageable number of individuals to contact in a limited time.
- It consisted of individuals representing every possible project status, from those with operating digesters to those who decided to abandon their project.

As would be expected, the AD projects funded by the Farm Bill are most commonly found in dairy-producing states. Figure 2 shows the location of the 64 sample AD projects across the US. Eighty percent of the projects are located in the five leading states for cash receipts from dairy products:[9] California, Wisconsin, New York, Pennsylvania, and Minnesota.

[7] Although in some cases AD systems are owned by entrepreneurs or other off-farm entities, most often they are owned and operated by farmers, so for ease of explication, the latter term will be used in this report to represent the individual or entity who applied for funding.

[8] Of the original 37 grant recipients in 2003, three were no longer viable entities and thus were excluded from the sample: one recipient actually was a group of entrepreneurs who came together to apply for the grant but disbanded after not meeting initial conditions set by the granting agency; a second was a farmer who sold the dairy and moved; and a third was a farmer who relinquished his 2003 funding and reapplied in the 2005 cycle.

[9] National Agricultural Statistics Service. 2006. Department of Energy, Washington, DC.

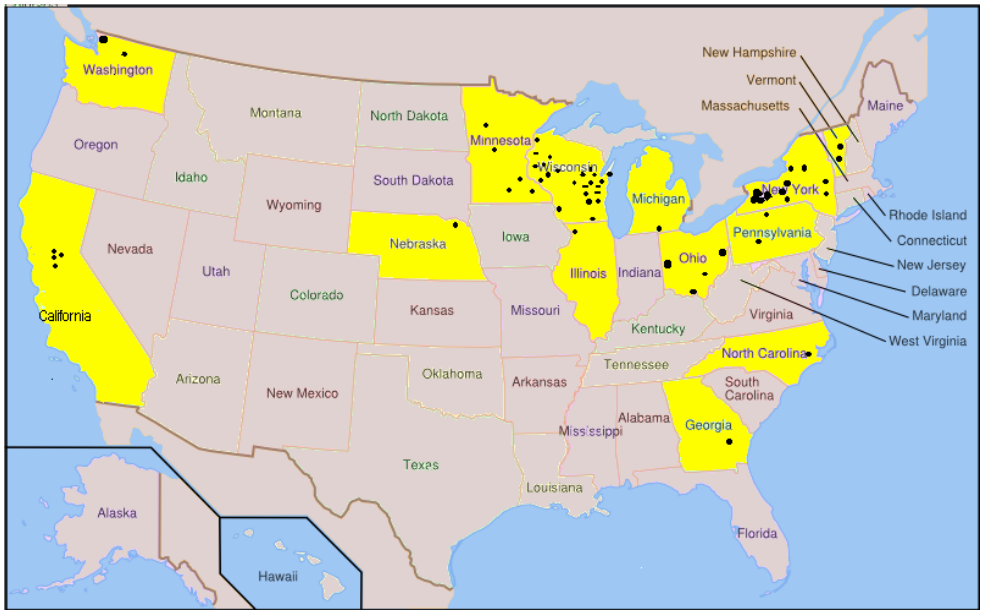

Figure 2. Location of anaerobic digester projects receiving Farm Bill funding in 2003 and 2004.

Fifty-nine of the projects were proposed for single farms, two for cooperatives, and three for ethanol bio-refineries. Two projects were intended for hog farms, one for a poultry operation, and the remaining 61 for dairy farms.[10] The number of animals per farm ranges from 400-4,000 cows, 8,000-10,000 hogs, and over 800,000 chickens.

Data Collection

Structured telephone interviews with the farmers provided the primary source of data regarding experiences planning, installing, and implementing AD systems in the US. This was supplemented when necessary by e-mail, fax, and postal mailings.

In addition to gathering narrative information about their AD project, farmers were asked to complete a 4-item questionnaire that required ratings of factors related to their motivation to install an AD system, their challenges at each stage of the process, and their expectations.

III. Results

Results are presented by type of information: 1. description of the data, and 2. descriptive statistics based on questionnaire responses. Qualitative data from the interviews bear a strong relationship to the questionnaire responses.

Quantitative analysis was limited to descriptive statistics based on the ordinal data generated by the questionnaire. Relatively low statistical power, partly due to the

[10] The ethanol bio-refineries plan to process manure from beef cattle as well as dairy cows.

variability of responses, precluded any further non-parametric analysis. This means that all conclusions should be interpreted with care.

Data Description

Data. We completed interviews with all of the 64 grant recipients, for a 100% response rate. A total of 371 attempts were made to reach individuals and 76 interviews (covering more than 30 hours) were carried out from April through July 2006. In some cases, more than one owner of a farm was interviewed and in other cases a farmer received grants, and therefore provided information, for multiple farms. Interviews were also carried out with regional USDA representatives, AD system designers, financial lenders, and electric utility representatives for clarification and to gain additional perspectives.

Fifty-six of the interviewees (88%) completed the questionnaire. Responses were analyzed over all groups combined, as well as by AD project status, and by state.

AD System. A limited number of system designs were being offered in the US at the time this group was making their selection, and there were not many AD designers to choose from. Forty-eight of the farmers (75%) have completed their AD system or have selected the type of AD system they plan to use. Three design choices account for 94% of the selections, with the plug flow system being the most popular (Table 1).

AD Design	
plug flow	57%
complete mix	29%
covered lagoon	8%

Table 1. Proportion of the top three AD designs selected (One entity is planning to use an induced blanket reactor from Andigen, and another is considering a new European design. One farm tried a fixed film).

Currently, three AD designers cover 77% of the market in this sample (Table 2).

AD Designer	
RCM Digesters, Inc.	35%
GHD, Inc.	31%
Microgy, Inc.	11%

Table 2. Proportion of the top three AD designers selected.

Biogas Use. Although use of the biogas was not one of the primary motivations for installing an AD system, every farmer had something in mind. Ten of the projects plan to use the biogas from the AD system for on-site electricity (four of those 10, located on the east coast and the Midwest, plan to generate only enough electricity for on-site use), 50 plan to use the biogas to generate enough electricity to offset their

energy bills and sell the excess to the local utility, 16 of those 50 plan to use it to generate heat in addition to electricity, and four plan to convert it to natural gas.

Status. The current status of each AD project was classified according to the description given by the grant recipient/interviewee. The following categories were used: [11]

- Operational—digester is in the startup, shakedown, or steady-state phase
- Under construction—digester is in the process of being built
- In the planning stage—construction has not begun and the farmer is still working on plans for the digester
- Delayed—construction has not begun and plans are not moving forward at this time
- Undecided—the farmer is not sure whether to proceed with the AD project
- Not going forward—the farmer has refused the grant and ended the AD project

For ease of explication we have combined "operational (n=20)" and "under construction (n=7)" into a group called **developed**, we have combined "in the planning stage (n=13)," "delayed (n=7)," and "undecided (n=8)" into a group called **delayed,** and we have called the "not going forward group (n=9)" **discontinued.**

Overall, 40% of projects are developed, 45% are delayed, and 15% have been discontinued. Figure 3 shows the current status of all the AD projects in the sample.

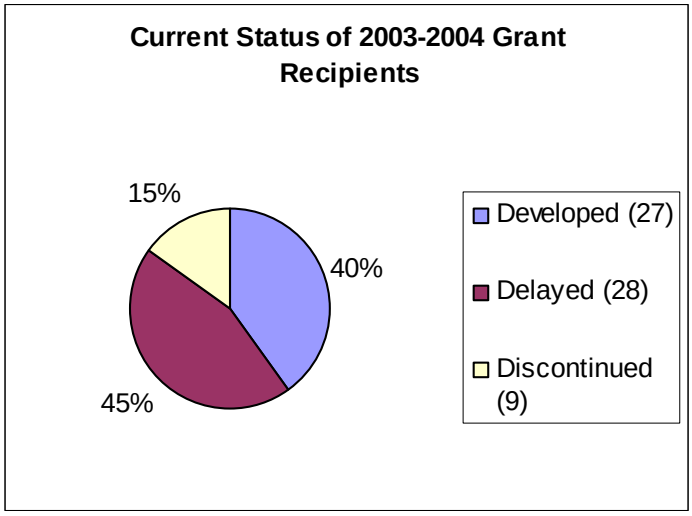

Figure 3. Current status of AD projects for 64 grant recipients.

When we consider project status by location of the AD project, we see the following results, also displayed in Figure 4:

[11] There are numerous ways to classify project status; further delineation into phases such as startup, shakedown, etc. is not relevant to this project.

State	Developed	Delayed	Discontinued
California	25%	75%	0%
Minnesota	0%	83%	17%
New York	33%	25%	42%
Wisconsin	44%	48%	7%

Table 3. Current status of AD projects for the top four states.

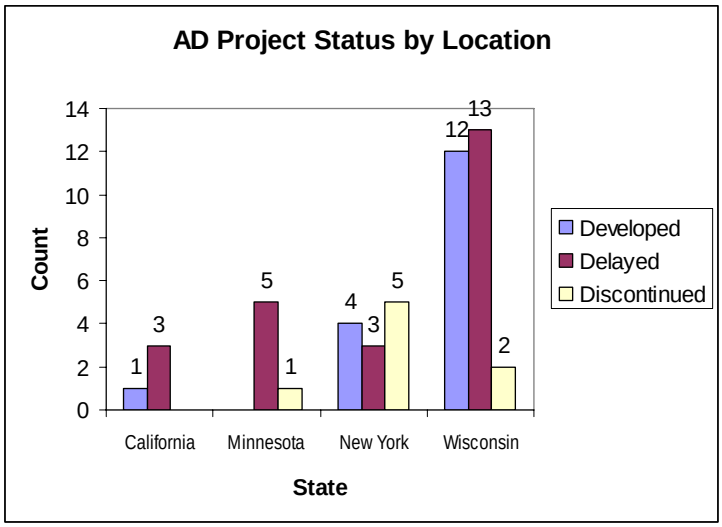

Figure 4. Current status of AD projects for the top four states.

Questionnaire Responses

Motivation. We were interested in the factors that led farmers to consider installing an AD system, and whether motivation differed by status or location. Farmers were asked to assign a number from 1 (low) to 5 (high) indicating their priorities for seven pre-selected issues potentially influencing their motivation to install an AD system. The seven issues chosen were those most often mentioned in the literature on anaerobic digesters:

- Odor—meaning odor control and reduction
- Land application—being able to apply manure to farmland more easily (e.g., when the ground is frozen)
- Electricity—including both electricity sales and offsets of electrical bills
- Bedding—using recovered digested solids for animal bedding or compost
- Fertilizer—using the digester effluent as a replacement or substitute for commercial fertilizer
- Environment—protecting air and water quality
- Manure management—managing the volume of manure

Farm Bill grants had a renewable energy focus, but the data show that offsetting their electrical bill or selling electricity was only a mid-ranked motivator overall (Figure 5).

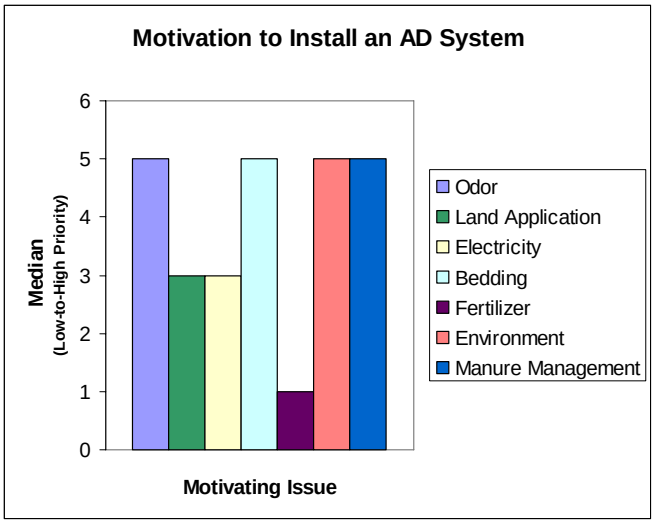

Figure 5. Motivation to install an AD system.

Four of the seven issues received a median ranking of 5, or highest priority: odor, bedding, environment, and manure management. Two issues had a median ranking of 3: electricity and land application of manure. Only one issue, fertilizer, had a median ranking of 1.

When we look at the data by project status, this same pattern of motivation is reflected in the priorities given by those in the developed category. Farmers who are in the delayed category also had the same top motivations but in addition, they rated land application of manure and electricity sales or offsets as high priorities. Only those in the discontinued group show a pattern of priorities that is divergent from the other two groups.

The highest priority for farmers in the discontinued group was electricity sales, and manure management was one of their lowest priorities, a reversal of the priorities in the developed group (Figure 6).

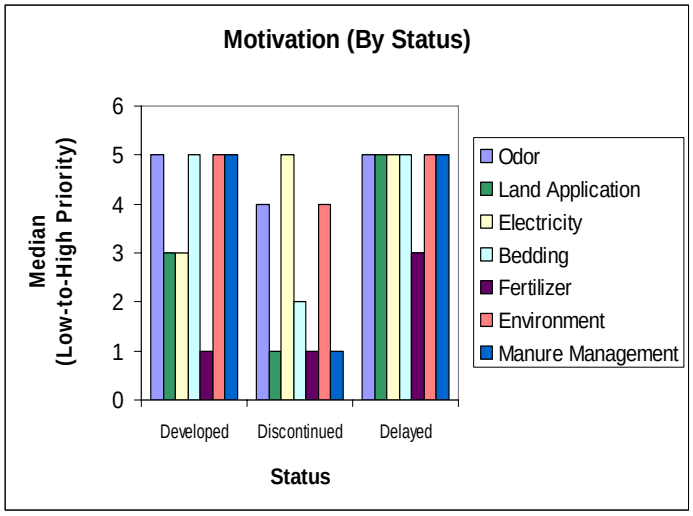

Figure 6. Motivation to install an AD system, by current status of the project.

In order to investigate possible regional differences, we also looked at the data by state for the four states that have the majority of the proposed projects funded by the Farm Bill: California (n=4), Minnesota (n=6), New York (n=9), and Wisconsin (n=24).[12] As can be seen in Figure 7, no single motivating factor received the highest median ranking in every state but fertilizer consistently was given the lowest priority.

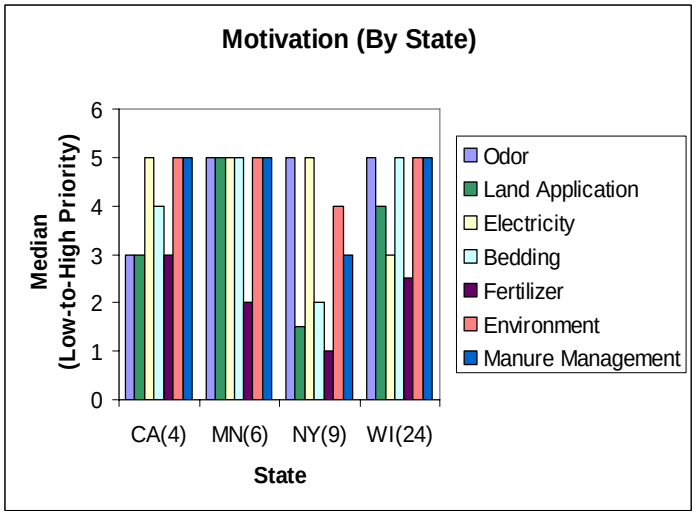

Figure 7. Motivation to install an AD system, by state, for four states.

Challenge. We also presented farmers with six possible obstacles to implementing an AD project and asked them to rate each one according to how challenging it has been. The six factors were chosen based on a review of the AD literature relating to potential barriers to implementation:

[12] Because the sample size differs among these four groups, any interpretation will be speculative.

- Grant—getting grant approval
- Financing—arranging acceptable non-grant financing
- AD system—selecting a specific AD system design
- Utility—negotiating an acceptable agreement with the local utility
- Permits—obtaining the necessary state and local permits
- Opposition—facing local opposition

Analyzing the data across all groups, negotiating with the utility emerged as the most challenging issue, with a median of 5 (very challenging). Financing was the second most challenging issue with a median of 4, followed by grant and AD system (median=3). Permits and opposition were rated the lowest, with a median of 1 (Figure 8).

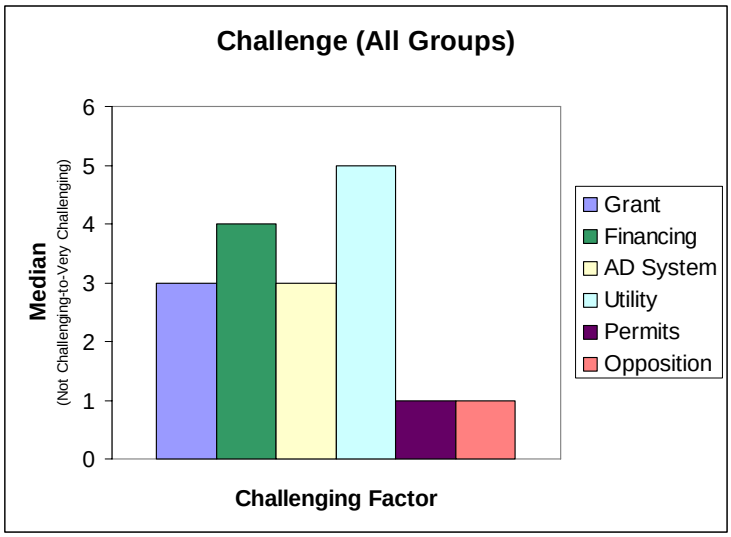

Figure 8. Challenges faced when considering or installing an AD system.

As one would expect, challenges varied by status of the project. Understandably, some issues present a challenge at the beginning of a project, whereas other issues do not surface until later. When looking at challenge by status, differences among the groups become evident.

Farmers in the developed group, as well as those in the delayed group, rated negotiating an acceptable agreement with the local utility as their biggest challenge (median=5). Farmers in the discontinued group rated selecting a specific AD system design as their biggest challenge (Figure 9).

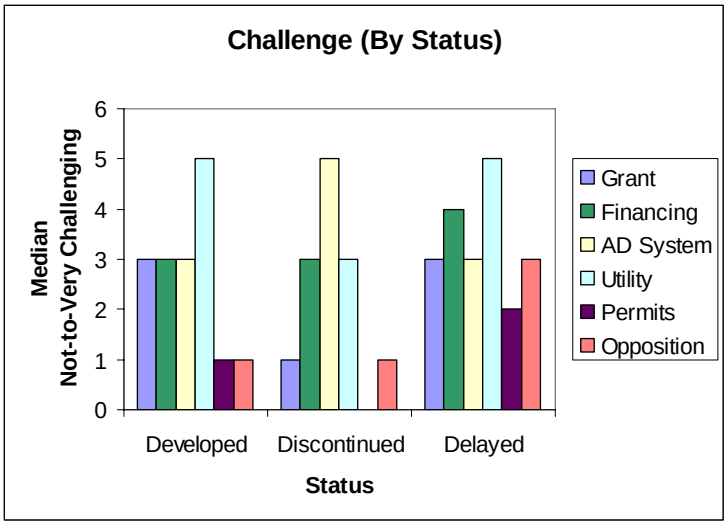

Figure 9. Challenges faced installing an AD system, by project status.

The challenges also differ by state. Permits are the greatest challenge in California, but Minnesota farmers find local opposition most challenging. In New York the challenges are with the utility and the AD system, and in Wisconsin the challenges are the utility and financing (Figure 10).

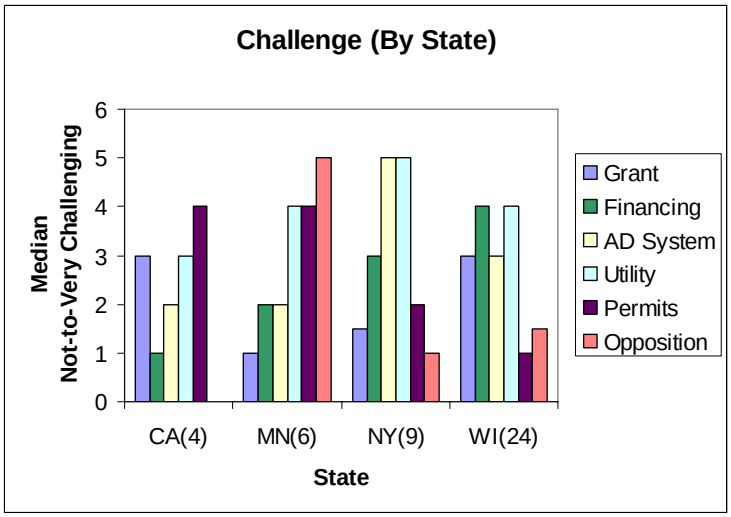

Figure 10. Challenges faced installing an AD system, by project state.

Expectation. We were also interested in the farmers' expectations of each of the potential challenges—whether it was harder or easier than they thought it would be, or whether it was about what they had anticipated. Across all groups, only negotiating an acceptable agreement with the local utility was harder than respondents thought it would be (median=4). The other five issues were rated to be about what respondents expected (median=3) (Figure 11).

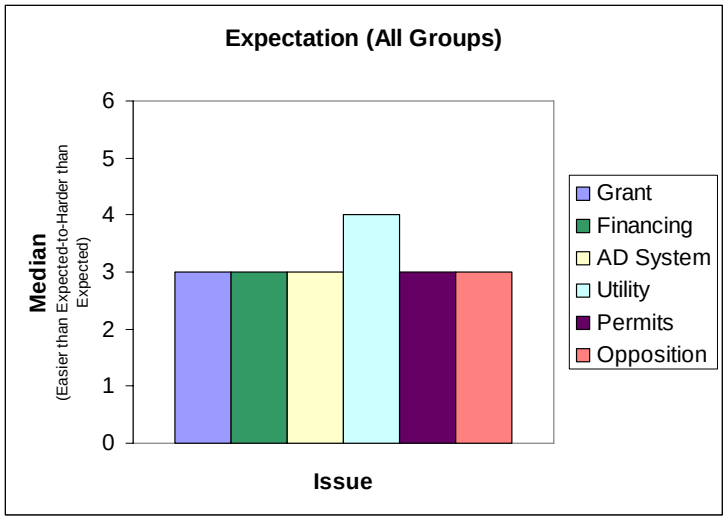

Figure 11. Expectations of the challenges faced when considering or installing an AD system.

As for expectation by status of the AD project, farmers in the developed group ranked each potential challenge to be about what they expected or easier. Those in the delayed group rated financing to be a harder challenge than they expected (median=4), and respondents in the discontinued group rated local opposition to be a greater challenge than they had expected (median=4) (Figure 12).

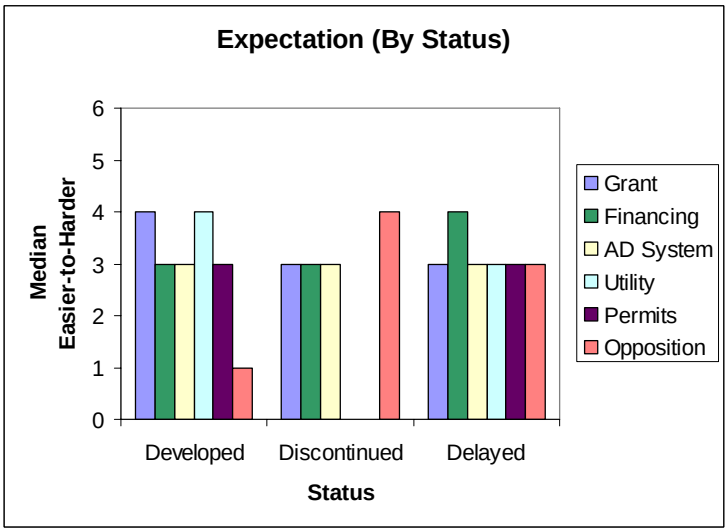

Figure 12. Expectation of challenges, by status of AD project.

Finally, looking at expectation by location, California farmers stated that they found permits, the utility, and selecting an AD system harder than they expected (all medians=4). Minnesota farmers said opposition was a greater challenge than they had anticipated (median=5), and permits were also harder than expected (median=4). In New York, respondents said selecting an AD system was a greater challenge than expected (median=5), as was working with the utility (median=4). And in

Wisconsin, farmers described only two challenges as harder than expected—financing and the local utility (medians=2.5) (Figure 13).

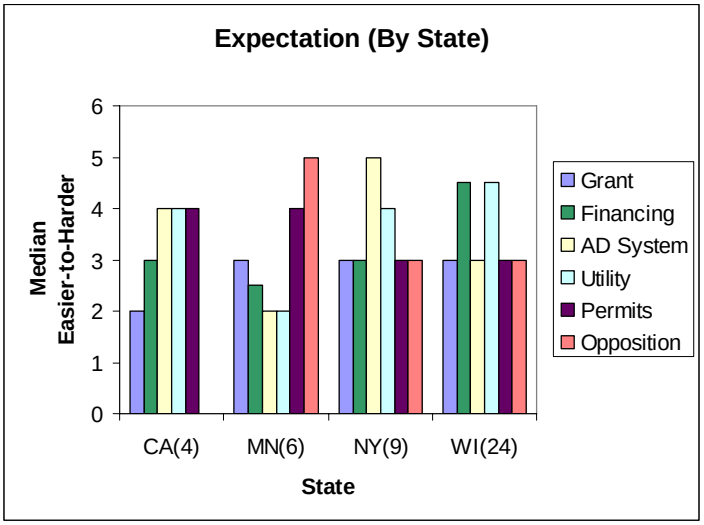

Figure 13. Expectation of challenges, by location of AD project.

Is the process of implementing an AD system worth the trouble? Despite the difficulties farmers face when trying to implement an AD project, they are overwhelmingly in favor of using this technology. The final question on the survey stated: "If you were just starting to research new methods of manure management would you still consider an AD system as a solution?" Of the 48 farmers who responded to this question, 92% said yes and 8% said no.

IV. Discussion: Experiences Implementing Farm Bill Anaerobic Digester Grants

The goal of this research effort was to form an understanding of the implementation issues encountered by farmers proposing to install AD systems. The 64 farmers who received Farm Bill funding in 2003 and 2004 contributed to this effort by providing their insights on their motivations for considering AD, and on the successes and barriers to implementation they have encountered.

Realistically, the economics of AD systems are most attractive for farms with a minimum number of animals—approximately 500 dairy cows, for example—because unit capital costs decrease as a function of herd size.[13,14] Consequently, the farms funded for AD systems tended to be at least that size or larger, including some

[13] Ciborowski, P. 2004. *Anaerobic Digestion in the Dairy Industry: Pollution Control Opportunities.* Minnesota Pollution Control Agency Air Innovations Conference.
[14] Martin, JH Jr. 2004. *The Economics of Anaerobic Digestion*. Hall Associates, Georgetown, DE.

classified as concentrated animal feeding operations (CAFOs),[15] or they were intending to expand. These highly efficient farms, many of which are family-owned and family-operated, have characteristics and concerns unique to sizeable farming operations, and it is these characteristics that formed the basis of farmers' motivations to install AD systems and that precipitated the challenges they faced along the way.

Motivation

The primary reasons farmers gave for their interest in AD systems were concerns associated with best management practices for large farming operations: odor control, environmental protection, and manure management, all assigned a rating of highest priority. AD was viewed as a technology that could address each of these issues.

Odor Control. Odor control was the most important motivator. Ninety-seven percent of the sample cited it as a top priority. Some were even passionate about the issue: "My highest priority;" "My one and only reason for wanting a digester;" "My single biggest reason;" "The leading issue for me." One said that he has not had pressure from neighbors about odor control but that he wants to address it anyway. Even a farmer who is firmly against having an AD system mentioned its positive attribute of reducing odor. The only two farmers who did not cite odor control as their top priority already have systems in place that manage odor: one has a lagoon that crusts over readily and the other has been separating the solids, which reduces odor. Farming operations have always been associated with odor but demographic changes are creating new objections.

Encroaching development

Residential development is expanding around many rural communities. Three farmers specifically noted the changing social dynamic associated with residents new to the countryside complaining about odors. Even without requirements, regulations, or fines, many farmers remarked: "I'm just trying to be a good neighbor," and "I wanted to have less odor out of consideration for my neighbors and they are pleasantly thrilled." "Because of the influx of wealthy neighbors building nearby," one farmer located near a large lake used for recreation promoted the farm's efforts to control odor by having a breakfast on the farm for 5,000 people. There was general agreement that contributing to good neighbor relations can help prevent local opposition.

In the case of one New York community, a town supervisor organized a cooperative of interested farmers to apply for the Farm Bill grant. The town became interested in AD as a result of a contentious zoning issue that arose when one farmer tried to site a new manure storage tank. Because the farm was located close to town, the review meetings were unusually crowded. People knew little about manure and AD. There

[15] A CAFO is defined 700 mature dairy cattle (whether milkers or dry cows); 1,000 animal units from a combination of slaughter steers and heifers, mature dairy cattle, swine over 55 pounds and sheep. Not all of the farms in this sample are classified as CAFOs.

was concern about odor and fear that fumes from manure cause cancer. This particular farmer, who had a good reputation as being very community oriented, decided to re-site the storage tank and have it re-designed and re-engineered by experts. This episode began with misunderstandings and hostility and ended with a cooperative effort to curb farm odors.

Herd expansion

All of the farmers interviewed saw an AD system as a means to increasing herd size without increasing odor. One farmer said that he has wanted to expand to a larger herd, but felt limited because "it's such a headache dealing with the manure." He said that it is difficult to accommodate neighbors the way he'd like to when he gets calls asking him not to spread manure on certain days because, for example, their child is having an outdoor graduation party. He thinks the odor is regrettable but he is not always able to accommodate last-minute requests because he uses outside contractors to do the spreading and he has to schedule them well in advance. He is "excited about spreading nearly odorless manure on the fields."

Future of the farm

One young farmer summed up a feeling of farm stewardship that was expressed by many: "The biggest issues confronting farmers are odor and neighbor issues." His farm is located in a remote rural area, and yet, there are some fields where he can no longer apply manure because of the odor from the manure trucks passing residential areas. When researching digesters he toured a few that were operational and was surprised that there was no odor. He believes that an AD system will alleviate concerns with odor and will facilitate his plans to increase his herd size dramatically—from 50 to 400 cows. As another farmer said, "The bigger the better is the future of farming." And because being a good neighbor appears to be more important than ever, odor control may be the key to keeping and growing the farm.

Odor control may be a primary motivator for many farmers but unfortunately, it is not a management technique whose benefits can be measured in financial terms. AD systems installed specifically and exclusively for odor control have no capacity to be valued by their payback. As one farmer put it, "How do you value odor? I learned that bankers don't care about odor control."

Environment. Protecting the environment, particularly air and water quality, also was identified by the farmers as a top motivator. Twenty-five percent expressed great concern about environmental quality and showed enthusiasm for the potential of an AD system to make a positive contribution. A common feeling among many was expressed by a long-time farmer, "one of the big priorities for implementing the digester is to preserve our natural resources." Another said that he sees "Europe as so much farther ahead from an ecological standpoint," and a dairy nutritionist, who went into partnership with his former employer, described AD as "one of the most valuable environmental projects—ever—to help the farmers in multiple ways."

According to one interviewee, he feels "it's a very worthwhile cause to clean up the environment. People are entitled to clean water and air; that is their right." Another described his AD system as being near his drinking well and he is confident that the manure will not seep. "I don't want to drink contaminated water any more than anyone else does, nor would my cows want to drink it."

Other environmental motivations for AD systems had to do with having a vision for the generations to come. One AD project in the Pacific Northwest came about because a Native American tribe was looking for a way they could work together with local dairy farmers on environmental and water quality issues, which led them to explore the idea of a regional digester. Improving the water quality was very important to the tribe, so they formed a consensus-building organization with the farmers and an environmental group whose mission is to recover the endangered salmon population in the nearby rivers. In the future they plan to capture the heat from the digester for greenhouses that can grow riparian plantings for a salmon recovery and stream restoration project.

One farmer stated that he is "looking to the future and what it [AD] could mean for an improved environment." And finally, a young father explained that he wants to establish his farm for his children and he does not want to see farming have a negative impact on the environment.

Manure Management. Manure management—dealing with the huge volume of manure, and using recovered digested solids—were also rated as high priorities motivating farmers to install an AD system. All of the farmers interviewed stated that they want to maintain good manure management practices, or as one put it "trying to find a responsible way to manage what cows produce." All but two of the farmers interviewed agreed that an AD system is a good way to address manure management, and that the liquid effluent was easier to spread on the fields, but they had differing views on the value of the separated solids, particularly when it came to the issue of using the solids for bedding.

Volume and handling

The opportunities for manure management differ by the digester technology used. On some farms the liquid manure goes into a lagoon, and from there it can be land spread. Others see an AD system as the first step toward better waste treatment and eliminating the lagoons.

Manure management becomes a major challenge as a farm grows. Some farmers just want less manure volume, and frequently mentioned that, if the AD system is successful for manure management, they expect to take advantage of the opportunity it creates by increasing their herd size. For others, manure handling is the issue. For example, one farmer said he doesn't want to deal with sand and pits and an AD system offers him more options. Either way, AD systems offer the advantages of reduced volume and reduced nutrient loads, making the liquid more suitable for soils and crops.

Using an AD system for manure management can be an integral component of a comprehensive nutrient management plan, which is a necessity for large farms and a requirement for CAFOs. One farmer with an operational digester described his motivation as "nutrient management, in a nutshell. [AD] is the most cost effective way to deal with manure. It converts the ammonia, provides better nutrients, and separates the solids. And there is the ability to reduce cost here as well."

Another farmer remarked that he foresees nutrient management as a growing concern but one that can be managed through AD systems: "AD provides a way to stabilize the manure and get the nutrients to where they should go." A third expressed his optimism by saying, "I have no doubt that these digesters will be on every farm in 10 years because farmers will have to do something about handling the manure."

Digested solids

The ability to recover digested solids also depends upon the type of AD system. For example, in a lagoon-type digester there are no solids readily and consistently available for reuse. Farmers whose AD systems do produce recoverable solids are able to generate another income stream from selling them as compost. There is some disagreement, however, on the use of digested solids as bedding.

Bedding

Whether or not recovered solids are suitable as bedding for dairy cows may be debatable, but 28 farmers are either planning to use the solids or are already using them successfully. In contrast, five of the farmers interviewed expressed some concern that solids reuse for bedding may be a danger to their herds. One farmer said that, given his huge investment in his farm, it just wasn't worth the risk.

Only one farmer mentioned concern about the use of the bio-solids over sand bedding as a possible safety hazard. He explained that sand is good for traction in his barn and he worries that if he couldn't put sand in the sloped alleys anymore, his cows could be injured from slipping and falling. The four other farmers who weighed in on this issue expressed concerns associated with bacteria and disease.

One farmer complained that he had heard too many bad stories about digested solids as bedding for cows. And then after realizing that he could not continue to use sand for bedding if he had a digester (sand flushing in will ruin the digester equipment), he decided to abandon his plan for implementing an AD. Another farmer voiced his concern that an AD system does not run hot enough to kill off all the bacteria. He's heard of the solids being run through a super heater at 150-160 degrees in order to kill all remaining bacteria, but did not believe he could afford that expense. Similarly, another worried that a dryer system is needed for the bedding if the solids from the digester are to be re-used. He's concerned because he has heard of struggles with mastitis that resulted from using the digested solids. This farmer ranked bedding as a high priority because of the cost savings but he now believes it is also one of the

biggest risks due to the possibility of infection and reduction in milk quality and quantity.

The 20 farmers with operating digesters were the ones with the success stories. One said he uses the excess heat from the digester for drying solids for bedding and is pleased with the results, having found that using sand is "a pain to deal with." Another said he has been successful using the bio-solids as bedding. Initially there were some health issues that the farmer attributed to using the solids for bedding before the digester was consistently up to temperature, but once he worked that out he has had no further problems. A third farmer noted that for successful bedding, the solids have to be properly managed, "If it gets wet it's a disaster, but otherwise the cows love it, they stay cleaner because it falls off of them and doesn't stick like the sand bedding."

Nine farmers remarked on the cost savings they realized from replacing sand or other bedding materials with heated, de-watered solids from a digester. One farmer's cost for sawdust had reached about $10,000 a month. He added that, even up in the north woods where his farm is located, this is not cheap. He can only imagine what other farmers must have to pay who aren't located so near to the source and the lumber mills. Another said bedding for his cows normally had been costing him $50,000 a year.

In addition to using the solids from the digester for bedding as a cost savings, 18 farmers talked about having taken the initiative to create a commodity that provides an income stream. Bedding pays for two-thirds of the AD project costs for one southern farmer. He uses only half of it for his herd and sells the remaining solids—$20 per ton for bedding and $4 per ton as (composted solids) fertilizer—to produce revenue of $12,000 per year. As a result of his success, he said other local dairymen have been showing more interest in the AD technology.

The experience of one interviewee who has a fourth-generation, single-family farm demonstrates the potential value of an AD system, especially when it is combined with good management, innovation, and initiative. This farm has a complete-mix digester that separates solids post-digestion. Manure goes into the digester every hour or so and the separator is run eight to nine hours a day. The process generates approximately 90 tons a week of solids with a moisture content of 60-70%, which is used on-site as bedding. The farmer said he thinks the somatic cell count is neutral if you do a good job with the bedding. He also beds deeper now, and the cows can kick out as much as they want. He feels the cows are cleaner than they were with sand bedding and they stay drier.

This farm produces another 70 to 80 tons of post-digestion solids per week that is sold to neighbors as bedding and (at a higher cost) to compost companies and research facilities. One company has plans to mix the solids with sterilized soil recovered from hazardous waste sites and then sell it as potting soil. Researchers are developing processes to make plastic and paper products from the separated solids.

This farmer hopes to sell $50,000-$60,000 a year in solids and save about $70,000 a year in bedding.

Compost
Seventeen farmers mentioned the value of the solids as compost. Sixteen are providing compost to neighbors or selling it to them at a nominal price. One is planning to sell all of the solids for compost and some sell part of it to landscapers, golf courses, and tree farm nurseries, and at a higher price to companies selling organic compost. Two farmers with operating digesters mentioned that they use only half of the digested solids for bedding their cows and are able to sell the other half.

Land Application of Manure and Fertilizer Replacement. These issues were rated as lower priorities, mostly because the farmers in this sample are primarily herdsmen; many are not involved in growing crops. One farmer, however, who has a 1,000 acre farm, has a certified agronomist working for him to determine the nutrient levels needed for his crops. He no longer buys commercial fertilizer because of the digester. The value of the digester by-product fertilizer accounts for approximately $85,000 per year in savings.

Electricity. Although renewable energy was the focus of the Farm Bill grants, for this sample of farmers producing electricity was not rated as an important motivation for installing an AD system. As a matter of fact, in aggregate, only one factor, ease of land application of manure, ranked as a lower priority than electricity.

It is not that farmers lack interest in renewable energy; it's simply that other factors take precedence when it comes to motivation for an AD project. For example, one said, "As dairy farmers, the potential to help with energy issues is very important," but another admitted, "Electricity is more of a side issue." Unlike odor reduction, environmental protection, and manure management, the production of electricity, particularly to sell off-farm, does not contribute directly to best practices for a large farming operation.

Only eight interviewees specifically mentioned electricity as a motivation for wanting to install an AD system. An additional three farmers considered AD because they were approached by their local utility. There were clear distinctions between the characteristics of the farmers who viewed producing electricity as a priority and those who did not. The ones who were primarily interested in electricity tended to be the farmers who ended up discontinuing their AD project, and they tended to have fewer than 1,000 cows. Specifically, 83% of farmers who decided to abandon their AD projects ranked electricity sales and offsets as their highest priority, followed by odor (33%), bedding (17%), environment (17%), and manure management (0). In contrast, a majority of the farmers who have operating digesters ranked odor reduction (79%), savings on bedding (79%), protecting the environment (79%), and manure management (84%) as priorities, over electricity sales or offsets (42%).

These results are most noteworthy when we take into account the challenges encountered by farmers when implementing an AD system. Farmers generally found the process was as they expected it to be, with one exception—negotiating an acceptable agreement with the local utility. This factor alone received the highest-challenge ranking. Farmers found that dealing with their local utility was the most aggravating step in the AD implementation process.

Challenges

The challenges encountered covered a range of topics, such as financial issues—capital costs and operating expenses, contract negotiations with utilities and bankers—and issues associated with regulations and local opposition. Farmers' experiences with these challenges fall into categories based on the status of their AD project. For those whose projects have been abandoned, these challenges were fatal; for those who have an operational digester, they have been overcome; and for those whose projects are delayed, these issues are front and center. Dealing with the issue of electricity, however, was a challenge across all categories.

Electricity. When the farmers talked about their challenges, the ones they mentioned most often were associated with electricity. Electricity issues[16] tend to fall into three categories: problems negotiating with the utilities, dissatisfaction with the rates they are offered, and the costs of upgrading their existing electrical system. Delays due to utility negotiations brought aggravation and increased costs to the projects.

Negotiations

Farmers negotiate an energy contract with their local utility to cover a variety of issues, such as interconnection requirements and costs, insurance requirements, and standby charges. They also must agree on the rate for selling what they generate and buying back electricity used on the farm or for selling the excess electricity. These interactions with utilities were a substantial roadblock.

Five farmers across the country described their relationship with the local utility as "unworkable." A west coast farmer put it this way, "I like the idea of manure management with the digester system as a solution, but knowing what I do about working with the utility, I might decide to not use it." An east coast farmer mentioned that he is scheduled to testify before his state senate about difficulties negotiating an agreement with his utility. It has gotten so bad that others have hired attorneys to help craft an agreement, and one group has hired a lobbyist to put political pressure on the local utility.

[16] A side issue is the green credits and the carbon credits—whether to keep them or give them to the utility. In general, the utility offers an electricity buy-back rate that is a bit higher if they are able to keep the green credits. Consequently, in most cases, the utility keeps the green credits and lets the farmer have the carbon credits, which can be sold on the Chicago Climate Exchange.

Many described their negotiations with the local utility as very difficult. Sixteen farmers, including one west coast single-family farmer who lost $12,000 because the utility installed the meter incorrectly, said they were treated so badly by their utility that they had a hard time even talking about it.

Poor communication within the company, difficulties getting someone to sit down and talk with them, and negotiations taking too much time were complaints heard from many. In fact, farmers expressed their frustration by saying, "Basically, they [the utilities] don't want to deal with this kind of renewable energy; they don't want to deal with the farmers who have digesters," "They don't care about working with the farmers," and "They simply aren't interested." Others warned, "Don't assume that if you install a digester that a utility will want to or has to buy [biogas or electricity] from you. There is not a mandate for that in every state." One summed it up thus: "Bottom line, it's got to pay; therefore, I really need a guarantee with the utility. I need to know what it costs and I can't move forward without knowing."

Difficulty negotiating with the utilities has been named as a significant source of delays and cost overruns. The ease of negotiation differs not only from one utility to another, but from one project to another. One utility set up a few pilot projects and actually sought out the farmers with their offers, but then caused delays for a second group by postponing meetings with them. A Midwestern farmer says his utility caused a six-month delay when he was ready to go on-line. He estimated the delay ended up increasing his costs by 8% due to additional interest on his loans. Another described negotiating with the utility as the biggest delay in his project: "They are very slow, and farmers are used to just doing things and getting them done."

On the positive side, five farmers stated that they were able to negotiate an agreement with their utility without any problems. Further, the three farmers in this sample who are working with the Sacramento Municipal Utility District (SMUD) had only good things to say about their interactions. The utility put together a workshop, involved dairy customers to promote it, initiated a pilot program for renewable energy, and provided grant incentives. SMUD offered a turn-key program, leaving only one issue for negotiation: reimbursement for excess electricity produced.

A few farmers believe that utilities may become easier to work with in the future. A farmer from the west coast admitted that the utilities have not had much experience in these types of negotiations and he was hopeful that things would improve. One stated that he believes the utility company's attitude towards working with farmers on AD projects is finally changing because there are more operational systems to look at. As the price of electricity goes up, he believes they will become more interested in electricity from renewable sources.

Rates

Farmers voiced strong disappointment in the rates they receive from their utility for the power they produce. Twenty farmers specifically said they thought they were being treated unfairly by their utilities. There are three primary issues: the price the

farmer pays for the electricity he uses compared to the price he gets from the utility for the electricity he produces; the price the utility pays for the excess electricity he generates; and the length of the rate contracts. The term most of the farmers used to describe their expectations was "fair market value." There are so many factors that affect electricity rates, such as on-peak versus off-peak and agricultural versus residential, not to mention seasonal fluctuations and climate differences, that it would be very difficult to characterize existing rates. Even so, more than one farmer mentioned that there should be a standardized pay scale for the electricity across the nation, instead of the wide variation that now exists.

Price differential

The most contentious part of negotiations with a utility involves what the farmer gets paid for the electricity he produces and feeds to the electrical grid. Many farmers entered into this process believing they would be paid for their electricity at the same rate they pay out, in an arrangement known as net metering.[17]

Of the 64 interviewees, the customers of only one utility stated that they were offered this rate. Farmers find this the most acceptable situation. Six states represented in this sample—California, New York, North Carolina, Pennsylvania, Vermont, and Washington—have net metering programs that are applicable to the generation capacity of AD systems, but so many variables, in addition to the size of the generation system, enter into a net metering arrangement, that it is difficult for the farmers to anticipate the financial arrangements or to evaluate their proposed energy contract.

In states where there is no net metering, some farmers sell all of the electricity they generate to the utility and then buy back what they need. Other farmers are set up to use the electricity they generate for the buildings on the farm and then sell the excess to the utility. Typical of many, one farmer in the heartland sells all of his electricity to the local utility for which he receives a discounted wholesale rate, but then he has to buy it back at the market rate, which is nearly double what he gets paid. Four farmers vowed to generate just enough electricity to service their needs and no more.

An assessment common among those interviewed was captured by one farmer, "I don't like what I hear about utilities and the rates they offer." Nevertheless, there were several positive remarks about various pricing programs made during the interviews. In the Midwest, two farmers expressed some satisfaction with the electricity buy-back offers they received. According to one, the rate has made having the digester more economically feasible. The other mentioned that he will be paid for

[17] Net-metering is a simplified method of metering the energy consumed and produced at a farm that has its own renewable energy generator, such as an anaerobic digester. Under net metering, excess electricity produced by the digester will spin the existing farm electricity meter backwards, effectively banking the electricity until it is needed by the farmer. This provides the farmer with full retail value for all the electricity produced.

the electricity he generates at the same rate the utility pays for all of their electricity regardless of source.

Sales of excess electricity
An east coast farmer described her unique situation, and she wants people to know about it. In the beginning she was only interested in generating electricity for use on her farm to offset her $80,000 a year electricity bill. Despite achieving this, she still encounters difficulties with bureaucracy. Part of her farm operation, including the digester and the generator, is across the street from her house. Because of this arrangement, she is not permitted to use this electricity at her house. She must take credit for the excess electricity and apply it towards those electric bills. This farmer believes that something has got to change in order to make working with the utilities worth the trouble. She would like to see the farmers running local electrical production. Even if they are small operations, farmers could provide a source of energy at a reasonable cost.

This farmer's suggestion seems to be met in a Vermont program, where customers can sign up with their utility to pay an extra four cents per kilowatt hour for purchase of electricity generated by Vermont farmers. The utility then pays the farmer the "market price for energy plus the four cents"[18] for every kilowatt hour requested from customers. In this way, all of the extra revenue from the customers goes straight to the farmer who has the digester; there are no administrative costs deducted. There is a down side to this program, however—one Vermont farmer complained that there is no mechanism for the utility to pay for the excess electricity generated, and in this farmer's case, 100% of what she produces goes to the utility.

Contract length
Farmers view extended contracts—10 to 15 years is not unusual—as unworkable. Looking out this far and locking them into a rate at a time when the cost of electricity is increasing, is not only impractical for a farm with new technology but considered unfair to the farmer. Farmers voiced their interest in short contracts of 1 to 5 years. One farmer mentioned that he was able to write a paragraph into his utility contract stipulating that if the utility increases their rates to the consumer, the rate he gets paid will increase as well.

Upgrades
Most of the farmers seemed to be caught off guard when they found that their existing electrical system would have to be upgraded for interconnection of their AD system to the electrical grid, and that they would be responsible for covering all of the costs. One described a $50,000 cost overrun on the electrical upgrades. Many did not have three-phase power on the farm and had to bring it in, with costs varying: $10,000 for one mile in Pennsylvania, $20,000 for 400 yards in Wisconsin, $19,000 for 2 miles in Minnesota, including $3,500 for tree removal. Costs could run up to $130,000 for switching gear and three-phase power, as they did for one farmer in Pennsylvania. Even farmers who already had three-phase power incurred upgrade

[18] Central Vermont Public Service Cow Power™ Program <http://www.cvps.com/cowpower>

costs, for example, $80,000 for poles and transformers in Vermont, and $100,000 for rewiring to existing electrical services and adding switches in New York. And some of these costs were incurred for power company equipment that is not on the farmer's property.

Despite a surprise requirement of electrical upgrades, some farmers still had a success story to tell. For example, a Midwest farmer had to spend about $90,000 for a three-phase power line because he's about a mile and a half from a hookup. He estimates that general maintenance on the digester costs approximately 1½ cents per kilowatt hour, or about $75 a day, but he generates $350 a day worth of electricity. And he reports that his experience with the local utility was positive. Because he was one of the first in his area with an AD, his utility wanted to work with him to gain some experience accommodating electricity from a digester. He has a long-term contract for 10 years and he is getting better than six cents per kilowatt hour, but the exact rate is proprietary.

Challenges by Status of AD Project

In addition to describing their challenges negotiating an acceptable agreement with the local utility, interviewees were asked to rate the level of challenge they encountered getting grant approval, arranging acceptable non-grant financing, selecting a specific AD system design, obtaining the necessary state and local permits, and facing local opposition.

Looking at challenges posed in each step of AD system development provides a good picture of the stumbling blocks in the process. For example, working with utilities proved to be the greatest challenge for farmers whose AD project has been developed or is delayed. Farmers who have decided to abandon their projects typically did not get to the point of negotiating with a utility; they judged selecting a specific AD system design as their greatest challenge. Farmers who selected an AD design and a designer they could work with usually moved forward with their plans.

In addition, specific challenges emerge in the delayed group when we consider location. Permitting and local opposition, ranked lower by this group as a whole, can be seen to be major challenges in some locations.

Discontinued Projects. This group of nine farmers found their primary challenge to be with the limitations of the available AD technologies. Secondary challenges were the low prices offered for electricity, and the difficulty of obtaining financing.

These farmers often stressed in their interviews that an AD system is not a complete solution for manure management, just one piece of it. For the most part, they are in favor of using new technologies to manage their manure but they found the limitations of AD systems too great: poor design, time-consuming operation and management required, and poor serviceability of the digester. Some expressed

interest in exploring other technologies to manage their manure, but with regard to AD, many want to wait for a proven technology and not be a pioneer in this area. As one said, "It should be as easy to operate as a milking machine." And for one farmer in the north, "The technology has to become more efficient, particularly for a cold climate."

With the wide-spread distress over low milk prices, most farmers in this group expressed concerns about profitability. They do not see an AD system as a good investment unless they get a fair market value for the electricity, which they see as an unlikely prospect. Further, many in this group found arranging financing to be a big hurdle.

All but one of the farmers who have discontinued their projects said they would once again consider AD if the technology improved and it became economically feasible. The lone dissenter, who received grants for two farms with a total of 5,700 cows, said that after studying the AD technology he had lingering concerns about three issues: potential effects on cow health when using the digested solids for bedding; the high failure rate of digesters he's seen; and the high installation and operating costs.

Delayed Projects. Negotiating for electricity sales and offsets was by far the greatest challenge for those 28 farmers whose AD projects are on hold. Arranging for project financing was rated a medium challenge, and other difficulties came to light only when the farm location was taken into account.

Electricity

Farmers in this group generally have passed the hurdle of selecting an AD system and a designer. Their greatest obstacle is their local electrical utility. In fact, this is the group that reported most of the problems discussed previously in the section on electricity as a challenge, which will not be repeated here.

Financing

Obtaining the necessary financing was not rated as challenging as negotiating with the utility for this group, but it is a challenge, nonetheless, particularly in locations where the local bank does not have experience arranging financing for digesters. Even in the top dairy states, farmers in this group were worried that "lenders may be cooling their heels now" and waiting to evaluate the success of existing AD projects. Their general feeling is that the banks want to see a greater number of digesters running successfully before loaning money to more projects.

Permitting

We asked everyone to rate how challenging it was to obtain the necessary permits for their AD project. The number and type of permits that are required varies by state, county, and sometimes even by township. For example, all one farmer needed was a $3.00 building permit that he obtained at the county courthouse, whereas other farmers had to submit several lengthy permitting applications and wait months for approvals.

For most farmers permitting was not a problem, as one said, "If you know what you're doing, you can even speed up the process." However, the California farmers said they have been overwhelmed by the permitting process. The four California farmers in this sample point fingers at the state regional Water Quality Board (WQB) in particular, because they said it has held up the implementation of a number of AD projects in California.

One California farmer said that the environmental impact statement the WQB requires is 150 pages long. Because of changes in regulations in the year since he submitted his impact statement, he is in limbo. He estimates that, while he awaits approval, his costs have doubled over his 2004 estimate of $600,000. Another California farmer said he's had a 1½-year delay in permit approval from this agency and is reconsidering whether he wants to continue with the project because he estimates increased costs of at least 30%. A third reported that he has now received clearance from the WQB to move forward with construction on his AD project, originally intended to begin last summer. He still hopes to start construction soon, but he calculates that the cost of his project increased from $450,000 to $600,000 due to the delay.

Local opposition

When we asked about the influence of local opposition most farmers did not register any particular concern. Their responses described approaches they had taken in order to prevent problems. Farmers have invited neighbors to open-house events on the farm, held town meetings, and enlisted township officials and county commissioners to write letters of support for the planned AD project. A few mentioned that neighbors were not happy with utility-line upgrades that put power poles on their land, making it inconvenient to run a tractor around them. When poles were placed on public access easements at the side of a road or part of the line was placed under ground, there was little local concern. For Minnesota farmers, however, the situation is not as easy.

Four out of the five Minnesota farmers interviewed said they are watching the progress of an on-going, long-term litigation brought by a local township and a land stewardship project to prevent a farmer from constructing a large herd dairy facility, despite already having approval for the project at the state and county levels. They believe that, even though the opposition is primarily to building a large dairy and not to the AD project, attempting to build a digester in Minnesota has gotten a bad reputation by association.

The farmer spent a great deal of effort working with the township ahead of time so they would not feel pressured into approving his overall project. As he described it: "Originally I had permission to move forward, but then a strong Minnesota environmental group got involved. They want me to go back to the way my father farmed with 100 cows. This group is good at what it does and scares people to accomplish their goals. They managed to convince the majority of the town board to

change their minds. They also got a moratorium imposed on the number of animal units allowed per farm in the county." This farmer brought a successful lawsuit to overturn the moratorium. Now the group is fighting against the farmer's land use plan, and no resolution is in sight.

Other local and national environmental groups appear to have targeted Minnesota in their opposition to AD projects. One farmer described them as organized "vegetarian, animal, and political opposition groups." Another farmer who has not yet begun construction on his AD project remarked, "Some protesters drive by my dairy every day to ensure nothing is being violated." And because opposition usually coincides with permitting, those who have not begun that process are most concerned.

On the other hand, the Minnesota farmers who already have an established dairy, particularly one that is highly regarded, do not expect to have as much local opposition as individuals who are starting a new dairy operation, because they view the opposition to be primarily directed against the development of new CAFOs. One farmer also mentioned that he found it helpful to site his AD project in a remote area on the back of his farm instead of in the front, where it would have been visible and closer to two other houses.

Developed Projects. The 27 farmers with projects that are operational or are moving forward were successful in overcoming most of their obstacles. They ranked working with the utility as, far and away, their greatest obstacle. Three challenges came together in second place: financing, AD system design, and the grant process. In general, this group of entrepreneurs appeared to be creative in the ways they approached the business of farming, seeing AD technology as a potential profit center for the farm. As an example, three farmers in this group said that they receive income from a "tipping fee" that they charge to accept food wastes from nearby commercial interests, that they add to the digester.

Electricity

Electricity was the top ranked challenge for this group, but electricity was not a motivation for them to install a digester. As one said, "Electricity was more of a side issue." Many already had three-phase power coming to the farm and felt that they had established a good relationship with their utility. Even so, most had some complaint about the rate they were being paid for their electricity and two specifically mentioned problems with their utility's faulty meters. None of the farmers in this group talked about profit from sales of excess electricity; they were very circumspect about this issue. Four farmers are bypassing negotiations for selling excess electricity by generating just enough for their farm use, which enables them to pay for the operating expense of the digester with their electricity savings.

Financing

This group did not identify financing as a major obstacle for a number of reasons: they had a good relationship with their banker, they had a lot of equity in the farm, or they had private investors or their own money. Only a few found financing to be a

very difficult hurdle because they were starting a new operation and did not have sufficient farm equity or because the local bankers were apprehensive about the new AD technology. But these systems are expensive and at least four of the farmers depended on other grants to supplement their Farm Bill award.

AD system

The greatest challenges regarding AD design seemed to be due to the limited number of choices of digester designers and to the difficulties farmers had with the designers they did choose. The 13 farmers who were concerned about this issue felt that their designers were not forthcoming with critical information. Farmers felt uninformed about all that is involved with an AD project, such as the cogeneration unit, the buildings, and the plumbing. Problems were common during initial setup and delays were frequent—in construction, receiving engines, just about everything was mentioned. But as one said, "You know it's going to take time so you just wait."

Problems specific to design companies were described in terms such as "loosely run ship," "very high turnover rate of employees," "double the estimated cost," "too many surprises in contingency factors." One said "the design engineers should not be selling the components; they should stick to just selling the technology," and another cautioned that "all of the companies will give you a big sales pitch."

On the other hand, this is a very determined bunch. As a group, they tried not to rely too heavily on the designers' sales information by doing their own research and looking at a number of operating digesters. For them, the best approach was to carefully choose the best design for their particular operation and look for simplicity, cost efficiency, and ease of operation.

Grant

This group found the grant process to be cumbersome. One farmer described the process of implementing the grant as "a nightmare," and another "like having a root canal every day." And for some, this amounted to a financial concern. The grant money is back loaded so that farmers receive their funds when construction is finished and biogas is being produced consistently. For many, this means accumulating interest on loans in the interim.

For others, their complaints were regarding administration. According to one farmer, "the Farm Bill grant process was horrible, and I want to emphasize that. The intention was good but the administration is terrible. We're farmers with cows to milk. We like to get things done and not get tangled up in bureaucracy." Another explained, "Government administered grant programs can make the grant process easy or difficult. For example, the soil and water grant application was four pages long and was about an hour's worth of work. The Farm Bill grant was about two inches thick and included several contracts, each about 65 pages long. And that was only the proposal, not the paperwork required to execute the plan!"

All of the farmers in this group expressed a desire for more flexibility in the grant to allow them to use the methane in alternative ways, such as converting to natural gas. Two farmers are already exploring alternative uses for some of the biogas they produce, such as burning it in a boiler, absorption chilling, or using it for bio-diesel fuel.

V. Conclusions

The goal of this project was to provide a clear picture of implementation issues for farmers wishing to install an AD system. It was not meant to be an evaluation of the Farm Bill award program, or an assessment of AD technology. Other studies have covered those issues. It is a presentation of the reasons why farmers choose to pursue an AD system and a report of their experiences.

Farmers in this sample have relatively large farms, with 450 dairy cows being the smallest, and they chose AD technology primarily to reduce odor and to improve manure management. They tended to see AD as a key component in their plans to increase herd size. On the whole, they are progressive—interested in new technology, and in protecting the environment and securing the farm for future generations. Producing renewable energy was not a prime motivator for those who successfully implemented an AD system; however, producing electricity was the prime motivator for those who have since abandoned their AD projects.

On the other hand, the large capital costs required to implement a digester means that concrete plans for cost recovery are a necessity, and the potential for selling electricity to the local utility was anticipated to figure into this cost recovery. In the end, financing proved to be difficult for many. They were frustrated with the low rate of return they could achieve with the prices typically offered by the local utility company, and with the reluctance of bankers to a write loan for a digester, particularly if they have never seen one.

For farmers, choosing and setting up an AD system can be complicated and laden with problems. Operation and maintenance can be time intensive, taking farmers away from looking after their animals. They are also concerned about the investment they have in their livestock, so they are very careful about making any changes that could jeopardize the health of their cows.

In addition, there are two issues that only present challenges in certain locations—permitting problems in California, and local opposition in Minnesota. They are significant challenges, but are being addressed, and farmers are hopeful that they can be overcome.

Despite all of the problems encountered by the farmers in this sample, they are overwhelmingly in favor of AD technology—92% want to make it work.

VI. Recommendations

This report is intended to relate the experiences of farmers who received Farm Bill grants to implement AD systems; the study was not designed to elicit information on policy changes or amendments. During the open-ended interviews, however, many farmers offered their thoughts on recommendations.

In essence, all of their suggestions relate to helping farmers utilize their renewable resources by providing initial financial support. AD systems are expensive and cost recovery through sales of electricity is not always possible. Yet farmers are interested in AD technology because it facilitates best business practices, especially for growing farms.

If using AD technology to generate renewable energy is a goal, then instituting a transparent, committed process of negotiation between utilities and farmers is critical. On the other hand, farmers expressed an interest in receiving loan guarantees or other financing assistance for on-farm renewable energy systems that is not tied to the generation of electricity, but allows for flexibility in the use of the biogas. Farmers consider biogas as a commodity, and like with milk, they want to be able to have some control over how they produce it and how they market it.