An Economic Analysis of a Dairy Anaerobic Digestion (A.D.) System: Will dairy producers invest in A.D. technology to reduce potential litigation suits?

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Abstract

In many areas of the United States, dairy and livestock farmers are facing lawsuits due to a variety of externalities, such as odor and other forms of non-point source pollution, caused by Confined animal feeding operations (CAFO's). Complaints include: general illness, unpleasant odor, headaches, and property devaluation. However, state and national law requires all CAFO's to have some form of waste storage facility. These facilities, mainly lagoons, increase the potential of pollution and run-off into streams and other water sources. As a result, large producers are beginning to install anaerobic digestive (A.D.) systems, which are a new form of waste management practices that reduces negative environmental effects.

Therefore, the purpose of this study is to determine the future value of an ordinary annuity of an anaerobic digestive system by analyzing the joint probability of being sued and losing a litigation case. The analysis will also factor in potential policy incentives such as 100% grants with guaranteed electric buy-back premiums to determine a producer's joint probability of losing a litigation case.

Keywords: Anaerobic Digestion, Dairy Litigation suits, Dairy production

Dairying in the United States dates back to the 1850's. The first dairies were very small operations on the outskirt of towns and villages. Farmers supplied citizens with milk, which was churned into butter or used to prepare other goods. As the population increased, milk became a more demanded commodity. Today, dairies still provide milk and dairy products, but the number of cows per operations is much larger. The increased number of cattle per farm has not only expanded milk production, but it has also increased the amount of waste these animals produce. Today, one of the greatest challenges that dairy producers face is managing manure and process wastewater in a way that controls odors and protects environmental quality (AgStar 1998).

Private landowners and other citizens are filing lawsuits against large dairy farms, which are also known as Confined Animal Feeding Operations (CAFO's). In Mississippi, a well-conditioned cow will produce 40,000 pounds of manure per year, and in 2003 there was 31,000 head of dairy cattle in the state (MSUCares, 2004). This totals to nearly 1.2 billion pounds of manure annually. Waste management of CAFO's is a major problem in many states across the U.S., because in June 2004 there were 85,000 dairies supporting 9 million cows. As a result, dairy producers are beginning to adopt new forms of waste management practices to reduce negative environmental effects. This is turn will reduce the probability of litigation suits against dairy producers.

A dairy cattle's waste is composed of the gas methane, which is a very powerful greenhouse gas estimated to be 21 times more damaging to the ozone layer than carbon dioxide (WPSC 2003). However, researchers have found that methane (biogas) can produce both electricity and heat, which will decrease a farm's energy costs. By converting methane into electricity, carbon dioxide is reduced and the volume of solid manure decreases by more than 90 percent. The remaining solids are used as fertilizers and bedding for the cattle (Lusk 1998).

Dairy methane recovery requires an anaerobic digester where the term anaerobic means "without oxygen." The anaerobic digester is an enclosed tank that excludes all oxygen. Once the manure is placed in the digester, heat triggers bacteria to break the waste down into methane gas. These methane-producing bacteria are active in the range of 95 to 105 degrees Fahrenheit, thus most manure holding tanks must be heated. Most digesters circulate hot water through the system's pipes, which will maintain the desired temperature range for methane recovery (WPSC 2003). Once the gas is trapped, it can be burned off through an open flame or converted into energy. The methane can be used as fuel to power a generator, which creates electricity. The produced electricity could then be used to operate the dairy. Excess power may be sold to electric company grids, which is known as "green power." August 2004, the Vermont Public Service Board approved a "green power" program that will be offered by the Central Vermont Public Service program (CVPS). The CVPS "Cow Power" program will offer Vermont power customers an option of receiving 25%, 50%, or 100% of their electricity as "green power." However, consumers will pay an additional four cents per kilowatt-hour for the "green power".

Interested farmers have the option of selecting the best-suited digester system for their farm. Their choices include: covered lagoon digester, complete mix digester, and a plug flow digester. Covered lagoon digesters are earthed lagoons, fitted with a gas cover that traps methane from waste. According to the EPA, this system is best suited for flush or pit recharge manure collection systems with a total solid content of 0.5 to three percent. Complete mix digester are heated tanks constructed with reinforced steel or concrete, with a gas tight cover. The contents are mixed by either a motor or pump (AgStar 1998). This digester type works best with slurry manure and solid contents are three to ten percent. Finally, plug flow digesters are long tanks, with a gas cover, built just below ground level. Solid contents are usually 11 to 13 percent (Lusk 1998).

Anaerobic digesters have the potential to reduce cost to large dairy farms (CAFO's) and improve their image among environmentalist. Installation of this technology will reduce odor, protect water from lagoon run-offs, reduce dangerous greenhouse gases, and reduce energy cost. The most desirable aspect with this technology is farmers are converting a cost of dairying (waste management) into a cost saving for the operation and possible revenue source with the production of electricity (Herndon, 2004).

Problem Statement

Confined animal feeding operations (CAFO's) have been described as an irritation to society. In many areas of the United States, livestock farmers are facing lawsuits due to a variety of negative externalities caused by CAFO's, which include: general illness, unpleasant odor, headaches, property devaluation, and water pollution.

According to Mississippi Dairy Industry trends, there were 258 dairies with an average of 120 cows per herd and a total of 31,000 head of dairy cattle in the state at the end of 2003. One herd of cattle will produce thousands of pounds of milk and animal waste on a daily basis. Pollution due to cattle manure has been a chief concern among citizens. Law requires all dairy farms to have some form of waste storage facility. These facilities, mainly lagoons, have raised concerns of pollution and possible run-off. To avoid lawsuits and reduce the risk of possible pollution, farms are installing anaerobic digesters to handle cattle manure and wastewater from the operations.

The cost of installation for a digester is approximately $260,000 (Lusk 1998). However, the problem facing the farmer is determining if this is a beneficial investment for the farm. Even though the process of anaerobic digestion was introduced in the 1970's, many refer to this as a new form of technology. Due to the lack of government subsidies, farmers adopting this technology might have to invest their own money. Cost benefit analysis can be performed to determine if the investment is reasonable if a particular investor is slightly risk averse. By calculating the future value of the project, dairy producers could determine the joint probability of being sued and losing their case. This analysis could help farmers make a decision on whether or not to invest in the project.

Farmers will reap many benefits associated with the installation of an anaerobic digester. Environmentally, the number of manure stockpiles may be reduced which in turn reduces odors and the infestation of flies. Research has shown that anaerobic digestion reduced odor by 97 percent over fresh manure (WPSC 2003). This system also reduces the dangers of improperly functioning lagoons from manure run off into screams and lakes. By improving the environmental conditions of CAFO's, the public will be less inclined to file class-action lawsuits against the producer. Even though, this system cost an estimated $260,000, it has the potential to reduce the farm's input cost and risks of litigation for negative environmental impacts. Converting waste to energy, the farm would be able to reduce energy cost, and possibly increase revenues with energy sales. Greenhouse gases are reduced through the process of anaerobic digestion, which is another positive feature from the process. By capturing the methane, CAFO's would decrease the production of dangerous greenhouse gases and ammonia. Anaerobic digesters could also reduce the cost of propane. As mentioned earlier, heated water is required to trigger methane-producing bacteria. Farmers are able to use this water to help with cleaning of parlors and to help heat the milking parlors in the winter months. This also gives the farmer the option to use hot water for flushing walkways within the barn, and cleaning the milking parlors after the cows are milked. With these added benefits, propane cost savings will be an estimated $4,000 per year (Lamb, Nelson 2000). Besides the benefits, there are other issues that the farmer must recognize before he makes the investment. Usually, 30 to 45 minutes of daily maintenance is recommended to keep the system operating smoothly. This includes: system inspection, mixing the digester twice daily, and recording gauges that measure methane production and electricity output (WPSC 2003). Finally, generators require monthly maintenance and tune-ups, which include, changing the oil, cleaning the spark plugs, and making valve adjustments.

This technology also has the opportunity to enhance the image of large dairy producers (CAFO's), by demonstrating their commitment to improve the environment. Numerous benefits are associated with the production of "green power." However, investors should properly evaluate the strengths and weaknesses of these systems before making the commitment. Generally, anaerobic digesters are more feasible with a minimum herd size 300 to 400 head of dairy cattle (Lamb, Nelson 2000). However, farmers will be more inclined to adopt this technology with possible incentives. These incentives include: cost share programs, tax credits for methane recovering farms, no-interest loans for small dairies, and electric buy-back. Incentives along with the mentioned benefits will give dairy farmers, throughout the United States, the opportunity to improve farm profitability and their reputation among environmentalist and make their farms more cost efficient.

Literature Review

Meynell reported that the first methane digester plant was built in India in 1859. From there, the process found its way to England in the late 1800's. It served as a way to recover biogas from the city sewers, which was used to fuel city street lamps. In 2004, 1,000 anaerobic digesters are being installed worldwide. These systems are farm-related, household-related or public-related (water purification); however, farm-based facilities are where the majority of research is being conducted. Lusk has estimated the 44% of these systems were being installed in Europe and only 14% in North America. The majority of these facilities being installed in Brazil are used to treat the vinasse co-product from sugar cane based ethanol production.

The first facility in the United States was erected in 1970 and was located on a swine operation in Iowa. The farm had been in operation since 1952, but urban encroachment caused the owners to develop a system that help alleviate the odors (Lusk 1998). After two years of trial and error, the system was complete. In 1972, the digester was stocked with 6,000 gallons of sludge from the farm and local town's waste digester. On May 10th excess methane tripped a relief valve creating the first farm-based digester in the United States.

Recent research has evaluated anaerobic digestion technologies using objective economic criteria (Lusk 1998). Lusk and Mattocks have shown that a number of pro forma economic evaluations for a 150-ton per day AD systems were conducted using three different feedstock combinations: manure only, organic industrial residue (OIR), and both manure and OIR. In their research, four economic evaluations were conducted and established parameters that would most likely make each project scenario "costeffective.” Their scenarios included: low and high efficiency engines recovering sludge (cake), low and high efficiency engines without recovery. Table 1.0 gives the results of the three different feedstock combinations (courtesy of Lusk and Mattocks).

Table 1.0

Project Scenario Economic Evaluation Summary for an anaerobic system

	Manure	Manure & OIR	OIR
Capital Cost	$ 2,776,976	$2,353,124	$2,398,387
1st Year Revenue	$ 964,808	$ 1,225,026	$ 1,506,520
1st Year Expenses	$ 963,366	$ 823,020	$ 1,220,239
Net Income	$ 1,442	$ 402,007	$ 286,280
Net Present Value	($ 1,265,327)	$ 1,897,764	$ 804,536
Internal rate of return	0.10%	27.60%	20.30%

Dairy Waste Regulations

In Mississippi, water quality regulators are administered by the Mississippi Department of Environmental Quality (MDEQ). According to the MDEQ, livestock waste must be at least 100 feet from any water source. Waste operating permits are issued in Mississippi for Grade A dairies and these permits give the legal right to operate an animal waste treatment facility. Dairy farmers are also required to comply with other regulations concerning buffer zone requirements and animal waste sanitation concerns (MSUCares 2004). These include the construction of dairy facilities and land-applied cattle that waste must be 300 feet from neighboring property lines, and 1,000 feet from any other resident's land that the farmer does not own. Dairy waste lagoons and other storage facilities must be at least 100 feet from the milk room, and cattle must not have access to waste storage facilities.

Dairy Litigation Suits

Literature has shown that dairy litigation cases are not commonly filed by plaintiff's concerning waste regulations. However, Vreba-Hoff (VH) Dairy, LLC has been the target of Michigan's Department of Environmental Quality for failure to properly manage dairy waste. In September of 2004, the Michigan DEQ filed a civil suit against Vreba-Hoff for repeated discharges of manure and silage waste into state waters linked to two VH dairies, which house approximately 6,000 cows near Hudson, Michigan. Additionally, Sutherly's paper discussed how Ohio's Environmental Protection Agency (EPA) proposed that VH pay $177,000 for violating storm water rules at 10 construction sites.

In June of 2004, the Community Association for Restoration of the Environment (CARE) filed suit in federal court in Spokane, WA against Smith Brothers Dairy for past and ongoing violations of the Federal Clean Water Act (CWA) (Western Environmental Law, 2004). CARE claimed these CWA violations were caused by over-application of liquid and solid manure, which reached irrigation canals, drainage ditches, and eventually made its way into the Columbia River. According to CARE, Smith Brothers also failed to submit detailed reports of the release of federally designed hazardous substances including ammonia, methane, and hydrogen sulfide. The suit also alleges several operational violations by Smith Brothers such as dumping manure on frozen ground, depositing manure on roads, and other poor practices that could lead to discharging manure into waterways. If found in violation of CWA and liable, Smith Brothers dairy could be fined $27,500 per day (Western Environmental Law, 2004).

In February of 2004, the city of Waco, Texas filed litigation suits against 15 dairy farmers located in Erath County, Texas that are approximately 100 miles away from Waco. The suit claimed that run-off from Erath County dairies were polluting the Bosque River and Lake Waco. Prior to the filing of the suit, the city of Waco spent $ 3.5 million to treat water quality problems in Lake Waco related to an algae bloom. Furthermore, the algae bloom caused unpleasant taste that was a result of high levels of phosphorus in Lake Waco. About 75 percent of the water from Lake Waco comes from the Bosque River, and contested studies have shown that 44 percent of phosphorus in the North Bosque comes from dairies (Robinson, 2001). Due to the lawsuit, many farmers have removed their cattle from Erath County to avoid further legal action, but others have either filed for bankruptcy or stopped farming. Stefan Bly, of Dutch Cowboy Dairy, has spent $70,000 on his $400 per hour attorney to handle this case. Legal fees for the 15 farmers are projected to be $1.5 million for this suit. Settling costs are not public information, therefore not possible to obtain. However, based on the cost of legal fees, it will cost farmers approximately $325,000 per farm to settle lawsuits brought against these operations. However, this is assuming that legal fees are 33 percent of the settling fee.

The majority of litigation filed against dairy producers due to violations of the CWA has been filed in recent years. The increased trend of lawsuits makes the installation of an anaerobic digester a potential solution to dairy farmers that face these suits. The installation would allow producers the opportunity to reduce possible lagoon water run-off into lakes, streams and rivers, which is a violation of the CWA if the producers do not have a permit to discharge into water sources.

Methods and Procedures

Mills Dairy, located in Scott County, Mississippi, agreed to provide data for the analysis. Mr. Quinton Mills, the owner, is currently in the completion process of installing an anaerobic digestion system. Mr. Mills was selected to be a part of a cost share program in conjunction with the Mississippi Land, Water, and Timber Board (MLWTB). Currently, Mills' dairy is the only dairy that has adopted AD technology in the state of Mississippi. Data collected include general input production cost including feed, labor, utilities, construction cost, and operational cost. Other data include milk production, milk prices received, depreciation on farm equipment, and maintenance cost.

Data collected from Mills Dairy will be manipulated in AgStar's FarmWare 2.0 simulation package to determine the net present value (NPV) of the project along with the internal rate of return (IRR), and simple payback period. FarmWare is a user friendly software program used to assist in making project decisions, and will allow users to determine an annual abatement cost required by the producer to invest in the technology. In addition to FarmWare, Microsoft Excel will be used to calculate the future value of an ordinary annuity of an anaerobic system. This analysis will allow producers to determine the joint probability of being sued and losing a litigation case, due negative externalities caused by a dairy operation.

A joint probability is having the probability of both x and y happening, and in this study x is being sued and y is losing the case, respectfully. Joint probabilities are calculated as:

$$\iint p(x, y)\,dxdy = 1$$

In this study to calculate the joint probability, analyses will be completed first in FarmWare to determine the annual abatement payment farmers will require adopting A.D. technology. Below in Table 1.1 are the assumptions that will be used to determine the annual abatement cost.

Table 1.1

FarmWare assumptions used to calculate the NPV of an anaerobic digestion system

Down payment	20 %
Loan rate	8 %
Loan term (yrs)	10
Depreciation (yrs)	10
Tax rate	35 %
Discount rate[*]	4.5 %
Electric buy-back	$0.04

In the analysis, incentive packages will be placed within the FarmWare model to estimate producer's sensitivity of offering certain financial packages. Estimated packages

[*] Value based on 10 year T-Bill

will include 100% grants with or without guaranteed electric buyback, and 10 year low interest loans with or without guaranteed electric buyback. By analyzing the model with different financial packages, this study will provide evidence that producers will become more inclined to adopt A.D. technology with some form of incentives. Incentives to invest could be monetary or an opportunity to off-set litigation risk due to a higher joint probability of being sued and losing a case.

Once abatement cost are calculated, in FarmWare, based on the different incentive packages, the future value of the A.D. system will be calculated into Microsoft Excel. The Future value is the future value of an asset or cash at a specific date in the future that is equivalent in value to a specified sum today (Investopedia.com 2005). Below is the future value formula which will be used for calculations.

$$FV_n = X(1+r)^n$$

Where: **n =** number of years

X = amount invested

r = interest rate

When abatement cost and future values are calculated, the joint probability of being sued and losing a litigation case will be estimated. In this study, to calculate the joint probability of losing a litigation case, it is required to have to settling cost from a similar case. Unfortunately, settling cost in dairy litigation cases is not attainable due to privacy issues. Therefore, assumptions were made on actual settling cost based on literature reviewed from previous cases. In the case of Waco, TX versus dairy farmers in

Erath County, TX, the average cost of legal representation was $107,142 per farmer involved in the case. Legal fees are 33% of actual settling cost, therefore the assumption, used to calculate the joint probability will be $324,675.

The joint probability will be displayed in terms of percent, by dividing the future value of an anaerobic digestive system by legal settlement cost. Results should show that the joint probability will differ based on financial incentive packages which are offered to the producer.

Results

Analysis was conducted in both FarmWare and Microsoft Excel to estimate the additional abatement cost and the future value of adopting an anaerobic digestive system. Below in Table 1.2 are the results of the calculations based on different financial packages offered to producers. As expected, joint probabilities differ based on incentives or financial packages. When the analysis was conducted using incentive packages of 100% grants with guaranteed electric buyback, the joint probability was only 7% with a future value of $21,737 and an abatement cost of $1,769. Further analysis showed an increase in the future value and joint probability when the guaranteed electric buyback incentive was omitted. The additional abatement subsidy increased to $2,262 with a future value of $27,795 and joint probability of 9%. When 10 year loan incentive packages were analyzed the results varied significantly compared to 100% grants. 10 year loans with guaranteed electric buyback estimated abatement cost to $7,111 with a future value of $87,381 and joint probability of 27%. As expected, these figures changed when electric buyback incentives were removed from the model with abatement cost increasing to $7,604 with a future value of $93,439 and a joint probability of being sued and losing of 29%.

Table 1.2

Calculated Future Value, required annual Abatement Cost, and the Joint Probability of being sued and losing a litigation case

	Abatement Cost	Future Value	Joint Probability[†]
100 % Grant			
Electric Buyback	$1,769	$21,737	7%
No Buyback	$2,262	$27,795	9%
10 year Loan			
Electric Buyback	$7,111	$87,381	27%
No Buyback	$7,604	$93,439	29%

To help clarify the results, if the joint probability of being sued and losing is greater than the calculated joint probability, a producer would be more inclined to invest in anaerobic technology for their operation to off-set risk of litigation. This analysis will also allow producers to decide whether or not to invest based on the future value, since it is difficult to forecast potential litigation against their operation. Therefore, if the monetary value of being sued in court was greater than the future value, a producer would

[†] All Joint Probabilities were calculated used a legal settling cost of $324,675.

invest to avoid legal actions against their operation. For example, in the case of having a 100% grant with guaranteed electric buyback, if the probability of being sued and losing is greater than 7% a producer would invest. Also, if the monetary settling cost of a lawsuit against their operation is greater than the future value of $21,737 a producer would invest to off-set any risk associated with litigation. A producer would use the same logic in making an investment decision regardless of which financial package that operation may have.

Summary and Conclusions

The findings obtained from both Farmware and Microsoft Excel point out joint probabilities varies depending on financial packages and incentives. These results offer a better explanation of how a rational dairy producer may decide to invest in this technology based on potential litigation or incentives.

Findings emphasize that dairy producer would be less likely to invest in A.D. technology, regardless of the joint probability, if they are not offered incentives compared to producers that have recieved100% grants. For example, producers that are financial responsible for installing an anaerobic digestive system for an operation would require an annual subsidy or abatement of $7,604 compared to $1,769 for an operation with no financial responsibility. Furthermore, producers that were offered 10 year loans are less likely to invest if the potential monetary value of being sued and losing is less than $93,439 or $87,381, respectfully. Otherwise, with the amount of capital required to install this technology ($260,000 to $500,000), there are no monetary incentives for that operation to make the financial commitment to install an A.D. system.

Installation of a dairy anaerobic digestion system will allow producers to reduce risk associated with class action litigation. This technological advancement will lead in the reduction of potential negative dairy externalities that have lead to legal against producers in the past. Along with the positive attributes of anaerobic digestion and the increased trend of litigation cases against dairy producers, the increased adoption of this technology should continue to increase if producers are offered incentives.

Even though this study is based on an assumption of litigation settling cost, the findings display what potential factors could drive a producer to adopt this technology based on incentive packages offered. Finally, the results of this study provide evidence that without the threat of being sued or having incentives offered, producers will be less likely to adopt A.D. technology if it does not act as a revenue source for an operation.

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