Case Study

Bob Aman, AA Dairy, Candor, NY

Carbon-Trading Opportunities for Anaerobic Digesters: Estimating methane emissions and offsets

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Manure management strategies were evaluated for methane, a potent greenhouse gas
According to a 1992 EPA report (Safley, Casada, Woodbury, & Roos, Global Methane Emissions from Livestock and Poultry Manure, EPA/400/1-91/048), 20% of NY dairy manure was stored as liquid/slurry. This produced 16,067 metric tons of methane (CH_4) and accounted for 47% of NY State dairy manure methane emissions. To compare, daily spread which accounts for 70% of dairy manure handling, produced 14,058 metric tons of methane and accounted for 41% of the dairy manure methane emissions. The remaining 10% of manure handling was solid storage which accounted for 12% of the dairy manure methane emissions. Liquid/slurry storage produces the most methane (CH_4). While daily spread has the lowest methane emissions of the three systems compared, it has other associated environmental problems such as nutrient runoff affecting water quality, etc. This case study does not address the greenhouse gas impact of nitrogen emissions.

Table I: Methane emissions from three major manure management strategies

Manure Management Strategy (1992, NY, EPA)	% handling practice	% methane emissions	Metric Ton CH_4/year
Liquid/slurry	20%	47%	16,067
Solid storage	10%	12%	4,017
Daily Spread	70%	41%	14,058
Total	100%	100%	34,142

Capturing methane
Capturing methane produced by anaerobic storage conditions and combusting it (for heat, with a flare, or in a generator to produce electricity) offers solutions for mitigating methane production on farm. While methane (CH_4) is 23 times more potent a greenhouse gas than carbon dioxide (CO_2), if combusted, methane is converted into carbon dioxide, thus reducing its impact to the atmosphere. A covered liquid/slurry storage unit that flares the methane has a net benefit to the atmosphere. Using this methane for heat or electricity can also displace the greenhouse gas emissions from fossil fuel generated heat or electricity. However, it is important that no methane leaks from the system. Anaerobic digesters address odor associated with storage, increase flexibility for nutrient management and destroy methane emissions associated with manure. There are at least 16,067 Metric Tons (MT) of CH_4 produced by liquid slurry storage systems in

NY State (based on 1992 numbers) that could be captured and combusted. Combusted methane can be sold on carbon-trading markets to mitigate climate change.

Carbon-trading, Regional Greenhouse Gas Initiative (RGGI), and offsets

Methane (CH_4) is 23 times more potent a greenhouse gas than carbon dioxide (CO_2). Producing methane contributes to climate change; destroying methane reduces the impact on the climate. Documented destruction of methane can be sold on carbon-trading markets.

Voluntary trading is already occurring in the United States on the Chicago Climate Exchange (CCX, www.chicagoclimatex.com). As of December 20, 2005, seven Northeast states have agreed to the Regional Greenhouse Gas Initiative (RGGI) Memorandum of Understanding. This is a basic Cap and Trade Program, still under development, aimed at regulating CO_2 emissions from fossil fuel-fired electricity generating units greater than 25 megaWatts. This program is currently scheduled to begin on January 1, 2009 instituting a 2-phase cap. The current agreement sets the first cap to stabilize CO_2 emissions by the end of 2015 from these power plants at 121,253,550 short tons of CO_2. The second cap is currently a further 10% reduction to be met by 2019. These emission reductions can be achieved by several different means at the site of the regulated power plant such as co-firing biomass or increasing efficiency beyond normal economic benefit. Power plants can also purchase offsets.

Effectively one third of the 10% reduction goal can be met by ***offsets***. Offsets are greenhouse gas reductions achieved by non-regulated market participants. Greenhouse gas mitigation achieved by non-regulated parties can be purchased as offsets by a regulated power plant to meet the required cap. Offset opportunities relevant to farms in the Northeast currently include methane capture from farming operations, end-use efficiency for natural gas, propane or heating oil, and afforestation (transition of land from non-forested to forested state).

Table II. Regional Greenhouse Gas Initiative cap and maximum offsets allowed

RGGI	Short tons CO_2e	Metric Tons CO_2e*
Cap I(2015)	121,253,550	109,998,795
Cap II(2019)10% Below Cap I	109,128,195	98,998,916
Allowable Offsets	40,013,672	36,299,603

*note, this paper has kept all units in CO_2e *not* Ce. To convert to Ce, multiply by (12/44)

The anaerobic digester at AA Dairy

In 1996, Bob Aman installed a lined earthen manure storage and anaerobic digester system at the AA Dairy to reduce odor for his 500-cow dairy. His previous manure management practice was daily spread. The digester was designed for 1000 cows. Biogas production began in November 1997, and by June 1998, the digester was fully functioning. In the winter of 2004/05 fuel oil was required to keep the digester warm due to temporary complications with Rumensin affecting the ability of the bacteria to produce biogas. There was a problem with the gas meter not recording the electricity produced for several months. Bob Aman is also aware of methane leaks from his system.

In 2004, there was an average of 534 lactating cows. The average biogas production was 68.3 cubic feet/cow/day with a 40 day retention time in the digester. The biogas was ~ 62.7% methane. This resulted in 387,589 kwh of electricity produced from the generator while the farm used 333,608 kwh that year (David Belcher, Personal Communication). While dollar values can be estimated according to one's local electric prices, on peak and off peak demand makes the calculation more complicated. Regardless, this electricity is independent of grid price flux and offers an on-farm form of alternative energy.

Carbon-credits from methane destruction

In 2004, there were an estimated 160 tons of methane (CH_4) produced by the AA Dairy digester. Methane is 23 times as potent as CO_2; CH_4 can be converted (multiply by 23) to CO_2 equivalents (CO_2e) – the standard unit of carbon trading. Thus the methane produced at AA Dairy is equivalent to 3,675 Metric Tons (MT) of CO_2e. *If* we assume 66% of the total methane would have been produced in a baseline scenario – a liquid manure storage unit for one year in a northern climate without a digester (David Belcher, Personal Communication), 2,431 MT CO_2e of methane emissions would have been created by an open liquid/slurry storage unit but instead are captured and destroyed (ie, mitigated) by the digester/generator. Under this scenario, there is an additional 1,244 MT CO_2e (34% of 3,675 MT) of *intentionally* produced methane by the digester. Policy makers will need to decide if *intentional* methane produced should be counted as mitigation of greenhouse gases. Food waste which is added to the digester should also be considered *intentional* methane production if it was not producing methane under the previous disposal methods. However, the fossil fuel emissions displaced by producing electricity from such an activity are likely to be tradeable. As there is no accurate way to measure leakage of methane from a digester, this analysis does not include the greenhouse gas impact of such leakages. The discussion below explains how the discounting of saleable credits compensates for methane leakage and other unknowns.

Carbon-credits from fossil fuel displacement by electricity generation

In the case of the AA Dairy for 2004, we can calculate roughly the amount of greenhouse gas emissions avoided based on NYSEG's (NY State Electric and Gas) energy portfolio. The AA Dairy draws its electricity from NYSEG which is generated from 32% coal, 9% hydroelectric, 23% natural gas, 17% nuclear and 18% oil. Using an estimate of 0.76 lbs of CO_2e per kWh from the NYSEG portfolio, 134 MT CO_2e were avoided by producing 387,589 kWh from methane. Because AA Dairy has a net metering agreement with NYSEG, it is still unclear who owns these credits (AA Dairy – the producer, or NYSEG – the distributor). It is also unclear if these credits can be sold (recognized) because the digester was subsidized by New York State Energy Research and Development Authority (NYSERDA) grants.

Rules for carbon-trading

Date of implementation

As mentioned before, a voluntary trading market already exists, the Chicago Climate Exchange (CCX). Under CCX rules, individuals who destroyed methane beginning January 1, 1999 are eligible to sell their greenhouse gas reduction emissions on the public market. Because AA Dairy started making electricity in 1997, it would not be eligible to sell credits under CCX guidelines. However, it is possible that other trading entities would recognize these credits as acceptable trading units. The Draft Model Rules for trading under the Regional Greenhouse Gas

Initiative (RGGI) are scheduled to be announced this spring followed by a 60-day public comment period (www.rggi.org/agreement.htm).

Going price per metric ton CO_2e (February, 2006)
Currently on the CCX market, a ton of CO_2e is selling for $2.15. On the European Climate Exchange (ECX) which has its own rules, the current price is $29.95. The RGGI 'safety valve trigger' price per ton of CO_2 equivalents is currently set at $7.00/short ton of CO_2e. A simple interpretation of the trigger price is the *maximum price* one could receive under RGGI in 2009.

Discounting units
Until the extent of methane leaks from digester systems are more reliably understood (a 4% leak of methane from the AA Diary digester would equal all the GHG associated with AA Dairy electric purchase from NYSEG), perhaps those who operate anaerobic digesters should sell only the destruction credits from the methane derived by their manure storage and combusted by the generator. In essence, this is a kind of *discounting* of the *intentional* methane produced/destroyed beyond what an open liquid manure storage unit would have emitted. The scenarios in Table III present the *potential* offsets and are multiplied by the different trading values to explore market effects.

Table III. Possible saleable offsets by type (in CO_2e) at AA Dairy (annual basis):

Potential AA Dairy credits	Metric Tons CO_2e	CCX February, 2006	RGGI Trigger price*	European Market February, 2006
Price/MT CO_2e		$2.15	$6.35	$29.95
Liquid manure CH_4	2,431	$5,227	$15,440	$72,831
AD Intentional CH_4	1,244	$2,674	$7,899	$37,262
On Farm Electricity	115	$247	$730	$3,445
Electricity sold to grid	19	$40	$118	$557
Total	3,809	$8,189	$24,187	$114,095

*this would be the maximum price under RGGI in 2009; $7.00/short ton = $6.35/metric ton

Table III separates offsets by type without discounting. Table IV calculates credits under CCX rules. To calculate the credits under CCX rules for methane destruction (flares or electric generators installed on or after January 1, 1999), total tons methane destroyed was *discounted* by multiplying by 18.25 instead of 23. The scenarios presented in Table IV use the current rules for CCX and the various market prices to illustrate the market range for AA Dairy if it were eligible, and for all liquid manure management strategies based on 1992 NY State data from US EPA.

Table IV. Three trading price estimates under CCX rules: AA Dairy & NY liquid manure

CCX Rules	Metric Tons CH_4	$CH_4 \rightarrow CO_2$e Conversion factor: 18.25	CCX February, 2006	RGGI Trigger price	ECX February, 2006
$US/MT CH_4 destroyed			$2.15	$6.35	$29.95
AA Dairy CH_4 destroyed	160	2,916	$6,270	$18,519	$87,356
NY State Liquid	16,067	293,223*	$630,429	$1,862,041	$8,783,487

manure CH_4 destroyed (1992)					

* 293,223 CO_2e from NY manure is 0.8% of the 36MMTCO_2e approved offsets under RGGI.

"If I were getting paid $114,095 per year, I'd plug every damn leak." – Bob Aman
Bob Aman's comment reflects how carbon-trading policy *could* affect farm operations and financial stability. Table IV clearly shows the futures market associated with voluntary carbon-trading in the United States in anticipation of regulation. The ECX rate is 15 times greater than the CCX rate due to the legally binding adoption of the Kyoto Protocol in Europe. Increase in value for carbon-credits will encourage farm activities that mitigate greenhouse gas emissions.

Marketing renewable-fueled milk products as value-added
In the meantime a farm generating its own electricity with biogas can market their dairy products as being made with renewable energy thus adding value to their dairy products (see SILK wind powered campaign, http://www.eere.energy.gov/greenpower/buying/pr/0203_whtwave_pr.html).

The tables presented are scenarios only, the rules for trading offsets are evolving.
Recognize carbon trading is a futures market.
Pay close attention to the language, percentages, and time frame in contracts.