Cost-effective and Environmentally Beneficial Dairy Manure Management Practices

A Report Prepared By:
National Dairy Environmental Stewardship Council

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Executive Summary

Dairies are under increased pressure to address air and water quality impacts from their operations. Every dairy farm is unique, and the more options dairy producers have for sustainable manure management, the more likely the farm will be able to comply with environmental regulations and continue to operate profitably. Fortunately, effective and economically advantageous management practices and technologies, designed to handle manure in environmentally sound ways, do exist. These practices are being tested and used successfully on dairies across the United States.

In recognition of the need for technology transfer and policies that support innovation, two nonprofit environmental organizations, Sustainable Conservation and Environmental Defense, teamed up to form a National Dairy Environmental Stewardship Council (NDESC), a group of manure management specialists from dairy producer and environmental organizations, USDA, U.S. EPA, academic researchers and extension agencies. The objective of the NDESC was to identify innovative and successful dairy manure management options that are both environmentally beneficial and economically viable, and to recommend strategies for increased adoption of these practices.

The NDESC focused on technologies or practices that warrant increased promotion and adoption, as well as those that are promising and worthy of further research. The outcome of these efforts is this final report, available online at http://www.suscon.org/dairies/ndesc.asp, that highlights a selection of the most promising dairy manure management options for various regions and dairy farm sizes, successful models for implementation, and policy strategies to promote wider adoption.

Recommendations for fostering innovative manure management practices through cost-share programs and through communications and technology transfer are also provided in the section "Innovations Through Cost-Share Programs".

Introduction

Dairies in the U.S. are under increased pressure to address air and water quality impacts from manure, while simultaneously providing milk products to a growing population. Since the 1950s, the U.S. population has almost doubled and consumer demands for milk and milk products have grown commensurately. At the same time, intensification to achieve economies of scale has led to a decline in the overall number of dairy farms and an increase in average herd size. Suburbanization has driven land prices up in many of America's rural areas, and owning enough land to dispose of manure in an environmentally responsible manner is getting more difficult.

Further, federal, state and local environmental regulations are requiring many producers to change the way they manage manure. The challenge now facing the U.S. dairy industry is to identify manure management strategies and technologies that will help them comply with environmental regulations and that are cost effective. Fortunately, many dairy farmers in the U.S. are rising to these challenges, and innovative manure management technologies and strategies that meet both goals are being used successfully on dairies of all sizes across the nation.

The National Dairy Environmental Stewardship Council (NDESC) was formed to identify innovative manure management strategies that are working on profitable dairies and help producers comply with environmental regulations. The goal of this report is to communicate these strategies to the industry. The NDESC is a small group of manure management specialists from a variety of backgrounds. They come from across the U.S. with members drawn from dairy trade groups, U.S. Department of Agriculture, U.S. Environmental Protection Agency, academic and extension manure management specialists and environmental organizations. All of the members are in agreement that dairies need financially realistic options for reducing environmental impacts.

In light of new EPA confined animal feeding operation (CAFO) rules, balancing nutrient land application with crop requirements will be required for many dairies. Technologies and practices that can help producers achieve this goal can be categorized into two main categories: those that assist producers in matching manure nutrients to crop production on the farm and those that facilitate capturing nutrients in manure for more efficient use on the farm and/or exporting them off the dairy for use on other farms. Both of these strategies prevent the loss of nutrients to the environment.

Developing and implementing a nutrient management plan is generally the most logical first step toward achieving farm nutrient balance. With a nutrient management plan, producers have the information they need to land apply manure at rates that keep nutrients in the soil and crops, and out of the air and water, or to determine the amount of manure nutrients to be exported off the farm. This report contains examples of technologies and practices that can assist producers in matching and capturing nutrients. The first section of the report focuses on strategies for matching manure nutrients to crop needs and includes strategies for feed management, land application, management intensive grazing, and land swapping.

The second section features technologies for capturing nutrients and includes strategies that separate solids and liquids, aid in the transport or storage of manure, or treat or stabilize manure nutrients. Some of these strategies are also beneficial for addressing air quality impacts from manure, such as odor and gaseous emissions. In addition to descriptions of each treatment or management practice, the report describes experiences of dairy producers successfully using these technologies and practices, along with sources of available cost-share programs and technical information.

The report also describes a few of the promising technologies still under development, but worth considering in the future. Recommendations for fostering innovative manure management practices through cost-share programs, communications and technology transfer are provided.

Matching Manure Nutrients to Crop Needs

The technologies and management practices featured in this section are strategies that dairies across the U.S. are using to successfully match manure nutrients with crop nutrient uptake.

I. Feed Management

Operational advantages: Eliminating excessive phosphorus and nitrogen in dairy cow feed provides a cost savings, in many cases, by eliminating unnecessary supplements without lowering milk production. It also corresponds to decreased concentrations of nutrients in manure, which can provide increased flexibility for land application and reduced risk of nutrient loss to air and water. It further brings nutrient loaded soils into balance sooner and may allow for herd expansion.

Recommended region and farm size: This approach is suitable for all regions and dairies of all sizes.

Reducing phosphorus levels in manure

In regions of the U.S. where dairy producers must manage manure to minimize phosphorus loss to surface waters, excess manure phosphorus increases the acreage required for land application. Despite the environmental management drawbacks, dairy cows in the U.S. are typically fed 20-25% more phosphorus than is recommended by the National Research Council (NRC) (Figure 1), often in the form of mineral supplements.

Recent research has established that excess phosphorus fails to add to either milk production or reproductive performance, and phosphorus in manure from cows fed high-phosphorus diets is 2 to 4 times more vulnerable to surface runoff than manure from cows fed diets according to NRC recommendations. In many cases, excess phosphorus in dairy cow diets comes from mineral supplements that can cost dairy farmers $15 per cow per year. Eliminating excessive phosphorus in dairy cow diets provides major environmental benefits while saving producers money.

Kevin Buttles, a dairy nutrition consultant with Cooperative Services in Denmark, Wisconsin has about 20 customers who, for the past 4 to 5 years, have been feeding their cows phosphorus at NRC recommended levels with "absolutely no repercussions" on milk production and herd health. The only change dairymen have noticed is a positive one—it takes less land to apply manure according to phosphorus limitations.

Reducing nitrogen emissions by eliminating excess crude protein in cow diets

While most environmental concerns related to animal agriculture have focused on methods to mitigate phosphorus losses in runoff after manure application, there is an increasing awareness that ammonia losses from manure may adversely affect air quality. Ammonia production and loss associated with dairy cows is directly related to nitrogen in cow urine. When urine-nitrogen, which is largely in the form of urea, comes into contact with enzymes in solid manure, liquid ammonia is converted to a gaseous form and lost to the air, where it can combine with other pollutants to form particulate matter (P.M. 2.5, a precursor to ozone) and acid rain. Ammonia in the air can also rain down on surface waters contributing to nutrient pollution.

Reducing nitrogen in urine through diet manipulation can be a first and critical step in reducing ammonia loss from dairy farms. A recent study with high-producing Holstein dairy cows showed that increasing crude protein (a major source of nitrogen in cow diets) above 16.7% did not increase milk yield; it simply increased nitrogen concentrations in the urine. Feeding protein supplements with a favorable crude protein to phosphorus balance can reduce urine-nitrogen concentra-

tions and decrease air emissions of ammonia.

Recommendations for reducing dietary crude protein levels and enhancing the use of protein supplements are:

1. Know how much crude protein is being fed by keeping current on crude protein analysis of feed.

2. Diets should be balanced for rumen fermentability, for example by diluting hay silage with corn silage and feeding processed grains to improve rumen digestion (e.g., rolling of high moisture corn).

3. Diets should be balanced for rumen degraded and un-degraded protein.

4. Feed to precisely meet animals' requirements by grouping cows according to level of production and managing the herd for high dry matter intake.

5. Monitor milk yield when lowering diet crude protein (so you don't go too far).

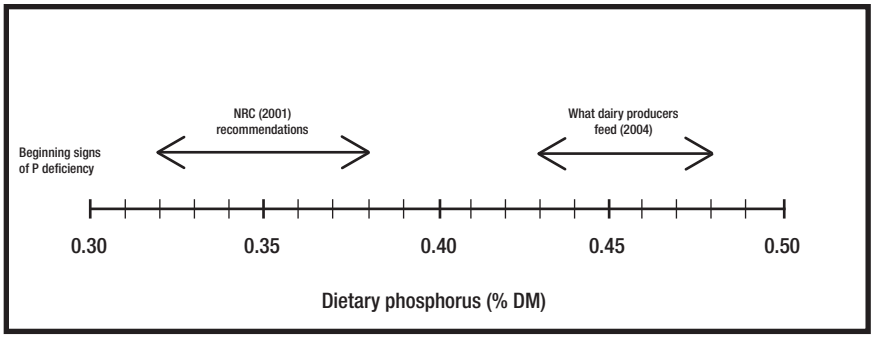
Additional Resources

Dairy Cattle Nutrition and Feeding Website. Penn State's Dairy Cattle Nutrition Group: http://www.das.psu.edu/dcn/

Feeding Management to Reduce P Loss from Dairy Farms, by Katherine Knowlton, Virginia Tech's Dept. of Dairy Science: http://www.dasc.vt.edu/extension/nutritioncc/kfk2000a.pdf

Livestock and Poultry Environmental Stewardship Curriculum Lesson 12 - Feeding Dairy Cows to Reduce Nutrient Excretion, available from the MWPS at: http://www.lpes.org/Lessons/Lesson12/12_Cows_Excretion.html

Figure 1. Phosphorus in dairy diets versus NRC recommended levels (NRC, 2001)



Bottom line for dietary nutrient management: Don't feed it if they don't need it!

II. Synchronized Rate Nutrient Application

Operational advantages: Producers using synchronized nutrient placement have been able to reduce or eliminate fertilizer purchases, while land applying lagoon liquids in a way that protects groundwater from contamination.

Recommended region and farm size: This approach is suitable for farms of all sizes that land apply lagoon liquids via irrigation.

Dairy producers in the Central Valley of California are protecting groundwater, maintaining crop yields, and saving money using an approach called 'synchronized rate nutrient application', a lagoon water application strategy that maximizes crop uptake of nitrogen and minimizes the opportunity for manure nitrogen to leach to groundwater. In a study where synchronized rate nutrient application was used to supply nearly all the crop needs for five years, groundwater nitrate concentrations were reduced by over 50% in an area with sandy soils and high water table.

Crops grown in the Central Valley are typically irrigated every 7 to 10 days in the summer. Synchronized rate nutrient application involves determining how much nitrogen the crop needs according to its stage of growth and injecting into the irrigation water just the amount of lagoon liquids that will supply the crop with the amount of nitrogen the crop will need between the current and next irrigation.

Adjusting the flow meter

Dairy farmers using synchronized rate nutrient application have installed flow meters that allow them to control the rate of lagoon water application. On the day of irrigation, a nitrogen quick test analysis is performed using a simple field kit to determine the concentration of nitrogen in the lagoon water. The flow rate that will provide the desired amount of nitrogen to the crop is calculated based on the concentration of nitrogen in the lagoon water and the expected duration of the irrigation. Flow rates are determined using either a computer program or a look-up table.

Measuring lagoon water nutrients with a nitrogen quick test

After the irrigation, the actual number of gallons applied is entered into a spreadsheet that calculates the amount of nitrogen that went on the field and projects the amount needed for the next irrigation.

The control of nutrient application rates using this approach has allowed producers to reduce and, in some cases, eliminate commercial fertilizer purchases without sacrificing yields.

Jeff Strom, of Clauss Dairy Farms in Hilmar, California, (milking 4000 Jerseys on three dairies) has been using only nutrient water to grow corn for the last five years. Every year, he says "we save about $80 per acre on corn and forage fertilizers." For the Clauss Dairy's 500 acres, that translates to a cost savings of $40,000 per year, with no decrease in yields. Strom considers synchronized rate nutrient application "good for water quality and dairymen."

Other Central Valley producers report cost savings associated with not having to purchase commercial fertilizers in the range of $60 to $100 per acre. As far as the time involved in managing the system, according to Strom, "once this system is in place, it doesn't take all that much more time to manage than ordering fertilizers, and any extra time spent is well worth it considering the cost savings and the benefit to the environment."

Additional Resources

University of California Cooperative Extension's dairy lagoon management webpage:
http://groups.ucanr.org/LNM/index.cfm

Irrigating with lagoon water

III. Draghose Systems

Operational advantages: With draghose systems, manure is incorporated in the soil at the same time it is land applied, thereby eliminating a tillage operation. Immediate incorporation reduces nitrogen losses, improves soil quality, reduces runoff and significantly limits odor associated with land application of manure.

Recommended region and farm size: Draghose systems are suitable for any size farm in regions where manure is land applied periodically during the year.

Draghose liquid manure application systems are being used on dairies in the Midwest and East Coast as an alternative to conventional truck and tank application. A draghose system uses an irrigation pump to send the manure through a flexible hose to a tractor. The tractor pulls the hose and a tillage implement that immediately incorporates the manure.

According to Scott Potter, a custom manure applicator with Dairy Support Services in Truxton, New York, "many of my customers prefer draghose application because manure is directly incorporated into the soil." Not only does immediate incorporation keep nitrogen from volatilizing into the air, thereby increasing the nutrient value of the manure, it reduces odors as well.

For the last nine years, Tim Fessendon of Fessendon Dairy in Kings Ferry, New York (milking 650 Holsteins) has been using Potter's services to apply manure with draghose systems on 150 acres. Fessendon considers the cost of hiring a custom applicator comparable to costs associated with using a typical tanker and trailer approach, however, the drag hose system "gets the job done quicker and more efficiently," with minimal soil compaction. "A tanker and trailer type spreading system ties up 3 to 4 people and maybe applies 500 gallons per minute on a good day. With the draghose system, one operator can apply manure twice as fast, non-stop."

Ed Larson, of Larson Acres in Evansville, Wisconsin (milking 1,400 Holsteins) used a custom applicator for the first few years, but when he expanded his herd from 800 to its present size, he opted to purchase his own equipment. Larson considers the draghose system to be the simplest and most cost-effective way to land apply lagoon water, although he cautions that this approach works for him because his land is nearby (within 3 miles of the dairy). For Larson, reduced odor and soil compaction, as well as immediate incorporation, are major benefits. "With the draghose, we can inject the lagoon water, keep the odor down, and keep the neighbors happy."

Keeping the neighbors happy is also a major objective on the Fessendon Dairy. "We are able to apply manure to fields in close proximity to non-farm neighbors for the first time without any odor issues, and we've had positive feedback from neighbors. They appreciate this method of land application." As far as Fessendon is concerned, if more dairymen used draghose systems, "there would be a lot less public concern about odor from land application."

Additional Resources

Cornell Manure Management Program website:
http://www.manuremanagement.cornell.edu/HTMLs/LandApplication.htm#DragHose

IV. Management Intensive Grazing

Operational advantages: In some situations, a shift from confinement or continuous grazing to management intensive grazing can improve farm profitability by reducing input and labor costs, while also decreasing soil erosion, reducing barnyard runoff, reducing soil phosphorus levels, and improving the overall farm nutrient balance.

Recommended region and farm size: Management intensive grazing is an option in all parts of the country where quality forage is available. In winter months, however, confinement will likely be required in northern areas. This approach is most commonly used on small to medium sized dairies with access to adequate land base for herd size. However, it is being carried out in Florida with herds of 1000 head.

Management intensive grazing (MIG), also known as rotational grazing, decreases costs associated with milk production by moving cows out of confined areas into pastures. With MIG, cows are rotated through multiple paddocks and timing, distribution, livestock type, and stocking rate are managed to achieve optimal pasture forage quality, livestock growth, and protection of water quality. As with any other strategy, successfully shifting to MIG, from both environmental and economic perspectives, depends upon sound planning and good management practices and requires an assessment of the farm's existing nutrient management practices and production goals. Poorly managed grazing systems can increase nitrate leaching, have a negative effect on water quality beneath pastures, decrease forage quality and quantity, and negatively impact herd health and productivity. Key considerations include whether a farmer is willing to make the infrastructure and management changes required, the availability of technical assistance and support, and production goals. While milk production per cow may decrease, overall profitability can increase significantly due to decreased labor and input costs.

Dave Forgey of Forgey's River-View Farm, on the shores of the Wabash River in Logansport, Indiana (milking 175 Holsteins) first got interested in MIG when he was looking for a way to reduce production costs to stay competitive with larger dairies. He began experimenting with MIG in 1991, and a year later, shifted his whole herd from the barns to the fields using this approach. "At the time, we were looking for a way to stay in business - we weren't even considering the environmental benefits."

Since adopting MIG, Forgey has increased his per cow net profit threefold, to around $1,000 per cow annually. With MIG, cows spread their own manure, distributing it directly on the fields where forage is grown. MIG has eliminated the chore of collecting, moving, and land applying manure, and dramatically decreased the time, expense, and equipment required for tillage. "Once the pastures are established, there is no need to till them again. If we do need to do tillage for pasture improvement, we use no-till techniques."

Like Forgey, farm economics prompted Ralph Schlatter of CJ Natural Meats and Dairy, in Defiance, Ohio (milking 90, mostly Jersey and milking shorthorn crosses) to convert his dairy from confinement to MIG. "I grew up with conventional, confinement dairying, but it got to a point where we decided that if there was any way we were going to survive economically, it would have to be with grass-based grazing. If we hadn't adopted MIG, we would probably have been out of the dairy business seven or eight years ago." The MIG approach has allowed Schlatter to drastically reduce machinery and equipment usage, and he no longer does any combining or tillage.

Properly managed, MIG can have multiple benefits for the environment. Because manure is spread 'naturally' by the cows, slowly over time, the likelihood that land applied manure will runoff into surface waters is reduced. Avoiding regular soil tillage and maintaining well-established pastures saves time and money, while reducing soil erosion, compaction, and fertilizer requirements. Schlatter has reduced his commercial nitrogen application rate from about 125 pounds per acre to 35 pounds per acre per year. According to Schlatter "as far as land stewardship goes, I've just been amazed at what is happening on our farm since it's been in grass and clover. The soil has improved, we have dense sod and earthworm activity, and it takes a lot more rain to get water to run off our fields."

Both Forgey and Schlatter noted that for young people interested in starting out in the dairy business, MIG is a low cost way to get started.

Additional Resources

Greener Pastures: Is Managed Grazing Right for your Operation? Provides information on how to assess if managed grazing is right for your operation, including economic, time saving, and environmental benefits of managed grazing (University of Wisconsin-Extension Water Resources Programs):
http://clean-water.uwex.edu/pubs/grazing

Information on Managed Grazing from EPA's Office of Wetlands, Oceans, and Watersheds:
http://www.epa.gov/OWOW/NPS/MMGI/Chapter2/ch2-2e.html.

Grazing information from ATTRA - National Sustainable Agriculture Information Service:
http://www.attra.org/attra-pub/PDF/rotgraze.pdf

V. Land Swapping

Operational advantages: Land swapping is an arrangement where vegetable growers and dairy producers farm each other's land for a period of time. Rotating dairy forage and vegetable crops has economic benefits for the vegetable grower and dairy producers, and increases options for manure application for the dairy. Soils previously under vegetable production improve with the addition of dairy manure and forage crop production. Land swapping also breaks weed and pest growth cycles, allowing for reduced insecticide and herbicide use.

Recommended region and farm size: Any size dairy with high soil phosphorous levels that is close to a progressive crop farm can use this manure management technique. Both farm managers need to have long term plans and be able to stick to them.

Application of dairy manure at rates sufficient to meet forage crop nitrogen requirements typically results in the over-application of phosphorus, which can lead to high levels of phosphorus in soil and surface runoff and degradation of surface water quality.

However, high soil phosphorus levels—combined with the rich soil conditions that also result from the continual production of forage crops such as alfalfa and the regular application of manure—are ideal for vegetable crop production. In addition, fields that have been under forage rotations do not harbor populations of insects and other pests that feed on vegetables. Swapping dairy and vegetable crop land can provide significant advantages for dairy and vegetable farmers.

John Noble of Southview Farms in Castile, New York (milking 3,600 Holsteins at two locations) contracted with a vegetable grower to turn his nutrient rich soils from a management challenge to an economic asset. Southview Farm owns more land than it needs to grow forage, and now some of its fields are under a forage and vegetable crop rotation. Noble considers this arrangement an "opportunity for best use of their resources in the long term. If we can share some of our nutrient resources with the vegetable crop grower, so that he or she doesn't have to buy those fertilizers, it makes a whole lot of sense. It's an advantage to them and an advantage to us - it's a win-win situation."

Technologies and practices featured in this section are methods producers are using to capture manure nutrients successfully. These technologies are related to the transport (movement), storage, or stabilization of manure nutrients for the purpose of protecting air and water quality.

VI. Wet Manure Collection with Honey Vacs

Operational advantages: Honey vacs remove manure from confinement areas using a powerful vacuum that collects manure in a tanker, where solids can be transported to storage or off the farm. Honey vacs reduce flies and odors from freestall or feed lane floors without using water.

Recommended region and farm size: Honey vacs can be used on existing open lot and scraped dairies. They are currently used on facilities of all sizes and are suitable for any region.

"Honey vacs" are large, powerful vacuum tankers that can remove manure from dairy alleys or lanes. Honey vacs eliminate the need for flushing to clean freestall or feed lane floors and are a cost-effective way to transport and deliver manure having a high solids content. In operation throughout the west for a number of years, tanker capacity and collection capability can be scaled according to a dairy's operational needs. Typically, honey vacs are used to collect fresh manure and deliver it to storage, direct land application, or manure processing areas.

In the Chino Valley of Southern California, groundwater salt and nitrate concentrations are so high that dairy farmers are not allowed to land apply any manure at all.

To address this manure management crisis, the Milk Producers Council teamed up with Inland Empire Utilities Agency, a municipal sewage company located in Chino, and developed a system for collecting manure from local dairies and digesting the manure anaerobically, in a centralized digester. It is a win-win situation for the dairies and the utility company.

In Southern California, most dairy facilities are open dry-lot operations where dairy cattle loaf in open corrals and manure from those corrals is typically dry (~50% solids). Given the high solids content of the manure and the need to transport manure to the central digester, the participating dairies switched over to honey vacs for manure removal.

Dairy producers using honey vacs have reported a number of benefits, including a decrease in flies, odors, and water use, and an increase in herd health and production.

Dan Swager of Swager & Sons Dairy in Chino, California (milking 1,250 Holsteins) has been participating in the centralized digester program and using the honey vacs for nearly three years. He collects manure from the feed aprons and ships it to the centralized digester daily. The honey vacs require less work on his part and the feed apron cement is always clean. Before he started using honey vacs, he had to dry manure in the corrals. "The honey vac system costs me about the same as the flush system, but my cows are happier and more comfortable than before. Incidents of hoof disease and mastitis are down and the cows are cleaner and drier - they never have to walk in deep, wet manure." Plus, since his dairy is cleaner, "my farm is a better place to work."

Additional Resources

Loewen:
http://www.loewenwelding.com

Jako-Landbouw:
http://www.jako-landbouw.com/engels/index.html

Veenhuis:
http://www.veenhuis.com/uk/index.html

Unverferth:
http://www.unverferth.com

VII. Innovative Solid-Liquid Separation Systems

Operational advantages: Efficient solid-liquid separation systems, like weeping walls and double screen separators, give dairy producers greater control over manure nutrients. Separated solids often can be recycled on the farm as bedding or soil amendments, or sold or given away to neighboring farms and homeowners.

Recommended region and farm size: Solid-liquid separation is useful for dairies of any size and location.

Featured approach:
Weeping wall basins

The reality on many dairies is that the manure manages the dairy producer rather than the producer managing the manure. This is the case when hauling manure is the main task to accomplish on all suitable days, rather than performing other dairy or family functions.

Weeping wall basins provide flexibility in managing manure hauling tasks by providing extended storage periods for solid waste. Robert Sextro, of Sextro Dairy in Seneca, Kansas (milking 100 Holsteins and Brown Swiss Crossbreds) reported that "before we installed the weeping wall basin, we used to have to haul manure weekly. Now, depending on the weather, we haul manure about every three months." He estimates that the weeping wall basin is saving him 5 to 10 hours of labor per week.

With the weeping wall basins, liquid manure is loaded into the basin, and hauled directly out of the basin to the fields. Jack de Jong of River Ranch Dairy in Hanford, California installed a weeping wall that has "completely changed" the way he manages manure, allowing him to eliminate excavation costs. Before,"we would have to first excavate the manure out of the solid settling basin and dry it before we could haul it out to the fields. Now, we can take it right from the basin to the fields."

Weeping wall systems can remove 60% of the solids in manure and work well in conjunction with sand bedding. Solids from the basin can also be recycled as bedding.

In addition to savings in cost and labor associated with managing manure, the weeping wall basins produce manure of consistent quality that is a valuable soil amendment. On the River Ranch Dairy, nearby farmers pay to have the manure hauled to their fields. Robert Sextro of the Sextro Dairy said that with the old system, hauling manure was "a chore that we wanted to get done as quick as we could. Now, we plan land application of manure like we used to plan fertilizer application."

Weeping wall basins have been installed on dairies in at least 15 states, including California, Kansas, Georgia, Texas and Minnesota. They are being used on scrape dairies ranging in size from 20 to 1,500 cows and flush dairies ranging in size from 50 to 5,000 cows. For a basin providing 120 days of storage, capital costs range from $200 to $250 per cow.

Weeping wall basin

Featured approach:
The Dias double screen solid-liquid separator

Richard Dias, a dairyman in Kings County, California, used to have a solids settling basin that filled up every 30 days, and in the winter, when the solids did not settle, he had a sludge build-up in his lagoon. "It's the heart of winter and raining. You turn the pump on and pump down one foot and the lagoon is full of sludge. What do you do? I've been there."

So Dias invented a double screen solid-liquid separator that has made managing manure on his dairy a whole lot easier, a technology which he recently patented. With the Dias system, manure is screened twice - once for coarse solids, which are recycled as bedding, and the second time on a finer mesh screen to remove fine solids.

John Mello of J.D. Mello Dairy in Hanford, California (milking 800 Holsteins) has been using a Dias double screen separator for nearly three years. Neither he nor Dias has had to pump solids out of their lagoons since the separators have been up and running. Mello and Dias also have noticed a host of other benefits. Odor on their dairies is negligible. With the cleaner lagoon water, the freestall floors are less slick, reducing incidents of cow injury due to slippage. Plus, the fine solids make an excellent soil amendment. Mello and Dias let the neighbors take their excess solids, and they have had no problem getting rid of it.

Asked what he thinks about the recently awarded patent, Dias said, "I'm real proud. I knew I had a problem and I solved it. I feel real good about what we're doing now." Mello agrees, "you don't have to be an Einstein to see that this system is a plus for my dairy and the environment."

VIII. Dairy Manure Composting

Operational advantages: Composting can reduce separated manure solid volume by more than 50%, and produce a saleable product. Selling compost is a means by which dairy producers can reduce land application of manure and meet nutrient management plan objectives.

Recommended region and farm size: Composting manure and other organic residuals on farm can be done in most regions of the U.S. While northern regions may experience a period of low or suspended activity during winter months, even in cold climates, composting can occur year-round. Composting is appropriate on dairy farms of any size. A low moisture/high carbon amendment or solid separation facilities will be needed.

Composting transforms raw manure into a biologically stable material that makes an excellent soil amendment. Composting manure reduces the manure solids or raw manure and amendment mixture volume (by 50% or more), reduces odors, pathogens, and weed seeds, and produces a consistent product that can either be land applied on the farm, or sold to ornamental horticulture markets, landscaping companies, homeowners, and neighboring farms. Where acreage is insufficient to land apply manure, composting can be a cost-effective method for moving manure off the farm.

Important factors to consider when deciding whether to pursue composting include time, space, and labor. If the intent is to produce a saleable product, someone will have to monitor the piles, turn them regularly and market the finished compost. Also, depending on the level of sophistication, specialized composting equipment may need to be purchased or infrastructure installed, such as an impermeable surface on which to build and manage compost piles.

A range of technology options and management intensity levels for composting manure can be tailored to individual dairy farms depending on their size, location, and goals. If new to composting and the intent is to make compost for your own use, you might start out using a simple approach, turning the piles with a front loader. Later, if you decide to make a saleable product or expand your site, you might decide that you can justify the costs of more sophisticated equipment and more intensive management.

Case Study: Rosenholm-Wolfe Dairy, Cochrane, Wisconsin
(*http://www.rwdairy.com/index.html*)
The Rosenholm-Wolfe Dairy, located in central Wisconsin, has been producing and selling compost in addition to milk for the last 14 years. For John Rosenow and family, the decision to make and sell compost was primarily financial. In 1990, they had 300 cows and 300 acres. He would have needed almost 800 acres to land apply the manure. Based on phosphorus limitations, to expand to 600 cows, which they now milk, over 1,500 acres would have been needed. John Rosenow explained "we wanted to figure out a way that we could dairy without having to farm so much land." Composting was the most cost-effective option for achieving this goal.

Now, the Rosenholm-Wolfe Dairy composts all of its solids, leaving only the lagoon liquids for on-farm use. Solids from the separator are hauled to a two-acre asphalt pad, where the solids are allowed to dewater prior to composting. Rosenow uses a 14 foot self-propelled Scarab turner to turn the compost weekly.

Rosenow explained that good solids-liquid separation is key to composting and reducing odors. His cows generate about 12,000 cubic yards of solids annually. With composting, the volume is reduced to about 5,000 cubic yards, which has significantly reduced costs associated with hauling manure. Rosenow estimates that

his dairy spends about 10% of what it would take to haul and land apply all their manure, not to mention the time savings and equipment costs avoided by not having to farm 1,500 acres.

Marketing the finished product is a major part of the Rosenholm-Wolfe Dairy's success, for which compost sales have been generating a profit since 2002. Tested regularly for chemical and biological quality, finished compost is sold for $24 per cubic yard in bulk. Sales are divided between organic farmers (40%), landscape contractors (30-40%), and individual homeowners (20-30%), mostly within a 50-mile radius of the farm. John Rosenow does most of the marketing himself. Also, the Rosenholm-Wolfe dairy has a "free for neighbors" policy for the compost. They think this, along with sound lagoon management and reduced odors associated with not land applying manure solids, is a major reason why they do not get complaints about odor that so often plague dairies with residential neighbors.

By far the best thing about composting, from Rosenow's perspective, is that by avoiding manure hauling and land application, he is better able to focus his time and attention on running the dairy. "We make money on the barns, not the fields. Land applying manure on 1,500 acres would require us to be more crop farmers than dairymen, and pretty soon the focus of the business is on the farming, which isn't making much money, instead of on the cows which do make us money. And we are in the business to make money."

Rosenow's decision to adopt composting has definitely paid off. He has increased the herd size and avoided increased land requirements while being environmentally responsible with the nutrients produced. The end result is a dairy that is profitable and geared towards what Rosenow enjoys—being a dairyman.

Additional Resources

"The Art and Science of Composting", an Extension publication by Leslie Cooperband. It can be downloaded as a pdf file from the University of Wisconsin's Center for Integrated Agriculture (CIAS) website: http://www.cias.wisc.edu/archives/2002/03/01/the_art_and_science_of_composting/index.php

On-Farm Composting Handbook. Rynk R, 1992. Northeast Regional Agricultural Engineering Service Pub. No. 54. Cooperative Extension Service, Ithaca, N.Y.; 186pp. A classic in on-farm composting. $20 from NRAES, Cooperative Extension, 607-255-7654 or 607-254-8770. email: nraes@cornell.edu

Farm scale composting resource list from ATTRA - National Sustainable Agriculture Information Service: http://www.attra.org/attra-pub/farmcompost.html

Cornell Composting: http://compost.css.cornell.edu/composting_homepage.html

IX. Producing Renewable Energy with Anaerobic Digesters

Operational advantages: Anaerobic digesters produce biogas from manure, providing energy to run the farm. Because digesters capture methane and other air pollutants, they reduce harmful emissions from manure and provide superior odor control, while offsetting consumption and emissions from non-renewable fossil fuels. In regions where dairies can offset their electricity purchases with biogas-derived power, they are cost effective with potential payback periods of 3 to 6 years (depending on federal cost-share fund availability).

Recommended region and farm size: Anaerobic digesters are suitable for any region, and are an option for all farm sizes. Economies of scale and energy production favor larger operations, but odor control and other environmental benefits would be achieved for dairy farms of all sizes.

Anaerobic digesters are enclosed vessels that use bacteria to decompose manure (and other organic materials) and produce biogas, a mixture of mostly methane gas and carbon dioxide. They work similarly to the natural decomposition that occurs in a cow's stomach. The biological decomposition takes place in a "closed tank" or "covered lagoon". The methane gas that is generated can be captured and used directly (e.g. for heating water) or combusted in an engine generator to produce electricity for on-farm or off-farm use. The large supply of animal waste on most dairy farms insures a continuous supply of fuel.

Fixed-film anaerobic digester for flushed manure system

Anaerobic digesters on dairy farms can have significant environmental and operational benefits including reduced air pollution, decreased greenhouse gas emissions, and significant odor reduction. Digesters also reduce manure pathogens and inactivate weed seeds, while increasing the fertilizer value of manure.

Dairymen operating a digester and producing their own electricity can realize significant energy cost savings. As a rule of thumb, for every 100 lactating cows, you can generate 200 to 300 kilowatt hours per day of electricity. For a 550-cow dairy, that means over 600,000 kilowatt hours of electricity every year. At 5 cents per kilowatt hour, that translates into about $30,000 per year worth of electricity.

The most common types of methane digesters are: (1) covered lagoons (similar to storage ponds), usually with a synthetic membrane over it; (2) plug-flow digesters, which are typically large in-ground concrete tanks that use engine 'waste heat' to accelerate decomposition as the manure moves through the digester; and (3) complete-mix digesters (heated, steel or concrete tanks) that keep the solids in suspension. A fixed-film anaerobic digester design has also recently been developed.

Anaerobic digesters can be combined effectively with other manure management technologies. For flushed systems, primary treatment involving solids separation methods (mechanical screening and/or sedimentation) is used prior to digestion to remove non-degradable fibrous solids. For scraped systems, solids separation is used on the back end of a digester.

Digester Examples

Plug-Flow Anaerobic Digester for Scraped Manure

The Haubenschild Farm in Princeton, Minnesota (milking 830 Holsteins) installed a plug-flow digester more than five years ago in conjunction with operational expansion to produce energy, reduce odor, and improve the fertilizer value of their manure. Fresh manure is scraped from freestall floors and stored in a collection pit, where it flows by gravity into a 14,000 gallon mix tank. From there, manure is pumped into the digester twice a day.

The Haubenschild Farm digester has been producing electricity for more than 96% of the time of its operational life. According to Dennis Haubenschild, the original financial objective was a payback period of no more than five years, and they are meeting this goal. Plus, he really appreciates "not having to pay that electric bill each month."

In addition to odor control and improved fertilizer value of the manure, one of the most important benefits from Haubenschild's perspective is the contribution his dairy is making towards producing energy from renewable resources. "My digester is producing enough electricity to run my operation plus another 80 residential homes. I would like to see agriculture on the ground floor of renewable energy production, so we can change how people look at having a dairy in their neighborhood from 'not in my backyard' to 'yes in my backyard', because everyone benefits from

renewable energy."

Fixed-Film Anaerobic Digester for Flushed Manure

For the last five years, the Dairy Research Unit at the University of Florida in Gainesville (milking 500 Holsteins) has been successfully using a fixed-film anaerobic digester for reducing odor and producing biogas, with a portion of the biogas being utilized to heat hot water for the milking parlor. The milking herd is on total confinement in sand-bedded freestalls, and the cow alleys are flushed with recycled lagoon water. According to David Armstrong, the Farm Manager, "the digester is highly effective in its use and requires a minimum of attention and maintenance." Fixed-film anaerobic digestion is suitable for any livestock manure that is subject to dilution with water for transport or processing, such as dairy and swine manure. Also, fixed-film digesters operate at short hydraulic retention times, 2-4 days, and require a smaller footprint than other approaches — an important factor where the land base is limited or local planning issues are a concern.

Additional Resources

AgSTAR Program, U.S. Environmental Protection Agency.
http://www.epa.gov/agstar/

Anaerobic Digester Standards, National Conservation Practice Standards – NHCP.
http://www.nrcs.usda.gov/technical/Standards/nhcp.html

Cornell Manure Management Case studies and fact sheets at:
http://www.manuremanagement.cornell.edu/

Haubenschild Farm:
http://users.ecenet.com/hauby/farm-presentation.prz/odyframe.htm

Wilkie, A.C. (2003). Anaerobic digestion of flushed dairy manure. In: Proceedings – Anaerobic Digester Technology Applications in Animal Agriculture – A National Summit, p.350-354. Water Environment Federation, Alexandria, Virginia.
http://biosolids.org/docs/26241.pdf

X. Covers for Manure and Wastewater Storage Facilities

Operational advantages: Lagoon covers reduce odors from manure storage areas by 50 to 90%. The only direct cost savings that can be expected with a lagoon cover is that in humid regions impermeable covers would exclude the extra rainfall from the amount of material to be hauled to the fields. More importantly, as an odor control, the neighboring area impacted by a livestock facility may be reduced when a storage cover is installed. This may allow construction in closer proximity to residential or sensitive areas.

Recommended region and farm size: This approach is effective for all regions. Similar levels of odor control can be achieved for all sizes of dairy farms, however, economies of scale in the installation and purchase of cover material favor larger farms.

Short of anaerobic digestion and aeration technologies, lagoon covers offer the best opportunity for achieving significant reductions in emissions of odor and gases, such as hydrogen sulfide, from manure and wastewater storage facilities. Although lagoon covers are not commonly used in the dairy industry today, they have been used successfully in swine systems over the last five to eight years, and impermeable covers have long been used for odor control on municipal and industrial wastewater lagoons.

The most successful types of lagoon covers are (1) impermeable covers with a vacuum-based gas recovery system, (2) permeable geo-textile covers, and (3) straw covers.

When choosing a cover and evaluating options, several steps can help avoid common problems. For geotextile covers, ensure that the cover does not sink below the manure surface. Flotation devices can help. Also, some of the first lagoon cover products had poor resistance to ultraviolet light with lifetimes of about five years. However, newer products now use coatings to extend the lifetime of the cover material. Geotextile materials sometimes suffer from degradation in a storage lagoon, where the material stretches with rising and falling liquid levels. Proper selection of materials with sufficient "stretch" to accommodate rising and lower liquid levels addresses this problem. Designing the system to remove gas accumulations and prevent cover exposure to winds is also important.

Additional Resources

Larry Jacobson, Jeff Lorimor, Jose Bicudo, and David Schmidt. 2001. Lesson 43: Emission Control Strategies for Manure Storage Facilities. Livestock and Poultry Environmental Stewardship Curriculum. Midwest Plan Service, Ames, Iowa. 29 pages.
http://www.lpes.org/Lessons/Lesson43/43_Facility_Emissions.html

This section features a few examples of technologies that are still in development, but that are promising and worth looking out for in the future.

XI. Aquatic Cropping Systems

One promising future alternative to land application of manure is to concentrate manure nutrients in algal biomass by cultivating algae in engineered ponds or raceways. Converting the nitrogen and phosphorus in manure into algal biomass increases the value and manageability of the nutrients. Laboratory-scale research of benthic algae growth chambers to recover nitrogen and phosphorus from raw and anaerobically digested dairy manure has demonstrated great potential. Nutrient balance results showed that most of the manure nitrogen and nearly all of the manure phosphorus was taken up by the algae.

In comparison to a conventional corn-rye rotation, benthic algae production rates would require just 26% of the land area requirements for equivalent nitrogen-uptake rates and 23% of the land area requirements on a phosphorus-uptake basis. The algal biomass had a crude protein content of 44%, compared to 7% for typical corn silage protein content.

The dried algal biomass resulting from the treatment offers a valuable slow-release fertilizer that could substitute for commercial fertilizers used for potting systems, as well as a potential high-grade protein feed that could be used to replace a portion of the protein content of animal feed imported onto the farm.

The high productivity and nutrient removal capability of aquatic plants suggest that floating aquatic macrophyte-based treatment systems (FAMTS) also have potential for removing and recovering nutrients in wastewaters from livestock operations. The harvested biomass of floating aquatic plants, such as water hyacinth, water lettuce and pennywort, can potentially be used for composting, soil amendments, anaerobic digestion with methane production, and processing for animal feed. Since anaerobic digestion reduces the organic content and increases the bioavailability of manure nutrients, a combination of anaerobic digestion and FAMTS for dairy manure treatment may provide an effective integrated waste management system.

Use of aquatic cropping systems to concentrate manure nutrients is still in the research phase. Additional farm-scale research and economic evaluation are needed before aquatic cropping systems offer a viable manure treatment option for producers.

Additional Resources

Sooknah, R.D. and Wilkie, A.C. (2004). Nutrient removal by floating aquatic macrophytes cultured in anaerobically digested flushed dairy manure wastewater. Ecol. Eng. 22(1):27-42. doi: 10.1016/j.ecoleng.2004.01.004 available online at http://dx.doi.org

Wilkie, A.C. and Mulbry, W.W. (2002). Recovery of dairy manure nutrients by benthic freshwater algae. Bioresour. Technol. 84(1):81-91. doi: 10.1016/S0960-8524(02)00003-2 available online at http://dx.doi.org

XII. Waste-to-Energy Technologies

The processes of pyrolysis and gasification can convert biomass into fuels for use in internal combustion engines or turbines. Conventional direct combustion produces steam, which then is converted to mechanical energy via a steam turbine. These processes can be used to produce fuel, while reducing the volume of dairy manure and concentrating nutrients.

A number of challenges must be resolved first for this option to be ready for widespread adoption. Researchers are currently working to address performance issues related to the high moisture content of dairy manure, variability in manure quality, the need for a consistent and large supply of feedstock manure, the low fuel density and flame temperature of manure compared to coal, and the high capital and operating costs.

Despite these challenges, these waste-to-energy technologies may offer a future solution to waste management issues. Engineers at Texas A&M have developed an approach in which feedlot manure is co-fired with coal. This co-firing research showed that partially-composted, fine-ground cattle feedlot manure mixed with pulverized Wyoming PRB coal (10:90 fuel blend) overcame the variability problems encountered in earlier 100% feedlot manure fuel combustion tests.

Preliminary investigations of gasification combined with anaerobic digestion of dairy manure shows the potential to use manure solids for energy production on dairy farms. By integrating the gasification and microturbine system with anaerobic digestion, producers may be able to solve water quality and manure odor problems while providing a net benefit to the farm in energy production. A preliminary feasibility study on a dairy farm in New York showed that the gasifier/microturbine and anaerobic digestion combination should be able to almost double the current electrical power generation capacity of the farm compared to the digester alone. Further tests are needed to provide verification of performance and costs.

XIII. Alternative Herd Management

Cows and heifers can spend considerable time in outside areas, such as pastures, 'dirt lots', feed bunk areas, and barnyards. On average, 30-40% of the manure mass produced from a dairy operation is produced by non-lactating cows that do not need to be confined. Substantial gains in manure nitrogen recycling through crops can be achieved by corralling non-lactating dairy cows and heifers on cropland.

A research trial at the U.S. Dairy Forage Center in Wisconsin showed that crop nitrogen uptake in plots where heifers were corralled were higher than where barn manure was applied. This increase in crop nitrogen uptake in corralled plots continued for two complete corn silage-rye rotations indicating that the positive effects of winter corralling on crop nitrogen uptake may last for more than two years.

Next steps in evaluating the alternative herd management approach include collecting additional crop data on corn silage yields and nitrogen uptake and launching large-scale on-farm trials and economic analysis of manure management practices.

XIV. Innovations Through Cost-Share Programs

Innovative and more effective and cost effective approaches and tools for managing manure are essential if dairies are to meet their own goals and growing public and regulatory pressure to address natural resource challenges. Instead of focusing on traditional best management practices, research, incentives, and cost-share programs need to shift their attention to include technologies and practices that not only provide comprehensive solutions to manure challenges, but hopefully turn manure into a value-added product. While traditional best management practices should not be abandoned, identification and implementation of innovative and more effective options is critical to the future viability of the dairy industry and improvement of air and water quality and public health.

The upcoming 2007 Farm Bill will play a critical role in the implementation of innovative approaches to manure management over the next 5-10 years and beyond. It is critical that the 2007 Farm Bill provide financial and technical assistance to researchers to continue developing, and to producers to demonstrate and implement, improved and more effective technologies and approaches to resource management on dairy farms, and in agriculture in general. In particular, it is essential for the future of innovation and progress in manure management that Congress and the Administration increase funding in the 2007 Farm Bill for programs such as the Environmental Quality Incentives Program (EQIP), Conservation Innovation Grants Program, and Conservation Security Program (CSP) run by USDA's Natural Resources Conservation Service (NRCS); USDA's Agricultural Research Service (ARS); USDA's Cooperative State, Research, Education, and Extension Service (CSREES), US Environmental Protection Agency (USEPA) grant programs dealing with animal agriculture, and other related programs.

Among the key policy and programmatic recommendations of the Council are:

• The selection processes by which many state and federal programs award incentive and cost-share funds (also called "ranking systems") should encourage the adoption and implementation of innovative approaches and promising new technologies tied to achieving desired environmental goals and should reward higher levels of improvement toward defined environmental outcomes.

• Cost-share programs should encourage and fund demonstration projects developed specifically to illustrate defined environmental outcomes and benefits of promising new approaches and technologies.

• To ensure that NRCS funds are used for worthwhile, promising innovations and not wasted on untested or unproven technologies and practices, NRCS should work with key stakeholders in states or groups of states to form Technology Evaluation Teams composed of NRCS, ARS, and Cooperative Extension experts and qualified stakeholders and consultants to selectively evaluate proposed innovative projects and technologies.

• To ensure that the nation's producers and natural resources benefit to the greatest extent possible from the funds and valuable discoveries of ARS, Congress and the Administration should require that ARS, Land Grant Universities, NRCS, USEPA, Cooperative Extension, and other relevant agencies develop and maintain a more structured and coordinated means of technology transfer.

• Congress and the Administration should provide funding and direct NRCS to create a more comprehensive and ongoing mechanism to provide training as well as follow-up for operational and maintenance support to technical and field staff. This training should include developments in conservation science, environmental regulations, and effective tools and technologies for meeting conservation goals and operational needs.

XV. National Programs

Environmental Quality Incentives Program

Purpose: Provides financial and technical assistance to install or implement structural and management conservation practices. Sixty percent of total funds is targeted to projects involving animal agriculture. Water and air quality are two of the four national priorities. EQIP can be used for manure transport, composters, solids separators, land application of nutrients, and related equipment. EQIP is also open to new technologies and practices that have demonstrated effectiveness. To leverage EQIP for these new approaches, stakeholders, in cooperation with NRCS, need to develop an interim practice standard for that technology or practice.

Eligible recipients: Farmers and ranchers. EQIP can fund both individual and multi-farmer projects.

Cost sharing: Up to 75% of the costs of conservation practices or incentive payments for management practices.

Funding: Average of $1 billion per year from 2002-2007. Per project maximum funding set at $450,000.

How to apply: Contact local or state NRCS office.

Website: http://www.nrcs.usda.gov/programs/eqip/index.html

EQIP Conservation Innovation Grants Program

Purpose: Voluntary, competitive grants program intended to accelerate technology transfer and adoption of promising technologies and approaches to address some of the Nation's most pressing natural resource concerns.

Eligible recipients: Non-Federal governmental or non-governmental organizations, Tribes, or individuals. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with Federal, State, and local regulations.

Cost sharing: 50% non-federal match. No more than 1⁄2 of match may be in-kind.

Funding: Funded as a subprogram of EQIP. FY04 funding set at $41 million. In future years, there could be State CIG programs in addition to the national program.

How to apply: Respond to RFP, anticipated in early spring each year.

Website: http://www.nrcs.usda.gov/programs/cig/

Renewable Energy Systems and Energy Efficiency Improvements Program: Section 9006 of 2002 Farm Bill

Purpose: Establishes a grant, loan, and loan guarantee program to assist eligible farmers, ranchers, and rural small businesses in purchasing renewable energy systems for making energy efficiency improvements.

Eligible recipients: Farmers, ranchers, and rural small businesses.

Cost sharing: Grant amount not to exceed 25% of activity funded. Combined loan/grant not to exceed 50% of the cost of activity funded.

Funding: 2002-2007, $23 million per year. FY03 funding activity: 47 biomass projects ($11.5 million), 35 wind projects ($7.4 million), 6 solar projects ($700,000), 2 hybrid projects ($600,000), 24 energy efficiency improvement projects ($1.5 million). FY04 funding activity: $22.9 million total.

How to apply: Respond to annual RFP.

Website: http://www.rurdev.usda.gov/rbs/farmbill/index.html

Biomass Research and Development Program: Section 9008 of the 2002 Farm Bill

Purpose: Support of research, development, and demonstration projects on biobased products, bioenergy, biofuels, and biopower.

Eligible recipients: Institutions of higher learning, federal and state research agencies, private sector entities, non-profit organizations.

Cost sharing: Minimum 20% non-federal.

Funding: Discretionary funding -- $24 million authorization.

Website: http://www.bioproducts-bioenergy.gov/

Value-Added Grants Program

Purpose: To assist with marketing of value-added products. Grants may be used for planning activities and working capital for marketing value-added agricultural products and for farm-based renewable energy.

Eligible recipients: Independent producers, farmer and rancher cooperatives, agricultural producer groups, and majority-controlled producer-based business ventures.

Cost sharing: 1-1 match required from the applicant or a third party.

Funding: $14.2 million discretionary funding for FY04. The maximum amount that can be awarded is $500,000. Priority is given to projects under $200,000.

Website: http://www.rurdev.usda.gov/rbs/coops/vadg.htm

EPA Clean Water State Revolving Loan Fund

Purpose: Fund a wide variety of water quality projects including all types of non-point source, watershed protection or restoration, and estuary management projects, as well as more traditional municipal wastewater treatment projects.

Eligible recipients: Range of borrowers including municipalities, communities of all sizes, farmers, homeowners, small businesses, and non-profit organizations.

Funding: CWSRF offers revolving loan funds to provide independent and permanent sources of low-cost financing for a wide range of water quality infrastructure projects. Total funds available to the program since its inception approaches $47 billion. CWSRFs provide over $100 million annually to control pollution from non-point sources and for estuary protection, exceeding $1.7 billion to date.

How to apply: CWSRF monies are loaned to recipients and loan repayments are recycled back into the program to fund additional water quality protection projects.

Website: http://www.epa.gov/owm/cwfinance/cwsrf/index.htm

EPA Water Quality Cooperative Agreements/Grants Program

Purpose: Promote the prevention, reduction and elimination of pollution. Section 104(b)(3) funds are to be used to focus on innovative demonstration and special projects, including research, investigations, experiments, training, environmental technology demonstrations, surveys, and studies related to the causes, effects, extent, prevention, reduction, and elimination of pollution. In FY04-05, the Water Quality Cooperative Agreement has five priorities, including NPDES Program strategies to implement watershed-based efforts (demonstration projects that facilitate watershed-based permitting and trading or innovative techniques to facilitate NPDES program management) and Animal Feeding Operations (innovative or alternative technologies for CAFOs to treat/process wastewater or manage manure and

CAFO producer outreach programs to train/educate the industry on implementation of the CAFO rule.)

Eligible recipients: State water pollution control agencies, interstate agencies, municipalities, Indian tribes and other non-profit institutions. For-profit entities are not eligible.

Cost sharing: Cost share is not required.

Funding: In FY04, total funds were $13.97 million. Per project funding ranges from $10,000 to $500,000. Average project size is $100,000.

How to apply: Respond to the request for Initial Proposals issued by EPA.

Website: http://www.epa.gov/owm/cwfinance/waterquality.htm

Sustainable Agriculture Research and Education Grants Program

Purpose: Advance farming systems that are profitable, environmentally sound and good for communities through a nationwide research and education grants program. The program, part of USDA's Cooperative State Research, Education, and Extension Service, funds projects and conducts outreach designed to improve agricultural systems.

Eligible recipients: Researchers, agricultural educators, farmers and ranchers, and students in the United States.

Funding: Three types of programs:

- Research and Education Grants: Funding ranges from $30,000 to $150,000 and supports projects that usually involve scientists, producers, and others in an interdisciplinary approach.

- Professional Development Grants: To spread the knowledge about sustainable concepts and practices, these projects educate Cooperative Extension Service staff and other agricultural professionals.

- Producer Grants: Producers apply for grants that typically run between $1,000 and $15,000 to conduct research, marketing and demonstration projects and share the results with other farmers and ranchers.

How to apply: Respond to SARE call for proposals from the appropriate region. The four SARE regions are North Central, Northeast, Southern, and Western.

Website: http://www.sare.org/grants/index.htm

XVI. State Programs

The following table lists some of the programs offered by states that can provide producers with some financial assistance for implementing technologies and practices to improve manure management. We have not included information about the nutrient management best management practice cost-share and incentive programs offered by most states because they are so numerous and common. We have selected those programs that offer assistance for a wide variety of options for managing and treating manure, with a particular focus on programs that fund more innovative approaches and those included in this report. This is not a complete list, and we apologize for any omissions.

State	Program	Purpose and website	Technologies in NDESC report fundable under this program
AL	Renewable Fuels Interest Subsidy Program	Interest subsidy payments on loans to install qualified biomass projects http://216.226.178.189/txtlstvw.aspx?LstID=7d865154-617a-495b-afb8-5cf4271b56ed	Anaerobic digesters
AR	Non-point Source Management Programs	Grants to fund best management practices in priority watersheds, including anaerobic digestion http://www.state.ar.us/aswcc/NPS_Webpage/Mgmnt.html	Anaerobic digesters Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
CA	Section 319 Grants	Help meet developed total daily maximum load limits in impaired watersheds http://www.swrcb.ca.gov/funding/319h.html	Anaerobic digesters Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
CA	Self-Generation Incentive Program	Provide financial incentives for business and residential customers who install up to 1.5 MW of “clean” distributed generation equipment onsite http://www.sdenergy.org/ContentPage.asp?ContentID=35&SectionID=24	Anaerobic digesters
CA	Energy Efficiency Improvements Loan Fund	Low-interest loans to small businesses in California for renewable energy systems http://www.safe-bidco.com	Anaerobic digesters
IL	Clean Energy Community Foundation Grant	Developing and increasing the use of renewable energy resources - wind power, solar power, biomass energy and innovative new technologies such as fuel cells - that can decrease pollution, diversify Illinois’ energy portfolio and create economic benefits for the state’s communities http://www.illinoiscleanenergy.org	Anaerobic digesters
IL	Renewable Energy Resource Program	Promotion of renewable energy investment, development, and utilization in Illinois http://www.illinoisbiz.biz/com/energy/renewable.html	Anaerobic digesters
IN	Alternative Power and Energy Grant Program	Support for ventures by businesses and institutions seeking to install and study alternative and renewable energy systems that generate electricity, heat or cool buildings, or transform waste to energy http://www.in.gov/doc/businesses/APEGPguidelines.html	Anaerobic digesters
IN	Distributed Generation Grant Program	For businesses and institutions seeking to install and study alternatives to central generation systems. The systems must employ either renewable or high-efficiency distributed generation technologies http://www.in.gov/doc/businesses/EP_transportation.html	Anaerobic digesters

State	Program	Purpose and website	Technologies in NDESC report fundable under this program
IN	Indiana Biomass Grant Program	To assist in the research and implementation of Indiana biomass energy systems http://www.in.gov/doc/businesses/EP_Basics.html	Anaerobic digesters
IA	Alternative Energy Revolving Loan Program	Promotion of the development of renewable energy production in Iowa. Approximately 20% of funds are targeted to biomass energy products http://www.energy.iastate.edu/funding/aerlp-index.html	Anaerobic digesters
IA	Energy Center Grants	Energy related research, demonstration, and education http://www.energy.iastate.edu/funding/gp-research.html	Anaerobic digesters
KS	State Energy Program Grants	Promotion of energy conservation and efficiency projects, including biomass energy projects, to foster commercialization of developing and underutilized technologies http://www.kcc.state.ks.us/energy/forms.htm	Anaerobic digesters
MI	Biomass Energy Program	To encourage increased production and use of energy derived from biomass resources through program policies, public and private partnerships, information dissemination, and state project grants http://www.michigan.gov/cis/0,1607,7-154-25676_25753_30522---,00.html	Anaerobic digesters
MN	Sustainable Agriculture Loan Program	Loans to facilitate sustainable farming practices, including alternative agricultural practices among farms that enhance environmental quality while endowing farmers with long-term economic benefits http://www.mda.state.mn.us/esap/esaploan.htm	Anaerobic digesters Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
MI, MN, ND, SD, WI	Xcel Energy Renewable Development Fund	Grants for the production of renewable energy, as well as research and development leading to full commercialization of renewable technologies http://www.xcelenergy.com	Anaerobic digesters
MO	Animal Waste Treatment Loan Program	Fixed rate loans that can be used to purchase new animal waste treatment systems and make improvements to existing systems for independent farmers http://www.mda.state.mo.us/Financial/a2c.htm	Anaerobic digesters Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
MT	Alternative Energy Revolving Loan Program	Provide funding for homeowners and small businesses seeking to install alternative energy systems, of which digester gas qualifies, for onsite use http://www.deq.state.mt.us/energy/Renewable/altenergyloan.asp	Anaerobic digesters
NY	New York State Energy Research and Development Authority	Financial and technical assistance for energy-efficient farm waste management, on-farm energy efficiency improvements, use of low-cost waste biomass, and other types of research to improve productivity and profitability of the agriculture sector http://www.nyserda.org/	Anaerobic digesters
NC	Energy Improvement Loan Program	Low interest loans for onsite renewable energy electricity generation http://www.energync.net	Anaerobic digesters
NC	Section 319 Grants	To support best management practice demonstration projects, environmental education, and technology transfer http://h2o.enr.state.nc.us/nps	Anaerobic digesters Lagoon covers Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG

State	Program	Purpose and website	Technologies in NDESC report fundable under this program
OH	Water Pollution Control Loan Fund	Low interest loans for the environmentally sound collection, treatment, disposal, and reuse of livestock waste. Particular interest to projects that use innovative technologies that increase the effectiveness of reducing and reusing livestock wastes http://www.epa.state.oh.us/defa/assistance_programs.html	Anaerobic digesters Lagoon covers Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
OR	New Renewable Energy Resources Grants	Fund renewable energy and energy efficiency projects in Oregon to help the state meet its goal of generating 10% of its energy from renewable sources by 2012 http://www.energytrust.org/index.html	Anaerobic digesters
OR	Section 319 Grants	Address water quality impairments in priority areas. Grant money can be used to assess or evaluate the effectiveness of agricultural management practices targeted to water quality concerns http://www.deq.state.or.us/wq/nonpoint/wq319gt.htm	Anaerobic digesters Lagoon covers Possibly honey vac Possibly solids separation Composting Targeted nutrient application Feed management MIG
OR	State Energy Loan Program	Low interest, long term, fixed rate loans for energy projects targeted to projects that promote energy conservation, development of renewable energy resources, or use of alternative fuels http://egov.oregon.gov/ENERGY/LOANS/selphm.shtml	Anaerobic digesters
PA	Energy Harvest Program	Promote advanced energy technologies proven to generate jobs, improve air quality, preserve land, protect watersheds and enhance energy security, with an emphasis on renewable energy deployment; biomass energy projects; waste coal reclamation for energy; implementation of innovative energy efficiency technologies; or clean distributed generation infrastructure improvements http://www.dep.state.pa.us/dep/deputate/pollprev/EHG/default.htm	Anaerobic digesters
PA	Sustainable Energy Funds	Provide loans, investments, and grants for use of renewable energy resources http://www.gggc.state.pa.us/gggc/cwp/view.asp?a=3&q=151721,	Anaerobic digesters
TX	Lonestar Revolving Loan Program	To provide loans to all public entities for projects that provide long-term energy savings http://www.seco.cpa.state.tx.us/ls.html	Anaerobic digesters
VT	Vermont Methane Program	Promote the use of methane recovery technology on Vermont dairy farms http://www.state.vt.us/psd/Menu/EE_and_Renewable/Methane.htm	Anaerobic digesters
VT	Lake Champlain Basin Alternative Manure Management Grant Program	Demonstration of technologies to reduce on-farm nutrient production from animal manures http://www.lcbp.org	Anaerobic digestion Solids separation
WI	Focus on Energy	Equipment grant for purchasing renewable energy equipment, demonstration grants for educating the public about renewable energy systems, or cash back rewards for installation, purchase, and upgrade of a bioenergy system that generates electricity or heat http://www.focusonenergy.com	Anaerobic digesters

Producer Organization Contacts

California Dairy Campaign
Turlock, CA
209-632-0885

Council of Northeast Farmer Cooperatives
Alexandria, VA
703-751-8022

Dairy Producers of New Mexico
Roswell, NM
505-622-1646

Idaho Dairymen's Association
Twin Falls, ID
208-736-1953

Illinois Milk Producers Association
Bloomington, IL
309-557-3703

Indiana State Dairy Association
West Lafayette, IN
765-494-8025

Iowa State Dairy Association
Ankeny, IA
515-971-3620

Kansas Dairy Association
Belvue, Kansas
785-456-8357

Maryland Dairy Industry Association
Frederick, MD
301-473-7522

Maryland and Virginia Milk Producers Cooperative Association Inc.
Reston, Va
703-742-6800

Michigan Milk Producers Association
Novi, MI
248-474-6672

Midwest Dairy Association
St. Paul, MN
651-488-0261

Milk Producers Council
Chino, CA
909-628-6018

Minnesota Milk Producers Association
Waite Park, MN
877-577-0741

Montana Dairy Association
Helena, MT
406-442-1330

National Milk Producers Federation
Arlington, VA
703-243-6111

Northeast Dairy Producers Association, Inc.
http://www.ansci.cornell.edu/nedpa
315-683-9268

Northeast Organic Dairy Producers Alliance
Richmond, VT
http://www.organicmilk.org/

Northeast Pasture Research and Extension Consortium
State College, Pennsylvania
814-777-4680

Northwest Dairy Association
Seattle, WA
206-286-6700

Ohio Dairy Producers
Ottawa, OH
614-292-1868

Oregon Dairy Farmers Association
Portland, OR
503-229-5033

Professional Dairy Producers of Wisconsin
Fox Lake, WI
800-947-7379

Project Grass (PA)
Clearfield, PA
814-765-2629

South Carolina Dairy Association
Irmo, SC
803-772-5354

Southeast United Dairy Industry Association
http://www.southeastdairy.org

State of Nevada Dairy Commission
Las Vegas, NV
702-486-8212

Sunshine State Milk Producers
Orlando, FL
407-648-4311

Texas Association of Dairymen
Grapevine, TX
866-770-4823

United Dairymen of Arizona
Tempe, AZ
480-966-7211

Utah Dairymen's Association
Lehi, UT
801-368-7403

Vermont Pasture Network Program
University of Vermont Center for Sustainable Agriculture
802-656-3834

Washington State Dairy Federation
Elma, WA
360-482-3485

Western United Dairymen
Modesto, CA
209-527-6453

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