Making the Most from Manure

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Sustainability of any entity requires a balance of resource management while addressing economic viability, environmental impact, and societal needs. No doubt, economic viability is always at the forefront of the decision making process on dairy operations. Over the last few years, environmental compliance and analysis of environmental impact have opened a new language for many in the dairy business. In addition to ever changing regulatory requirements (at the Federal, State, and potentially international levels) producers are faced with ever increasing pressures from an expanding urban society and a global market place. The volatility in production input prices (feed and fuel) combined with sinking prices received for milk and a particularly unstable banking market make most dairy operators (and processors) very nervous. The time-honored practice of adding cows during tough times isn't working for many operators during these difficult times due to over supply of milk in processing plants. Financially, dairy operators are trying to figure out how to cut costs. Yet, various industries and food processors continue to initiate programs and/or respond to consumer groups' concerns in order to inch toward greater sustainability for their supply chain and market outlets.

Evaluate your system

Managing manure to minimize costs and maximize revenue becomes more important when milk supplies are long and milk prices are low. Critically evaluate your existing manure collection, storage, treatment, and utilization systems to determine if and/or where improvements are possible to reduce costs or increase revenues. As always, be sure that any alterations in manure management are acceptable to local and state regulatory agencies when appropriate (if you're in the San Joaquin Valley of California be sure to check with your County permitting agency, Central Valley Regional Water Quality Control Board and the San Joaquin Valley Air Pollution Control District).

Step 1. Analyze the inputs to the waste stream. There are numerous inputs into your liquid/slurry/solid manure waste streams. It's important to identify if simple management changes can reduce costs associated with handling waste (typically by reducing volume). Common sources of input to the waste streams are identified with suggested areas to consider (Table 1).

Table 1. Analysis of waste stream inputs to identify management/infrastructure options to reduce waste stream volume.		
Source of input into waste stream	Evaluate this source to reduce contribution to waste stream	Alternative management needs
Water used for milk cooling	Is water reused before entering the waste stream (used for drinking water, udder hygiene, etc.)? Does milk cooling efficiently utilize water?	Modify milk pumping through plate cooler to maximize efficient transfer of heat with minimal water use; modify plumbing system to deliver plate cooler water to water storage system.
Water used for udder hygiene	Can water use be reduced or eliminated?	Increase management of animal housing area; alter bedding use.
Water used to sanitize milking equipment	Can water use be reduced?	
Fresh water used to flush any animal lanes	Can fresh water used for flushing be eliminated?	Re-plumb flush system to recycle liquid manure; modify manure collection to slurry or solid system
Footbaths	Are other products available for use? Would a pre-footbath wash increase effectiveness of footbath (extend footbath duration; reduce number of changes/month).	Install pre-footbath wash. Identify if other products are available and if used monitor foot health closely to be sure new products are acceptable. Potentially switch between products over time.
Rainfall and potential runoff from buildings	Is runoff a significant contributor to liquid storage needs?	Install and maintain gutters to DIVERT roof runoff from liquid storage structure.
Bedding	Are alternative materials available for bedding (potentially ones that have larger particle size, are less damaging to pumps, have lower nutrient composition, are more degradable, are less degradable)? Can less bedding be used?	Modify management of corrals and roofed housing areas to minimize need for bedding; modify bedding material storage area to minimize losses of useful material; modify animal surfaces to minimize need for bedding.
Wasted/spoiled feed	Can feed be managed to reduce waste and spoilage?	Manage wet feeds (especially during extreme weather conditions); Improve management
Earthen material	Does equipment used to collect solid manure capture	Modify solid manure collection equipment/methods

	soil?	(use box scraper instead of tractor bucket)
Feed management	Are diets formulated, mixed, and delivered to get desired production?	Use feed capture system to collect feed data and compare to anticipated ingredient uses; feed supplements only when accounted for in dietary formulations.
other		

Step 2. Analyze alternative outlets for manure if waste stream is modified. Most operators are governed by a nutrient management plan of one form or another. It becomes increasingly important to minimize atmospheric losses of nitrogen from manure. This is important since the atmospheric losses reduce the amount of plant available nitrogen in the manure. Nutrient excesses exist when manure nutrients exceed the capacity of the land application area to receive nutrients. Address potential options for alternative composition to existing manure sources (Table 2) and determine if it is feasible to modify current manure collection/treatment practices to yield different compositional outputs (drier, higher N, etc.) and potentially increase income with the new product.

Table 2. Potential modification of existing manure to find if alternative markets exist for manure.

Desired outcome for manure	Potential methods to assist in achieving objective
Increased quantify of manure in solid form	Scrape manure onto surface for air drying (instead of flushing)
Increase N, P, and/or K in manure	Collect as slurry instead of liquid; collect more frequently to reduce N losses;
Modify solid manure characteristics (drier, weed seed ‘free’, or has a reduced pathogen load).	Dewater; heat treat via compost to reduce weed seeds and pathogens; use anaerobic digestion as pathogen reduction treatment.
Specific particle sizes or density.	Select mechanical separation screen to meet requirements; improve separation of sand or earthen components.
If liquid manure has more/less solids.	Use processing centers to concentrate nutrients; reduce water inclusion in stream;

Step 3. Identify practice(s) or technology(ies) to achieve desired outcomes identified in Step 2 (establish a job description or goal). Potential investment in technologies may be helpful if the desired modification to manure composition isn’t achieved after alternative management practices are implemented. As identified in previous Western Dairy Management Conferences (2003), it is best to identify the job description before selecting the technology. Once a job description is identified, it is potentially possible to identify one or more technologies or combination of alternative management practices and technologies to achieve the desired outcome. Identification of technologies that have no cross media impacts may be needed for producers in areas where air, water and county regulatory requirements potentially conflict with one another.

There is no perfect technology to manage dairy manure and address both water and air quality concerns. A review of submitted technologies in 2005 by interested stakeholders in California identified that most technology providers were unable to provide data collected by an impartial third party to identify technology effectiveness (See assessment panel). Technologies were categorized as: thermal conversion (combustion, gasification and pyrolysis), solid--liquid separation and filtration, composting, anaerobic digestion, aerators/mixers, nitrification/denitrification processes, covers for lagoons and compost piles, microbials/enzymes/other additives, feed management and miscellaneous. Most vendors merely provided testimonials to market technologies. Technologies have a higher probability of being successful when the job description required is specific and simplistic.

It is easy for a vendor to imply that a technology will resolve all problems associated with manure management. Be sure you **review actual data** from research projects done with the technology ON DAIRY farms. It's critical that the testing process occur on a facility with similar management practices to your facility if you are interested in transferring findings to your operation. Complete Table 3 for the prospective technology and then compare the findings with what you need in a technology. After you review the findings complete your homework and follow-up with calls to the dairy operator where the research was conducted. Ask specific questions to find out if they are satisfied with the technology, if they're still using it, and probe to find out if they paid for it or received it at minimal cost. Point blank ask if they would do it again and if they recommend that others pay full price for it.

Table 3. Analysis of potential impacts of technology on liquid and solid manure components (identify if each component is reduced, increased, or stays the same if a technology is used).

Component	Effects on Wastewater	Effects on Manure Solids
Organic Nitrogen		
Ammonia Nitrogen		
Phosphorus		
Dissolves Solids		
Total Dissolved Solids (TDS)		
Forms Nitrate Nitrogen		
Reduces Pathogens		
Stabilize Manure		
Reduce Manure Volume		
Reduce Emissions[1]		

[1] Important to evaluate: reduction of emissions [ammonia, nitrous oxide, volatile (or reactive) organic compounds, methane, hydrogen sulfide, particulate matter, and odors] and production of emissions [carbon monoxide, nitrogen oxides (NOx), nitrous oxide (N_2O)].

As a reminder, the importance of writing down your job description needs and comparing it to the potential technology is to save you from installing something that will not provide value for you. As an example, the standard anaerobic digestion methodology remains effective to reduce organic fraction in materials. However, it does nothing to salts or P and potentially increases plant available form of Nitrogen (ammonium form) while reducing the organic fraction of N. If the biogas is burned through a combustion engine to generate electricity you should reduce methane emissions. Depending on your air district and your engine, you may violate emissions of NOx, and potentially emit small amounts N_2O (a very potent greenhouse gas).

Cash in on new sources of revenue

Cap and trade systems for water and air emissions will provide new opportunities for new revenue on dairies. Depending on the location of a dairy, credits for reductions in phosphorus, nitrogen or sediment (erosion) may be available. In other locations, attention to criteria pollutants (particulate matter, NO_x) or select greenhouse gases (methane, nitrous oxide, carbon monoxide) may have value. Although the United States did not sign the Kiyoto Treaty there are still many opportunities to obtain and market greenhouse gas emissions credits for use by companies in the US or abroad. Additionally, in areas where air quality is poor there may be opportunities to implement management practices/technologies to reduce emissions thereby allowing a business to sell, bank or trade emissions credits. In such airsheds, new or expanding dairy operations must comply with new source review analysis and implement best available control technology and purchase offsets. In California, "the state regulation identifies general requirements and criteria that local air districts must meet in certifying, calculating, banking, and using emission credits. The state regulation ensures that emission credits represent real reductions in air pollutants, that reductions are surplus to any reductions already required, and that reductions are not "double counted" or credited more than once".

Emissions Reduction Credits. An existing emissions source can implement management/technology practices to reduce these emissions. Another emissions source interested in increasing emissions is not able to do so absent the opportunity to offset these emissions. The sum of the reduction and increase must not exceed zero. . One of the challenges is to validate the actual emissions reductions. Reductions must be real, quantifiable, and permanent. Reductions must be proven to have occurred. This requires a third party analysis to confirm reductions and must be completed per the regulatory and/or emission credit agency specifications. Accepted methodology must be available and employed when measuring emission reductions. Reductions are intended to be permanent. NOTE: It is probably that offsets would need to be purchases if in the future one would no longer generate the reductions.

The more commonly identified compounds for emission credits are criteria pollutants regulated through the Clean Air Act (NO_x, ROC, SO_x, and CO). Alternatively, one may seek to participate in carbon credits. As part of many local and regional Climate Action Initiatives there will be great pressure to reduce carbon footprint from dairy operations. As an example, the Western Regional Climate Action Initiative (including California, Utah, New Mexico, Arizona Washington, Oregon, and British Columbia) aims to reduce aggregate emissions 15 percent below 2005 levels by 2020. In California, AB32 is well on its way to inventory greenhouse gas emissions and identify methodology to implement emission reductions.

For almost all emissions, one is going to hire a consulting firm familiar with completing the required documentation and working on your behalf to receive high returns in the market for your reductions. Be sure you do your homework before hiring your consulting firm. Be sure they know how to get through your specific emission source, understand (and are able to document) emission reductions, are familiar with County, Regional and State regulatory obligations and emission credit options and have a solid track record.

Renewable energy credits. After last summer's incredibly volatile fuel prices it is a given there will be more incentives available for Federal and potentially State renewable energy credits. These programs are associated with "green" or "environmentally friendly" practices. They produce two products. The first is a tradable renewable credit, the second is electricity. Again, consulting firms are available to identify market opportunities, identify useful technologies, and assist in obtaining low cost financing. Reasons to invest in "green" power include improving image, satisfy regulatory need, or control costs of energy use. The potential investment now in reducing energy costs in the future may be a viable option. In some areas this will include generating energy from solar, wind or methane. Depending on the technology installed, market demand of local electric supplier, and potential payments for electricity it may or may not be more desirable to sell electricity off-farm or utilize it on-farm.

Addressing Sustainability. During the summer of 2008 the dairy industry held its first Sustainability Summit and developed an action plan committed to reducing greenhouse gases and increasing business opportunities across the value chain. Defining and marketing sustainability will be a necessary challenge for all of dairy production. The idea is to reduce fluid milk's carbon footprint while increasing business value from farm to consumer. [Carbon footprint is a measurement of the total CO_2 equivalents produced—in the case of producing milk it includes all CO_2 equivalents produced from manufacture of fertilizer, crop production/harvest/transportation, and animal husbandry.] More than 250 leaders representing producers, processors, non-governmental organizations, university researchers and government agencies held in Rogers, Ark., June 16 to June 19, 2008. The plan focuses on operational efficiencies and innovations to reduce greenhouse gas emissions while ensuring financial viability and industry growth.

"Decision makers from across the dairy value chain are working together to commit to concrete, innovative solutions. This will ensure an economically, environmentally and socially sustainable industry" said Thomas Gallagher, chief executive officer of Dairy Management Inc. (DMI). "In an era of record high energy prices and a changing global climate, we must do more. It makes economic sense to find ways to conserve energy and reduce production costs, while recognizing that a growing number of consumers care deeply about the health and environmental impact of the products they buy" said Jerry Kozak, National Milk Producer Federation's chief executive officer. Leading the initiative along with DMI are NMPF representing dairy cooperatives, and the International Dairy Foods Association representing processors and manufacturers.

Summit attendees recommended a number of actions, including to:

- Reduce energy use in the milk supply chain by developing technologies for next generation milk processing on the farm and in the plant.
- Establish a mechanism to optimize returns to the dairy industry from a carbon credit trading system that encourages the reduction of greenhouse gas emissions.
- Reduce carbon emissions and increase energy efficiency for dairy farmers and processors through financially viable best management practices and tools that calculate individual farm energy and alternative energy opportunities.
- Supply green power to communities by expanding the use of methane digesters.

- Stimulate development of low-cost, low-carbon, consumer-acceptable packaging.
- Reduce cooling costs and emissions associated with refrigeration by expanding economically feasible, environmentally responsible and consumer-accepted dairy products.

Over the next few years there will be a tremendous amount of information appearing in business journals and magazines and in popular press literature. Large variations in results will occur. Life Cycle Analysis methodology is used to address carbon emissions values. Already results from studies identify different emissions values depending on the boundaries established within each study. When one study focuses on inventories managed only by farmers the results will be different when compared to a study that also includes growth of all feed ingredients, transportation to farm and farm to market, and processing activities. It is very important that the dairy industry be engaged in the life cycle analyses being conducted.

References:

Ball, J. 2008. Six Products, Six Carbon Footprints Everybody's talking. http://online.wsj.com/article/SB122304950601802565.html. October 6, 2008

California Air Resources Board. 2005. Annual Report on State Regulation on Emissions Trading Methodology (H&SC Section 39607.5) May. http://www.arb.ca.gov/research/apr/reports/l3039.pdf

Meyer, D., J. Harner, W. Powers, E. Tooman. 2003. Manure technologies for today and tomorrow. Proceedings of the 6th Western Dairy Management Conference; March 12-14, 2003, Reno, NV. Available at: http://www.wdmc.org/2003/Manure%20Technologies%20for%20Today%20and%20Tomorrow.pdf

National Milk Producer Federation. 2008. Dairy Industry Commits to Reducing Greenhouse Gases, Increasing Business Opportunities Across Value Chain. June 25. http://www.nmpf.org/latest_news/press_releases/carbon_footprint062508

San Joaquin Valley Dairy Manure Technology Feasibility Assessment Panel. 2005. An Assessment of Technologies for Management and Treatment of Dairy Manure in California's San Joaquin Valley. Available at: http://www.arb.ca.gov/ag/caf/dairypnl/dmtfaprprt.pdf

Western States Climate Initiative. http://www.westernclimateinitiative.org/