

Odor and Nutrient Management



Aeration helps reduce odor in two-stage lagoon system

by Sherry Hoyer, Iowa Pork Industry Center

When Frank Hirschman and his son Don wanted information on how to reduce odor as they expanded their hog operation in southeastern Plymouth County from 200 sows to 2,500 sows, they went to town for answers. Their local town, Kingsley, used aeration in its municipal lagoon and that sparked an interest in using similar technology on their farm. After receiving a referral to International Industries, Inc. in Sioux City, the Hirschmans worked with company representative Don Frankel to learn more about the success of some existing aeration systems.

Frankel showed them some aeration systems that were successful at reducing lagoon odors, so they decided to try one. That was 4 years ago, and the Hirschmans continue to be pleased with the results. The system the Hirschmans use is providing them with good quality liquid to flush through shallow pits to help reduce odor and maintain high air quality inside and outside of the buildings.



Aerator on second-stage lagoon at sow facility.

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Typically, objectionable odors and gases such as hydrogen sulfide (H₂S) and ammonia (NH₃) are produced by anaerobic microbes, which live in animal manure pits and lagoons when no oxygen is present in the liquid. When oxygen is present, however, a different population of microbes exists that produce odorless gases. So by introducing enough oxygen into the manure, it can be made aerobic, so that odorless gases are produced. Aeration is the treatment system that introduces the oxygen and allows aerobic microbes to survive and thrive. It is frequently used by cities and industries before releasing wastes into waterways. Aeration is not often used by producers because of the additional cost and because they cannot release the manure into waterways even if treated.

Specifically, the aeration of the lagoon results in a more earthy smell, not like that from a normal hog confinement. And the odor does not seem to travel as far.

The 2,500-sow operation uses a two-stage lagoon with aeration in each stage.

Liquid from the second stage is either recycled to flush the pits in the hog buildings or applied with a traveling gun to alfalfa fields. The Hirschmans apply the effluent to the fields only on days when the wind speed is 5 miles an hour or less. Although some might consider a double aeration system too expensive, the Hirschmans said that after the initial cost of

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equipment and installation, the main ongoing expense is electricity and it is reasonable. The original cost was just under \$17,000. Now, it costs approximately \$3,800 a year for electricity (approximately 6.8 cents per pig).

To others who are concerned about odor, air quality, and being a good neighbor, Frank Hirschman said he definitely recommends this system. However, he cautions that others should make their own evaluation of costs and benefits and compare several aeration systems to select the one best suited to their circumstances.

Whole farm nutrient planning

by Jeff Lorimor, Department of Agriculture and Biosystems Engineering

If managed correctly, manure is an excellent plant nutrient resource and soil “builder,” resulting in many important environmental benefits. Soils regularly receiving manure require less commercial fertilizer (conserving energy and limited phosphorus reserves); are higher in organic matter, contributing to greater soil productivity; and may experience less runoff and erosion and better moisture conservation. However, an increased risk to water quality results from excess application of manure nutrients to a cropping system. Whole farm nutrient planning asks the question, Do my nutrient inputs equal nutrient outputs? The fundamental concern is whether a livestock or poultry operation is concentrating nutrients.

Single-field nutrient concentration issue. Some fields, often those closest to the

livestock facility, receive excessive manure applications, whereas commercial fertilizer is purchased to meet the needs of fields more distant from the livestock. Spreading manure based upon convenience and not the crop’s nutrient requirements concentrates the nutrients in nearby fields or in small areas within a field.

Individual farm nutrient concentration issue. Farms focused primarily on livestock production import significant quantities of nutrients as animal feeds. Livestock use only 10 to 30 percent of these nutrients, excreting the remainder as manure, which can result in a concentration of nutrients on the livestock farm and a shortage of nutrients (typically replaced by purchased commercial fertilizers) on neighboring crop farms that provided the feed for the livestock operation. The net result

may be a nutrient imbalance on the crop farm, and an oversupply on the livestock farm.

Regional nutrient distribution issue.

Whether considering a cluster of farms, a township, a county, state, or a larger region, the question remains the same: Do nutrient imports equal nutrient exports from the region?" If the answer is no then either nutrients are being concentrated or they are being depleted in the respective area. In livestock-producing regions, more often than not nutrients accumulate because of feed and fertilizer imports.

Nutrient flow.

Nutrients arrive on livestock operations as purchased animals, fertilizer, animal feed, nitrogen (N) fixed by legume crops, and nitrates in rain and irrigation water. These "inputs" provide nutrients for crop and livestock production as well as those nutrients that escape into the environment. As mentioned above, livestock use only 10 to 30 percent of the nutrients in livestock feed, excreting the rest as manure. Within the boundaries of the farm, there is a recycling of nutrients between the livestock and crop components. Manure nutrients are recycled, at least in part, for crop production, and feed crop nutrients are recycled as animal feed for livestock or poultry production. Outputs are meat, milk, eggs, crops, and manure. If the unused nutrients in the manure are ignored, and not efficiently used for crop production, a seriously unbalanced condition is initiated in the crop field.

Evaluating a livestock system's nutrient balance from a whole farm perspective provides a more complete picture of the driving forces behind nutrient-related environmental issues. The original sources of these nutrient inputs are clearly identified, which in turn suggest management strategies for reducing excess nutrient accumulations. The following four management strategies should reduce nutrient imbalances:

- 1) alternative livestock feeding programs,
- 2) efficient use of manure nutrients in crop production,
- 3) marketing of manure nutrients, and
- 4) manure treatment.

Alternative feeding programs.

Opportunities are available for reducing both N and phosphorus (P) inputs by alternative livestock feeding programs. For example, feeding phytase to swine and poultry and reducing the P in their rations can typically reduce P excretion by approximately 30 percent. Feeding dairy cows to National Research Council (NCR) requirements, rather

than overfeeding them, can result in significant reductions of manure nutrients. Minimizing protein and phase feeding can reduce manure nitrogen from swine. In addition to changes in feed rations, some additional options that may reduce purchased feed nutrient inputs include

- 1) alternative crops or crop rotations that result in a greater on-farm production of livestock protein and P

requirements, and 2) harvesting and storage practices that improve the quality of animal feed and reduce losses.

Using manure nutrients for crop production. By accurately crediting manure nutrients in a cropping program, the purchases of commercial fertilizer can be reduced or eliminated. Manure contains all the nutrients necessary for crop production, but these nutrients may not be in the proper ratios. Good multiyear nutrient management plans allow full use of the manure nutrients while supplementing with commercial fertilizers to achieve the correct balance. Swine finisher manure applied every other year ahead of corn in a corn-soybean rotation provides all necessary nutrients for both the corn and the following year's beans.

Marketing of manure nutrients. Once feeding strategies are fine-tuned and a good manure nutrient management plan is in place, if there are still excess nutrients, exporting some manure may be necessary. Additional farmland can be acquired or the manure may be marketed. Marketing of manure creates an additional managed output, similar to the sale of crops or livestock products. Many poultry producers in Iowa have successfully been marketing manure for several years. Marketing manure allows the farm "boundary" to be expanded to achieve a nutrient balance.

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Manure treatment. In some situations, producers may consider manure treatment technologies similar to municipal and industrial waste treatment systems. Some manure treatment systems focus on disposal of nutrients with modest environmental impact. For example, treatment systems commonly dispose of wastewater N as N gas (no environmental impact) or ammonia (some environmental impact). This alternative is preferable to N losses to surface or groundwater. Complementary manure treatment and manure marketing strategies can contribute to improved nutrient balance. For example, some producers are successfully combining composting (for odor control and volume reduction) with marketing of manure to crop farms and urban clients.

Indicators of potential whole farm nutrient imbalances. The following points may serve as guidelines to help you determine whether you have a nutrient imbalance on your farm:

- Soil P levels for the majority of fields are increasing with time.
- Soil P levels for the majority of fields are identified as high or very high in a soil test.
- The majority (more than 50 percent) of the protein and P in the ration originates from off-farm sources.
- Livestock feed programs routinely contain higher levels of protein and/or P than NRC or land-grant university recommendations.

- A manure nutrient management plan is not currently used to determine appropriate manure application rates to crops.
- Less than 1 acre of crop land is available per 1,000 lb of live animal weight, and no manure is transported to off-farm users.

Whole farm nutrient planning is not a new concept. Many producers are already doing it by using a good nutrient management plan and carefully controlling rations. It is simply another way to understand the basic relationships between farm imports and exports. If the two do not match, Mother Nature will make them. If imports are low, crop yields and/or animal production decrease. If imports exceed exports, nitrogen may be lost through ammonia volatilization, soil phosphorus increases, and increased phosphorus losses may occur. One way or another, a balance is achieved. Whole farm nutrient planning simply allows the producer to exert more control over what goes where.

Materials contained in this article have been adapted from the Livestock and Poultry Environmental Stewardship Curriculum supported by CSREES, USDA, U.S. EPA, National Agriculture Assistance Center and the University of Nebraska Cooperative Extension Service under Cooperative Agreement Number 97-EXCA-3-0642. Copies of the LPES curriculum can be ordered from Midwest Plan Service at <https://www.mwvshq.org/catalog.html>

Project demonstrates crop nutritive value of liquid swine manure

by John Lundvall, Iowa State University Extension, and John E. Sawyer, Department of Agronomy

The Iowa State University (ISU) Swine Manure Nutrient Utilization Project, part of the Integrated Farm/Livestock Management (IFLM) Demonstration Program, receives funding from the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, USDA Natural Resources Conservation Service, and the Leopold Center for Sustainable Agriculture. The project goal is to learn more about liquid swine manure nitrogen (N) and phosphorus (P) availability to crops and compare crop yield with manure

versus commercial fertilizer in a series of systematic demonstrations across Iowa.

Study leaders John Sawyer and Antonio Mallarino recognize that swine manure is an important nutrient source for corn and soybean in Iowa. However, environmental concerns arise when manure N and P are not adequately accounted for or used by crops. A goal of the project is to increase producer confidence in swine manure's nutrient availability and consistency relative to commercial fertilizers by encouraging soil

testing, manure nutrient analysis, equipment calibration, proper rate application, and use of best-management practices to reduce applications of additional commercial fertilizer when appropriate. Project objectives include the following:

- 1) Compare corn yield response between manure and commercial fertilizer
- 2) Estimate manure N and P crop availability
- 3) Address producers' uncertainty about applying additional N and P after manure application
- 4) Document soybean yield response to direct manure application
- 5) Monitor soil and plant nutrient responses to manure and fertilizer application
- 6) Provide education opportunities for farmers and ag business personnel through summer field days, winter meetings, promotional literature, and Web-based information.

Since 2000, the project has had 39 on-farm demonstrations with 16 cooperators in 12 Iowa counties. At each field site, preliminary soil samples are collected to monitor baseline soil P, potassium (K), pH, and organic matter levels. Cooperators collect surface or probed samples of stored liquid manure (finishing facilities with under-building pit or concrete tank storage) 2–3 weeks before land application. Samples are analyzed at the ISU Analytical Services Laboratory for solids, total-N, -P, and -K, as well as ammonia-N.

Using a cooperator's presample total-N analysis, targeted manure application rates are calculated. Manure is applied at zero (check), half, and full rates of total-N (target of 0, 75, and 150 lb of total-N per acre before corn in a corn-soybean rotation; 0, 100, and 200 lb of total-N per acre in continuous corn or before soybean). Field-length manure treatment strips are randomized and replicated three times at each field site. When manure is applied, portable scales are used to weigh application equipment for rate calibration. Multiple manure samples are collected during application and analyzed like the presamples to document total-N, -P, and -K nutrients applied in treatment strips. These data are

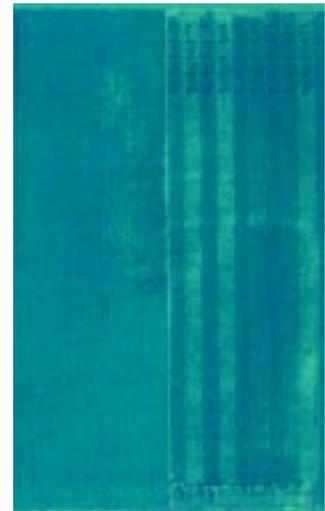


Weighing equipment to document application rates.

collected to evaluate both the application process and manure nutrient content and consistency.

To address producer uncertainty about applying additional N and P fertilizer after manure application, four rates of fertilizer are hand-applied to replicated small plots in each control and manure application strip. At field sites featuring corn after soybean, supplemental N fertilizer rates of 0, 40, 80, and 120 lb of N per acre are evaluated; at continuous corn field sites N fertilizer rates are adjusted to 0, 60, 120, and 180 lb of N per acre. In corn and soybean fields with a history of soil P testing in the high or lower soil test category, P fertilizer rates of 0, 20, 40, and 60 lb of P_2O_5 are evaluated in separate small plots. Crop-removal rates of K fertilizer are hand-applied to all small plots, with N fertilizer blanket-applied to P small plots and P fertilizer blanket-applied to N small plots.

Several methods are used to monitor crop nutrient status during the growing season. Early-season and post-tassel aerial photos of each corn field site provide a visual assessment of soil and plant characteristics. Late-spring soil nitrate test samples are



Aerial photos show crop response to manure N.

collected within small plots and throughout manure treatment strips. Crop P uptake during early vegetative growth is monitored by collecting aboveground plant samples from small P plots near the V5 (vegetative stage with 5 leaf collars showing) growth stage. Corn leaf N status is monitored near the R1 (silking) growth stage with a Minolta (SPAD) chlorophyll meter. Lower SPAD values mean "less green" leaf tissue, suggesting that the corn plant is not receiving adequate N for optimum growth. End-of-season cornstalk test samples are collected from small plots to evaluate N status at crop maturity.

Corn and soybean yield is determined by hand-harvest from the interior of each small plot. Cooperators combine-harvest the manure application strips by using yield monitors or weigh wagons to measure grain yields. After harvest, soil samples are collected from P small

plots for routine agronomic and potential environmental P tests. Soil profile nitrate is monitored at several N rates within each manure application strip.

New cooperators and field sites are being identified for the 2003 crop year. Producers interested in cooperating in this project should contact the project coordinator before fall manure or commercial fertilizer application. If you are interested in participating in the project, please contact project coordinator John Lundvall at 2104 Agronomy Hall, ISU, Ames, IA 50011; phone (515) 294-5429; E-mail jlundval@iastate.edu

This is first in a series of newsletter articles highlighting the ISU Swine and Manure Nutrient Utilization Project. Future articles will highlight manure sampling results and demonstration results.

Manure application and conservation compliance plans

by Kristy York, USDA-Natural Resources Conservation Service, Audubon County

Application of manure and meeting conservation compliance plans has been a controversial issue. The most common method of manure application is by injection or broadcast application followed by incorporation. Injection or incorporation is done to reduce offsite nutrient movement to waters of the state, place manure nutrients closer to the crop rooting zone, minimize odors, and provide some means of tillage. Injection or incorporation of manure can reduce residue, leaving soils bare and more vulnerable to wind and rain erosion. Fall application of manure by using these systems can leave soils bare longer, resulting in potentially greater offsite movement of soil and nutrients. So can manure application and conservation compliance live in harmony? The answer to this question is "yes."



Manure application equipment.

Through advancements in technology, better ways of incorporating manure are being developed and with the implementation of the Revised Universal Soil Loss Equation (RUSLE), more incorporation options are available to crop and livestock producers. RUSLE is the soil loss equation that is currently being used by the Natural Resources Conservation Service (NRCS). This marriage of manure application and compliance has been demonstrated through field days all over the Midwest.

At these field days different manure application companies demonstrate their ability to conserve residue under a variety of conditions. They have experimented with different depths of injection or incorporation, speeds, coulters, and residue managers to

preserve the maximum amount of residue. The condition the field is left in makes a big difference once the manure has been applied. It is critical to many conservation plans that the producer be able to no-till right into the residue after the manure has been incorporated. This approach can be a problem when manure application equipment leaves compacted areas and deep ruts. Although the NRCS prefers to see manure applied to cornstalks instead of bean stubble because the residue levels following corn are better able to withstand tillage from manure applicators, NRCS recognizes that manure application to soybean stubble for the following corn crop is a better use of the nitrogen in the manure for crop production. Soybean stubble is much more fragile and breaks down faster than cornstalks, leaving the slopes unprotected against soil and wind erosion.

The NRCS also is addressing nutrient management through comprehensive nutrient management plans (CNMPs). These plans look at the overall fertility of the farm, the nutrient value of the manure, and recommendations as to how and where to apply the manure. The development of a CNMP includes review of soil types, manure application history, soil fertility level, and identification of environmentally sensitive areas.

For more information about residue management, conservation compliance and



NRCS employees measure residue after manure application.

for CNMPs, please visit your local NRCS office.



Field day attendees evaluate crop residue after manure application.

Please take a few moments to complete the survey found in the Summer 2002 issue of the *Odor and Nutrient Management* newsletter and return it postage paid, to Angela Rieck-Hinz, 2104 Agronomy Hall, Iowa State University, Ames, IA 50011.

If you prefer, please complete the survey electronically and submit your response via e-mail to amriec@iastate.edu The electronic survey is located at <http://www.extension.iastate.edu/Pages/communications/EPC/Su02/nlsurvey.html>

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... and justice for all

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