Environmental Tradeoffs

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Farmers have long known that integration of livestock and crop production systems offers significant economic benefits.Traditionally, crops were used to feed livestock, and livestock products were consumed on-farm. Surplus crops and livestock products were marketed. The manure from livestock was recycled back to the land as a source of crop nutrients and soil amendments.

Advocates of returning to this type of production system can point to recent research results that prove that long-run soil productivity in many parts of the world can be most effectively maintained by applications of appropriate amounts of animal manure.

The other benefit of an integrated system is that livestock producers have a place to dispose of accumulated manure in a cost-effective and environmentally sound manner. With plentiful land close to livestock production sites, farmers can afford to apply manure at rates that do not result in nutrient build-up. Without ready access to cropland, two situations can arise. Livestock producers may adopt management systems that minimize the amount of material that must be land-applied. Or producers can respond by increasing manure application rates to levels that can lead to environmental problems.

Swine manure offers Iowa's corn and soybean farmers both short- and long-term benefits. In the short-run, manure nutrients can replace fertilizer applications. ISU researchers estimate the gross value of swine manure as a source of nitrogen, phosphate and potash is often as high as $2.22 per hog. This amounts to about $5,500 per year per 1,000-head finishing house.

The long-term benefit of swine manure is maintenance of a soil's productivity from the addition of soil organic material and nutrients. Most Iowa farmers do not include this value in their management strategies because the benefits of maintaining and/or enhancing soil tilth from a year's application of

manure are small and occur in future years. But annual applications of animal manure can maintain soil productivity in the long run even under intensive cropping systems.

Do Iowa's farmers capitalize on the value of manure in their cropping systems by substituting manure nutrients for fertilizer applications? It wouldn't be surprising if many don't because of the obstacles to overcome before the potential value of manure can be realized.

First, manure must be available at the right time of the season. In Iowa, manure is best applied to land in the fall after harvest. If manure must be land-applied at other times, then a crop farmer will not be able to utilize as great a proportion of the nutrients.

Second, the nutrient content of manure must be known so proper application rates can be made.Farmers who want to rely on nitrogen from manure, but who do not know the nitrogen content of the manure to be applied, will typically apply " insurance" manure to protect against being caught short of nitrogen. Farmers who apply supplemental commercial fertilizer to manured fields tend not to take proper credit for the manure nutrients, which leads to excess nitrogen being applied.

Third, nitrogen in swine manure can easily change to ammonia gas if the manure is not injected into the soil or otherwise immediately incorporated. So even if farmers have manure available at the right time, and know the nutrient content before application, they may not fully realize the benefits if they do not incorporate the manure into the soil.

A survey on current swine manure management practices in Iowa was conducted recently by the Iowa Agricultural Statistics Service for the ISU Department of Economics. Survey results indicate that 72 percent of Iowa's hog producers handle some solid manure on their farms. Based on the number of hogs these producers marketed in 1996, and the percent of total manure handled in solid form on these farms, this represents about 31percent of the total swine manure produced by market hogs in Iowa.

About 36 percent of the manure was generated from market hogs on deep pit systems, 7 percent from hogs on outdoor earthen basins, 9 percent from outdoor formed storage (concrete basins or above-ground steel tanks), and 7 percent from anaerobic lagoons. The remaining 9 percent of manure was generated from hogs on other systems, primarily pasture systems.

Solid manure is most often generated in open front feedlot systems where the manure is periodically scraped and transported to fields. Most producers who handle solid manure control runoff by creating barriers that trap the manure solids. These solids are then transported and spread on nearby fields. Typically, a producer handling solid manure land-applies the manure more frequently than a producer who uses a liquid system, which means producers using solid systems must have application fields that are available year round. Survey results confirm this: 30 percent of solid manure in Iowa is applied in the spring, 15 percent in the summer, 31 percent in the fall and 24 percent in the winter.

Are solid manure systems consistent with effective utilization of manure nutrients? Probably not, for two reasons. First, the nitrogen content of solid manure depends quite significantly on how long it has been exposed to the elements and the type of weather that has occurred before it is scraped up. This means the nitrogen content of solids varies both within a year and between years. Thus, each time manure is hauled, it would have to be sampled and tested to determine proper applications rate. No quick test yet exists for testing manure, although research and development continues.

The second difficulty is a timing issue. Manure nutrients applied in the summer cannot be applied and utilized on growing corn and soybean crops. Pastures can utilize the nutrients, although the efficiency of utilization is low because soil incorporation is not possible. Winter-applied nutrients also cannot be effectively utilized because incorporation in frozen, snow-covered ground is not practical. Waiting until spring to incorporate means the manure has been exposed to early-spring rain and snow, and freezing

and thawing ground. The survey results indicate that 39 percent of solid manure in Iowa is applied in the summer and winter.

Are liquid systems more conducive to effective utilization of nutrients? The survey results show that 34 percent of liquid manure is applied to land in the spring, 9 percent is applied in the summer, 46 percent is applied in the fall, and 11 percent in the winter. Thus 20 percent of liquid manure is applied in the summer or winter, in contrast to the 39 percent of solid manure. This finding is consistent with the notion that farmers with liquid systems have greater manure storage capacity than farmers using solid systems.

Liquid systems also have the advantage that the nutrient content of liquid manure is less variable than solid manure, especially if the stored manure is mixed (agitated) prior to pumping. Testing costs should be lower than with solid systems both because the frequency of tests is lower (liquid is hauled less frequently than solids) and there is less variability in nutrient content across years.

The advantages of liquid manure systems over solid systems in allowing farmers to utilize manure nutrients should lead to a greater proportion of farmers on liquid systems taking nutrient credits for their manure. One of the survey questions asked producers if they adjusted commercial fertilizer applications on their manure fields. Three out of four producers reported that they adjusted N, P and K application rates. This proportion was the same for producers using solid systems and for producers using liquid systems. Whether Iowa producers are taking proper credits is not known however. But 32 percent of the producers surveyed indicated they have prepared a manure management plan. This number is surprisingly high because only the largest Iowa hog producers are required to file formal manure management plans.

Survey results show that 93 percent of producers who reported that they marketed more than 2,000 hogs in 1996 said they adjusted commercial fertilizer rates and 76 percent of these producers

indicated that they had prepared manure management plans. These results suggest that as hog producers get larger, they pay more attention to the nutrient content of their manure and make adjustments in their commercial fertilizer rates.

The finding that larger swine producers manage their manure nutrients more effectively than smaller producers should not be surprising. For one thing, Iowa law mandates that the largest producers obtain a permit from the Iowa Department of Natural Resources (DNR). The permitting process requires filing a manure management plan. (DNR permits are required if a producer has more than 625,000 lbs. liveweight of livestock at any one time. This amounts to producers who have more than 4,167 market- hogs on site at any given time. This level decreases to 200,000 lbs., or 1,333 hogs if the producer uses an earthen basin or anaerobic lagoon.) Also, it is likely that larger producers have more resources available to devote to manure management.

If larger producers manage manure more effectively than smaller producers, then a greater proportion of nutrients from Iowa swine manure will be utilized effectively by crops as the proportion of Iowa's hogs being produced in large-scale facilities increases.

Will swine operations in Iowa continue to get larger? Yes, if current trends continue. One reason for the increase in size is that many modern swine operations employ three-site production systems whereby sows are located on one site, early-weaned pigs are located on a second site, and finishing hogs on a third. This type of production system requires larger units if benefits are to be maximized.

As hog operations get larger, what does this imply about environmental costs and benefits? Many people will think it absurd that this question is even asked. After all, large operations result in greater geographic concentration of manure, which leads to greater odor problems and a greater risk of a large-scale manure accident.

But there are also beneficial environmental effects from large-scale operations. One is that movement to large-scale hog operations in Iowa will likely result in greater utilization of manure nutrients in crop production. There are two reasons for this result.

First, development of a manure management plan costs about the same whether a producer has 300 hogs or 3,000 hogs on a site. The steps required to create a plan are identical for both operations.

But the cost per-hog or per-acre of cropland is less for the large operator than the small operator, which implies that the large operation can justify the cost more easily. This is particularly true for contract operations where the company that issues the contract may supply the contractor with a ready-made manure management plan. These cost advantages also exist for testing the nutrient content of manure. It costs about the same to test nutrients whether a pit holds manure from 300 hogs or 3,000 hogs. Thus, a larger operator will more likely test the nutrient content of manure.

Is size alone an inducement to take proper credit for manure nutrients? Consider two hog producers who both handle slurry from finishing hogs. The first producer raises 1,000 hogs per year. The second raises 10,000 hogs per year. The cost of delivering nutrients from these hogs, if the nutrients are applied at agronomic rates, is approximately $1,400 for the smaller producer. The cost of delivering the nutrients for the large producer depends on how far the slurry must be hauled. A hauling distance of two miles is not uncommon in Iowa. At this distance, the total cost of delivering nutrients is about $19,000.

The potential value of the nutrients in corn production is typically around $2.00 per hog. To realize this potential value requires some investment of time and money in developing and implementing a manure management plan. If this cost is $300 per year, the small farmer can cover the costs of hauling manure and have $300 left over. The larger producer can also cover delivery costs and will have $700 left over.

These results seem to indicate that both smaller producers and larger producers have an incentive to capture the value of nutrients. However, there is a wide difference in the total return to investing the $300 in manure management. The smaller producer realizes a $2,000 return, whereas the larger producer realizes a $20,000 return. Clearly the larger producer has more incentive to take the time and effort needed to capture the value of nutrients.

The second reason larger operations will result in increased utilization of manure nutrients is that as the scale of operations increase, so does the likelihood that the operation will store manure as a liquid. The ISU survey indicates that 69 percent of manure from market hogs is handled as slurry on farms where more than 2,000 hogs are produced on a site. This compares with 52 percent of manure for all of Iowa. As discussed earlier, manure nutrients are more likely to end up being utilized in crop production when manure is handled as slurry.

The conclusion that larger hog operations will better utilize manure nutrients does not necessarily mean that larger operations will be beneficial to the environment overall. Odor problems, the risk of catastrophic spills, and possible links between greater concentration of manure stocks and an increased risk of pathogen contamination of water supplies all suggest that large-scale hog operations can be more environmentally damaging than smaller operations.

But odor problems can be significantly reduced by adopting relatively inexpensive practices, if producers have the incentive to adopt them. Examples of these practices include soil incorporation of manure at the time it is applied, and use of straw to cover outdoor manure storage basins. And the risk of catastrophic spills and pathogen contamination of water supplies can be reduced through added investment in manure storage structures.

If these steps are taken, then there is no environmental reason to fear the industrialization of the hog industry in Iowa. Rather, the future of pork production in Iowa could be one where manure

nutrients are again viewed as a valuable resource to be used to lower crop production costs and to maintain the long-term health of Iowa's cropland.