

Using Risk Assessment to Manage Environmental Challenges on the Farm

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Over the past decade, there has been increasing emphasis placed on the role of farms in both environmental and human health. Much of this attention is a result of high-profile human health and environmental problems. The catastrophic failures of manure storage lagoons, *Pfiesteria* in the waterways of Maryland, and outbreaks of illnesses from food borne *E Coli O157* or waterborne *Cryptosporidium* have drawn heavy media attention. Partially as a result of this increased attention, the US Environmental Protection Agency has intensified efforts to regulate farm practices, mainly through existing authority under the Clean Water Act to regulate concentrated animal feeding operations (CAFO).

New regulatory initiatives and heightened public scrutiny come at a time when much of the agricultural sector is losing money due to heightened competition, reduced federal program support, poor weather, and low commodity prices.¹ When agricultural productivity is reduced, maintenance of a stable farm economy, a viable rural economy, and a reliable domestic food supply is seriously threatened. The livestock industry, currently the focus of EPA efforts, accounts for half of all sales in U.S. agriculture.² However, many current agricultural practices are perceived to result in unnecessary risks to animal and human health, damage to water resources and increasing public, political and regulatory pressure.

Given the potentially contradictory demands of more stringent environmental regulation in the face of a failing agricultural economy, tools are needed to analyze and manage farm resources to maintain profitability while protecting the environment and the health of humans and animals. Risk assessment/risk analysis is well fitted to this type of problem. These methods clearly identify the risk factors involved, allow "what if" analyses of alternative ways of reducing those risks, and provide a way to structure and incorporate complex information necessary for management decisions.

Concepts of "risk assessment" and "risk management" are not new to veterinary science. Whenever a decision is made as to a regime of treatment, there is an inherent balancing of the potential side effects of a treatment with the effects of the illness or condition being treated. Risk management is also inherent in day to day decisions on the farm, both on the economic and animal health side. For example, dairy farmers routinely need to decide whether a cow with mastitis should be treated with antibiotics or culled to salvage its slaughter value. If the cow is treated, potential outcomes include obtaining a cure, a cure with reduced production, a treatment failure, or having the animal die or become unfit for slaughter before the antibiotic withholding time has elapsed. Each of these probabilities has an associated cost, and the decision is further influenced by the existence in the cow of other diseases or conditions, the value of the animal for producing milk, the cow's reproductive status, and other extrinsic factors such as current milk and meat prices and the manager's need to increase or decrease the herd size.

The usefulness of risk analysis has been recognized at the national level, and has been made a required process in the development of federal regulations both by Executive Order and by law (EO 12866 and 7 U.S.C. §55.2204e). However, it is important to point out that the issues faced by

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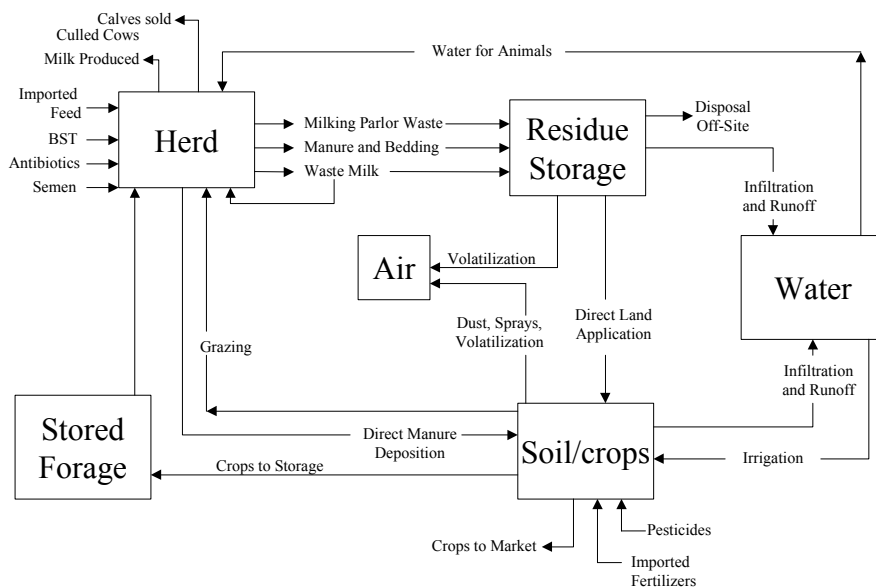
government regulators using risk assessment to help develop national policy decisions are very different than those faced by individual farmers. Therefore, even if the individual uses the same statistical models and decision tools used by government agencies, the individual farmer may make very different choices. Despite these differences, risk assessment is still a potentially powerful way of considering and balancing complex sets of competing interests and factors at the farm level.

Recognizing the increasing importance and utility of risk assessment and risk analysis concepts, the Journal of the American Veterinary Medical Association began running a series of articles on the application of risk assessment/risk analysis in animal agriculture in January 2000. This article is one of the final papers in the series and focuses on the potential role that risk assessment could play, both at the individual farm and at the regulatory level, to manage environmental challenges on the farm.

Risk Assessment and "On Farm" Management – the Nutrient Example

To best understand how risk assessment could be helpful at the farm level, consider the conceptual model of a dairy farm system in Figure 1. Nutrient and pathogen flows are represented among the identified subsystems of the farm at different levels of aggregation within the conceptual model. Outputs from the farm include products for sale (calves, culled cows, crops, and milk) and wastes. Inputs include direct herd inputs (feed, antibiotics, bST, semen) as well as crop inputs (fertilizer and pesticides). The conceptual model emphasizes the major subsystems involved in transporting and transforming materials within the farm system. Transfer and transportation of materials occur within the herd, residues storage (i.e., waste), water, air, soil/crops, and crop storage.

Figure 1: Conceptual Model of Material Flows in Dairy Farm



The conceptual model serves as the basis for the risk assessment process. Note that the conceptual model is not to serve as the end tool. Conceptual model development is the only the first, but potentially most important, step in the process. Through conceptual model development, the linkages between various activities can be identified. These linkages might have been previously ignored or perhaps not even recognized. The conceptual model presented above, for instance, demonstrates the

complexities of material flows and highlights the numerous opportunities for potentially damaging losses to the environment. The model highlights the fact that something as straightforward as changing the feed mixture for a herd may have impacts on nutrient runoff to a stream or infiltration to groundwater. Most efforts to reduce nutrient losses from farms have focused on manure management. Implementation of nutrient management plans and other best management practices (BMPs) on farms are classic, effective approaches.³⁻⁵ Relatively little attention has been paid, however, to the “front end” of the system: management of the herd and feeding program to minimize nutrient excretion. Reducing the amount of N and P in manure through nutrition is a cost-effective approach to reducing nutrient losses from dairy farms. Several studies indicate a direct link between P intake and P excretion.⁶⁻⁷ Most dairy farms overfeed P in the mistaken belief that it benefits herd reproductive efficiency.⁸ The perceived impact of P intake on reproductive efficiency far exceeds the actual effect, and overfeeding is not of benefit.

Similarly, overfeeding N has been shown to increase N excretion.⁹⁻¹¹ Improved efficiency of N utilization allows the same or increased productivity with a lower dietary N concentration, and reduces N excretion. Balancing rations for ruminally degraded and undegraded protein rather than total protein improves efficiency of N utilization and can reduce N excretion by 15%.⁹

Overfeeding of both N and P, therefore, increases excretion, and increases feed costs as well. Why then do farmers overfeed? Farmers are, perhaps unconsciously, using a rudimentary form of risk assessment. Decisions about the nutrient content of diets are made balancing the obvious risks of underfeeding against the costs, both economic and environmental, of overfeeding. To the farmer, the risk of lost production with underfeeding of N is obvious, and the perceived risk of underfeeding P has carried greater weight than the less obvious environmental costs. Use of a more formal risk assessment procedure in farm planning that incorporates all costs, risks, and benefits associated with ration formulation more precisely targeted to the needs of the herd should improve implementation of this BMP.

Risk Assessment as an Interface with Regulatory Agencies

Merely postulating the potential for an impact on nutrient input into the environment from a change in feed would not be sufficient to promote potential recognition of this approach at the regulatory level. This is where the risk assessment approach has its strongest potential impact. As noted above, risk assessment/risk analysis has now become a required element of the regulatory process. If risk assessment tools are also used at the farm level, it places the individual in a much stronger position to present her case to the regulatory agencies, and to potentially influence policy. More importantly, it also provides a tool to clearly demonstrate both the environmental and economic benefit of a proposed approach.

Risk Assessment and Cost-Benefit Analyses

When implementing BMPs on a farm, it is necessary to balance the benefits gained in terms of reduced nutrient input to the environment and possible increases in efficiency of nutrient utilization by crops or livestock with any capital investment required for BMP implementation and potentially increased business and financial risks. Early economic studies of the costs of controlling pollution losses on dairy farms focused on the economic costs and returns from dairy manure storage. Reducing nutrient losses by reducing overfeeding of N and P may be even more cost-effective. The risk assessment approach will allow a scientifically supported basis on which to argue "benefits" that could form the basis of an analysis by the farm manager on which alternative BMPs will produce the least

financial impact (or perhaps an economic benefit from reduced feed costs, etc.) while maximizing the benefit to the environment by reducing the introduction of excess nutrients.

Other on-farm applications of Risk assessment/risk analysis procedures

This brief article does not allow for a detailed discussion of how the risk assessment/risk analysis approach can be used. The nutrient example above is only an isolated part of what a typical, "whole farm" analysis would include. A full-scale risk analysis would also include tracking microbial loads as they cycle through the system and simultaneously analyzing any effects that implementation of a BMP might produce. A strong statistical association between environmental sanitation and intramammary infection in dairy cattle has been found for both coliforms and environmental *Streptococci*.¹² The potential exists to use risk analysis to help farmers determine how improvement of environmental sanitation scores or milking hygiene scores are likely to affect their economic loss due to diseases. Implementation of certain management practices has also been shown to reduce the incidence of shedding of microbial pathogens in waste, to reduce the incidence of mastitis infections, and to reduce the usage of antibiotics on dairy farms. Reduction of pathogen load on the farm may also reduce the pathogen load throughout the food chain. While most cases of food-borne disease are due to improper handling and preparation at the retail and home levels,¹³ enhanced food safety practices on the farm may also help control the incidence of food-borne disease and will certainly go a long way to show the public and legislative bodies that the agricultural community is "doing its part."

Conclusion

Formal risk analysis will continue to be an integral part of the decision making process at the local, state and federal government levels. The application of risk analysis tools to on-farm management offers a way to both help farmers maximize efficiency as well as effectively interfacing with regulators on larger-scale policy issues. Most importantly, risk analysis provides a proven way to manage farm resources to maintain profitability while protecting the environment and the health of humans and animals.

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