

Chapter 5. Animal and Public Health Impacts of Current U.S. Animal Husbandry Systems

No issue is more important economically, or more complex and contentious, than the impacts of large-scale feedlots and confinement systems on animal and bird health, their welfare and performance, reliance on animal drugs, and public health. Regrettably there are linkages between how animals are raised, their health, and our health.

We focus on two of the most important linkages in this chapter – the frequency and economic impacts of foodborne illness from consumption of animal products, and the complications and costs triggered by animal agriculture’s contribution to multiple antibiotic resistant bacteria. In millions of cases every year, these problems overlap.

When people get sick from exposure to antibiotic resistant foodborne pathogens, their health status declines and immune systems are taxed. Most recover without complications, but in a portion of cases, an episode of food poisoning opens the door to more serious problems, which then require a visit to the doctor and more aggressive antibiotic treatment. New complications emerge in a small percentage of cases, triggering hospitalization and sometimes-lengthy illnesses, made longer and more serious by the sometimes-erratic efficacy of antibiotics. It’s a slippery slope and the medical community is deeply concerned by our rapid pace down it.

Millions of people get sick annually from consumption of poultry and livestock products contaminated with foodborne pathogens – the current estimate from the Centers for Disease Control and Prevention is 76 million cases annually. Those impacted miss work and school, must pay for doctor visits and medication, and some face complications leading to, or contributing to hospitalization and in a small percentage of cases, death.

Some aspects of these impacts are relatively easy to translate into dollar impacts. Since the mid-1990s, the U.S. Department of Agriculture’s Economic Research Service (ERS) has invested significant time and talent in compiling sophisticated estimates of the costs associated with doctor visits, the need to take medication, lost wages, and the lost productivity stemming from deaths. We rely heavily on the ERS’s estimates in this chapter, which encompass the most common, well-studied foodborne pathogens. We draw on ERS’s work and recent reports in developing a more comprehensive projection of the costs associated with illnesses caused by all foodborne pathogens, as well as illnesses made more serious by exposures to antibiotic resistance bacteria.

The medical complications -- and costs to society -- stemming from 76 million illnesses caused annually by foodborne pathogens, coupled with the emergence of antibiotic resistant pathogens, some of farm origin, are difficult to quantify but assuredly enormous. The costs dwarf all other unintended “externalities” arising from how animals and poultry are raised in the United States. **If changes in the way animals are raised could cut these costs by just one-third – evidence is presented suggesting a 50 percent cut is attainable with current knowledge and technology -- the annual savings would more than finance any necessary transformations in the U.S. livestock**

and poultry industries, and within just a few years. Done well, this process would in all likelihood increase farm profits and the safety of those working on animal farms and processing industries. The end result will also lessen agriculture's impact on water quality and could trigger an explosion in U.S. exports of a wide range of animal products to a world increasingly aware of food safety and animal disease risks.

A. The Husbandry-Health Connection

With increasing clarity, scientists and animal-industry insiders are acknowledging the linkages between the scale and concentration of animal and bird housing systems, the incidence and severity of animal stress and disease, and food safety and human disease. Some examples follow.

“During the [swine] breeding herd expansions of 1993-99, U.S. herd health fundamentals were compromised on many farms.... herd health challenges have increased along with average herd size.”

“We still have many good performing farms, but poor health is dragging down the average in some systems because producers are pushing harder to put more pigs out the door. We have tried all types of management techniques but we always come back to basic health control procedures.”

Dr. Brian Caldwell

South Central Veterinary Clinic

Wells, Minnesota (*Feedstuffs*, “Hog Industry Insider,” 6/19/00)

In October 2000 the USDA's “National Animal Health Monitoring System” (NAHMS) released an extensive national survey of the prevalence of *Salmonella enterica*, serotype Enteritidis (SE) on poultry farms (NAHMS, APHIS, 2000). Isolates were found on 7.1 percent of layer houses monitored, ranging from zero percent in the Southeast to 17.2 percent in the Great Lakes region. The impact of scale of operation was unmistakable –

“Approximately 4 percent of [layer] houses with fewer than 100,000 layers were environmentally positive for SE, while 16.5 percent of houses with 100,000 or more layers were environmentally positive...positive houses had an average of more than 109,000 layers versus an average of fewer than 65,000 layers in environmentally negative houses.”

Beef cattle feedlots with 8,000 or more animals are almost twice as likely to use an injectable antibiotic when introducing new animals into the lot than operations feeding 1,000 to 7,999 animals (NARMS, “99 Feedlot, Part I, May 2000). Larger lots implanted cattle with growth hormones three or more times more frequently than smaller lots and also administered probiotics, a new class of growth promoters, about twice as frequently. About 58 percent of all female cattle placed in mid-sized feedlots (1,000 to 7,999 head) were fed melengesterol acetate, an estrogen compound that suppresses the animal's heat and increases feed efficiency, while over 82 percent were fed this drug in lots feeding

8,000 or more cattle. Larger feedlots rely much more heavily on concentrated, high-energy feeds than smaller lots. According to the May 2000 “99 Feedlot” report –

“Large operations (71.7 percent) were more likely to feed finishing rations with 75 percent or greater energy concentrate on a dry matter basis than small operations (54.7 percent). Over 25 percent of small operations fed a finishing ration containing 0 to 35 percent concentrates on a dry matter basis compared to 8.6 percent of large operations.” (NAHMS, *99 Feedlot: Part I*, 2000).

Drug use is also more common and intensive in large beef feedlots, as clear from a review of the Part III of the NAHMS survey of beef feedlots, which focuses on health management and biosecurity (NAHMS, *99 Feedlot: Part III*, December 2000). Over 80 percent of large feedlots administered an injectable antibiotic to treat shipping fever and respiratory disease compared to 26 percent of small lots. Treatments for bovine respiratory disease complex are twice as prevalent on larger lots (15.5 percent of cattle infected) than smaller lots (8.7 percent infected). Fluoroquinolones, a class of antibiotics with critical uses in the treatment of human diseases, were also more than twice as likely to be used on large lots than smaller ones.

Larger lots spent on average \$61.10 on drugs to treat a sick animal whereas smaller lots spent \$48.60, or 26 percent less.

An October 2000 “Hog Insider” article discusses a new hog gut disease, porcine colonic spirchetosis (PCS). *Feedstuffs* acknowledges that –

“As hog farm size mushroomed in the 1990s, new diseases emerged despite segregated early weaning and multi-site systems.”

The June 19, 2000 “Hog Insider” identifies some of the reasons why –

“In an obsession with the bottom line, producers mix sources, increase pig-stocking density, relax sanitation and disinfection standards and fail to vaccinate. Pressure to put more pigs into a given space and failure to adhere to all-in, all-out principles can fuel health breakdowns. Vertical disease transmission becomes harder to control as operations expand.”

“[Dr. Brian] Caldwell said 90% of herd health problems are related to pathogen entry. Pig-to-pig contact is the primary disease vector. Manure movement is second...Hog density is a primary factor.”

In Iowa, the State Department of Agriculture is proposing new rules to contain the spread of swine pseudorabies virus (PRV), and perhaps one day eradicate this damaging disease, as many other states have done. New outbreaks lead to strict quarantines, disposal of infected animals, rigorous vaccination and testing requirements, and new controls over hog movement. Among the producers plagued by a recent outbreak, Linus Solberg, an Iowa breeding stock producer attributes his outbreak to windborne infectious

materials, either from nearby large operations or passing trucks, and the failure of producers to vaccinate infected herds as required by PRV eradication and quarantine rules. But current rules are not enforced strictly enough and set-backs between operations are too small, according to Solberg. He states in a *Feedstuffs* article –

“We need one-mile setbacks. It’s not just PRV. These big herds are dragging in a lot of problems.”

1. Impacts of Scale and Husbandry on Disease Prevalence

Recent USDA surveys, research, and reports have begun to address, albeit gingerly, the implications of changes in the scale and intensity of animal agriculture on animal product food safety and human health complications. In the case of salmonella, among the most common and costly foodborne pathogens, a majority of cases stem from egg consumption. One serotype, *S. enteritidis*, has become the most common cause of salmonellosis from eggs. The ERS report “Bacterial Foodborne Disease: Medical Costs and Productivity Losses (ERS, AER-741) includes the following passages:

“Some evidence (e.g., 1985 outbreak traced to milk) exists to support the theory that widespread use of antimicrobials (i.e., tetracycline) for both human illnesses and animal husbandry has led to an increase in resistance and infection with specific strains of *Salmonella*.” (page 21).

“...the trend in food production toward a relatively small number of large producers make catastrophic consequences from *Salmonella* contamination possible. A case in point is the 1994 Schwan *Salmonella* outbreak, associated with the consumption of ice cream, which led to around 100,00 cases in 25 states...”

“...large and dispersed outbreaks have been shown to cross state and national boundaries. For example, in 1984, a large international airline served Salmonella-contaminated food on 29 flights from London to the United States over a 3-day period, affecting an estimated 2,737 passengers...”

An FDA scientist wrote in 1991 that:

“Treatment with antimicrobial agents can actually promote Salmonella infections in both humans and animals, particularly if the infecting strain is resistant to the agents used.” (Tauxe, *J. Food Protection*, July 1991; also quoted in ERS, AER-741).

In 1995 the USDA’s “National Animal Health Monitoring System” (NAHMS) carried out a survey of swine producers that included the sampling of 50 fecal samples on hundreds of farms to test for the presence of Salmonella and other foodborne pathogens. Southeastern operations were more than twice as likely to test positive (65.5 percent) compared to operations in the Midwest (29.9 percent). Hogs shed Salmonella in their

feces on less than one-third of farms raising 2,000 or fewer animals annually, while 57.1 percent of farms marketing 10,000 or more hogs tested positive.

The NAHMS released a report in 2000 on *Salmonella enterica* (SE) on egg layer farms. As noted above, larger flocks were about twice as likely to test positive for SE. In addition, the survey established that rodent control in and around houses was a key risk factor, and that the Hy-line breed was markedly less susceptible to SE. Significantly, flocks that had gone through induced molting in the past 16 weeks were 9.3 times more likely to test positive for SE than flocks that were 60 or more weeks of age and unmolted. (Induced molting involves withdrawing feed and water from egg layers for up to two weeks to force birds to molt [which causes them to lose their feathers], after which egg production increases. This practice is discussed further below).

Younger flocks were 4.7 times more likely to test positive than older, unmolted flocks. Flocks in excellent health and those not reporting any concurrent disease were about half as likely to test positive for SE. Floor reared flocks were 5.9 times more likely to test positive for SE than flocks that were caged reared. None of the egg layer houses using a flush system to manage manure tested positive whereas 13.4 percent of the houses with high-rise system or deep pits for manure tested positive for SE. None of the houses tested positive on farms where feeders or hoppers were cleaned and disinfected between each flock, and the washing of walls, cages, and ceilings reduced the likelihood of infection.

The NAHMS survey of egg layers demonstrates the value of careful surveys of the linkages between on-farm management, bird health and welfare. This survey, the most comprehensive and detailed ever done in the U.S., leads directly to several important conclusions. To lower the frequency of SE infections –

- Attention to and efficacy of rodent control efforts must be enhanced.
- Additional steps are warranted to keep young birds healthy, including use of vaccines and competitive exclusion products when layers are young, especially in houses with a history of SE.
- Houses should be thoroughly cleaned and disinfected between flocks.
- A moratorium on forced molting should be adopted until a less stressful method is developed that does not heighten risk of SE infections.
- Greater attention to, and in some cases, changes in manure management systems and practices will be necessary to lower infection rates.

2. New Science on Food Safety Consequences Builds Momentum to End Forced Molting

For years some three-quarters of U.S. egg producers have increased production through a practice called “forced molting.” By denying older birds access to feed or water for 7 to 14 days, the birds are forced into a premature molt. In the process they lose about one-quarter of their weight, but when feed is restored, they lay bigger eggs with firmer shells. But by the mid-1990s, USDA research had established a link

between forced molting and weakened immune response and enteric disease susceptibility, leading to increased salmonella risk in people consuming undercooked eggs. The 1999 NAHMS egg layer survey on SE confirmed the linkages, as noted above.

In a 1998 draft report, USDA’s Food Safety Inspection System estimated that eliminating forced molting would reduce human illness from salmonella by about 2 percent (cited in the *Washington Post*, 4/30/00).

The State of California assembly held hearings in 2000 on a bill to end the practice. Al Pope, President of the United Egg Producers (UEP), told the *Washington Post* in April, 2000 that –

“Ultimately, it’s the science that will dictate what we do. We would not like to eliminate [induced molting] because it has so many benefits, but we may not have much choice.” (*Washington Post*, 4/30/2000)

In August 2000, MacDonald’s Corporation issued precedent-setting animal husbandry guidelines to its 27 suppliers of eggs. Developed by a six-member council of animal behavior and health specialists, including three members also serving on the UEP’s advisory board looking into the same issues, the MacDonald’s guidelines specified minimum cage space per bird (72 square inches, almost double today’s industry average of 48 square inches) and that food and water withdrawal to induce molting must be stopped by early 2001. In discussing this requirement, Bob Langert, MacDonald’s director of community and public affairs, explained that the company was not against induced molting, just feed deprivation as the mechanism to trigger it. But since withholding feed is the only practical way to do so, this requirement boils down to a prohibition on the practice (*Feedstuffs*, 8/28/00).

While moving in the same direction as UEP’s husbandry guidelines, MacDonald’s went further than the industry in several key respects. In an effort to catch up, the UEP issued new animal husbandry guidelines in October 2000. The industry guidelines called for a 12-year transition to cages providing between 67 and 86 square inches per bird, depending on bird size (*Feedstuffs*, 10/16/00). And until alternative ways to induce molting are discovered, the UEP guidelines call upon farmers to withdraw feed for “the shortest period possible.”

To place these dramatic changes in U.S. poultry husbandry guidelines in perspective, mandatory new European regulatory standards must be fully adhered to by 2012 and require 116.3 square inches per bird, as well as nesting spaces, perches and sand boxes. Forced molting is also no longer permitted.

B. The Incidence of Human Food Poisoning from Animal Products

The Center for Disease Control and Prevention estimates there are 250 foodborne pathogens, many of which routinely reside in the digestive systems of healthy farm animals. These pathogens infect people through a variety of mechanisms – direct contact

on the farm, breathing of infected dust particles, through contact with manure, insect bites, via veterinarians and other animal handlers or workers in slaughterhouses, cross contamination in the slaughter house, in food manufacturing or in the home, through drinking water or consumption of animal products, and last but of growing importance, person-to-person contact.

As noted above, new diseases are emerging and old ones are becoming more virulent and costly, as they become resistant to more and more antibiotics.

1. Recent CDC-USDA Statistics on Foodborne Illness

Several government agencies have established FoodNet, a cooperative effort to better track the frequency, severity, and consequences of foodborne illnesses. The Centers for Disease Control and Prevention (CDC) is the principle source of data on the number of cases caused by various foodborne pathogens, including cases leading to hospitalization and death. The USDA's Economic Research Service is responsible for estimating the economic impacts of foodborne illness, a task which USDA has invested sizable resources in since the mid-1990s. Table 5.1 summarizes the most recent data available on the five known sources of foodborne illness (the table includes two types of one bacterium, *E. coli*).

	Cases	Hospital-izations	Deaths
Campylobacter spp	1,963,141	10,539	99
Salmonella	1,341,873	15,608	553
<i>E. coli</i> O157:H7	62,458	1,843	52
<i>E. coli</i> , non-O157 STEC	31,229	921	26
Listeria monocytogenes	2,493	2,299	499
Toxoplasma gondii	112,500	2,500	375
	3,513,694	33,710	1,604

According to CDC, foodborne pathogens annually cause 76 million cases of human illness, 323,000 hospitalizations, 5,200 deaths, and an unknown number of chronic conditions. Since many cases go undiagnosed or unreported, the actual number of cases may be significantly higher. The adverse consequences of foodborne pathogens is clearly growing worse each year, as more and more bacteria become resistant to more and more antibiotics, complicating treatment of a growing number of patients and opportunistic infectious.

CDC experts point out another unknown – the role of foodborne pathogens and illness in triggering various health problems and complications that cannot subsequently be traced to exposure to an infectious agent in a person's food. In thousands, and perhaps millions of cases each year, exposure to foodborne pathogens plays a role – in some cases

major, in others, minor – in triggering a cascade of events that result in minor to major health consequences. These uncertainties and linkages must be sorted out to sharpen projections of the total social costs associated with human exposures to foodborne pathogens. The costs covered in this chapter, and in recent government reports, are only those for which adequate data exist to approximate the number of cases and their consequences.

Equally important, scientists have much work to do to determine which pathogens emerge as problems largely from reservoirs within farm animals, in contrast to pathogens that are not resident in farm animals, but come to contaminate foods as it is processed, handled and prepared. For pathogens that do not reside in animals, steps to reduce stress and disease pressure on the farm, and improve animal health overall, would not be expected to have a significant impact on rates of infection. Likewise, foodborne illness should not be held solely responsible for all the medical costs and lost productivity stemming from cases where people become seriously ill, or die from complications triggered or made worse by a foodborne pathogen, but also caused by another, pre-existing medical condition, like AIDS or treatment with a chemotherapeutic agent that can depress immune system function.

2. The Social Costs of Foodborne Pathogens

Scientists have compiled extensive national data on several known foodborne pathogens. As part of the government's FoodNet program, CDC data on the annual number of illnesses, hospitalizations, and deaths stemming from foodborne pathogens have been provided to the Economic Research Service (ERS), which has in turn estimated the costs of illnesses triggered by five of the leading causes of foodborne illness (see Table 5.1). The mid-range costs are sizable, estimated by ERS at \$6.9 billion in 2000 for five leading pathogens. Costs associated just with salmonellosis in 1999 were estimated at \$2.4 billion by ERS. For *Campylobacter*, the mid-range estimate is \$1.2 billion. High-end estimates by ERS are several-fold higher; in a 1997 report ERS estimated high-end *Campylobacter* costs at \$5.6 billion (Buzby, et al., ERS Report No. 756, July 1997).

ERS points out that these cost estimates cover just illnesses triggered by these pathogens via food consumption, not all cases of illness triggered by the various pathogens through other routes of exposure. The costs include the expenses associated with medical complications, as well as productivity losses from days off work. In the technical footnotes to tables posted on the ERS website (see <http://www.ers.usda.gov/Emphases/SafeFood/features.htm> >), the text states that its current estimates of costs probably understate the full costs because several impacts are hard to measure and place a value on. There are no estimates of costs stemming from many moderate cases that do not trigger hospitalization or a doctor's visit, but nonetheless have an impact on a person's ability to carry out normal functions. In addition, no attempt is made to capture a person's willingness to pay to avoid pain and suffering.

ERS estimates are not available for the economic costs stemming from the approximately 10.3 million cases of illness triggered by other known pathogens, the bulk of which are associated with Norwalk-like viruses. Nor are ERS cost estimates available for the 62 million other cases of foodborne illness each year caused by unknown pathogens. Some of the rarer known pathogens triggering illnesses are much more serious than *Salmonella* and *Campylobacter*, which typically cause little more than 48- to 72-hours of digestive system problems in healthy adults. For example, of the 47 patients with *Vibrio vulnificus* infections, 43 were hospitalized and 18 died; 46 of 58 patients with botulism were hospitalized, and just 4 died (almost 7 percent).

On average, the 3.53 million cases triggered by the five most common foodborne pathogens in 2000 cost society \$1,964.00 per case, based on the ERS's cost estimates for 2000 (labeled "Five Leading Pathogens" in Table 5.2 below). We developed a method to project the costs associated with the other 10.3 million cases of illness caused by "Other Known Pathogens" (13.8 million total cases of "Known Origin" minus 3.5 million cases from the five leading pathogens).

We used the percent of cases leading to hospitalization and death as an indicator of the relative costs of an illness caused by an "Other Known Pathogen" in contrast to an illness caused by the five pathogens. The "Other Known Pathogens" triggered the need for hospitalization, and death, less frequently than the five leading pathogens. Accordingly, we adjusted the average \$1,964.00 cost of a "Five Leading Pathogen" case downward based on the lessened frequency of hospitalizations and death. (The assumptions and method are described at the bottom of Table 5.2).

Using this method we estimate that the average cost of the 10.3 million "Other Known Pathogen" cases is \$395.00, about 20 percent of the cost of an illness caused by the five leading pathogens. This estimate assumes that the average cost of hospitalization stemming from an illness is the same across all pathogens, and that the costs attributed to each death are calculated in the same way. The lower cost is a function of the lessened frequency of both hospitalizations and death.

Our \$395.00 estimate per case is very close to ERS's estimate of the cost of salmonella cases that result in no complications and no visit to the doctor. In 1993 dollars, the ERS estimates each *Salmonella* case not requiring treatment costs \$371.00. Adjusted for inflation, this figure would be close to \$395.00 (Table 7, ERS, AER-741).

A similar approach and set of assumptions was used to estimate that the average cost of the 62 million other illnesses caused by unknown pathogens was \$454.00, about 23 percent of the cost of the average case stemming from the "Five Leading Pathogens."

Health Cost Estimates in Perspective

To place our \$395.00 and \$454.00 cost per illness estimates in perspective, consider the impacts of a routine case of food poisoning not associated with complications leading to hospitalization. Some small percent of those afflicted tough out

the illness and do not miss any work and do not call their doctor or take any medication. For these people, ERS calculates little cost from the cases, since pain and suffering are not included. In the case of salmonellosis, ERS recently placed a cost of \$24.00 on cases requiring no treatment (*FoodReview*, May-August 1999).

But most people miss one to three days of work, at a cost of a few hundred dollars to a thousand or more, depending on annual salaries. Some portion of these people call or visit their doctors, a clinic, or an emergency room. ERS estimates that one person is hospitalized for each 3.36 people that visit their doctors (Table 6, ERS, AER-741). The higher costs associated with these more serious cases inflate the average cost of cases by several-fold. On average, ERS estimates people visiting doctors for salmonellosis miss about 4 days of work.

On average about 7 percent of salmonella cases lead to a physician visit. The average cost of cases requiring a doctor's visit, but no other complications, is \$315.00, based on a 1999 ERS update of an earlier study. In a 1996 ERS report, the estimate was \$794.00, whereas the average cost of cases requiring no treatment was estimated as \$371.00. The more recent \$315.00 estimate for cases leading to a doctor visit includes the cost of the appointment, tests, and medication. For the approximately 2 percent of cases leading to hospitalization, the average stay in the hospital was just over 4 days (Frenzen et al., *FoodReview*, ERS-USDA May-August 1999). Costs were estimated by ERS in 1999 at \$5,460.00 per hospital case, down from the 1996 estimate of \$9,087.00. An estimated 94 percent of the people hospitalized recover fully but about 6 percent die. Most deaths are among the young, elderly, and people with other health problems. Across all salmonella cases, about 0.1 percent prove fatal. Fatalities account for the largest share of estimated costs.

In the case of campylobacteriosis, ERS estimates that 5.4 percent of cases trigger a visit to the doctor, and 0.6 percent hospitalization. Infections are now the most common cause of Guillain-Barre syndrome (GBS), the leading cause of acute neuromuscular paralysis in the U.S. (Buzby, et al., *Estimated Annual Costs of Campylobacter-Associated Guillain-Barre Syndrome*, Agricultural Economic Report No. 756, July 1997). Less than one-in-ten doctor visits for illnesses triggered by *Campylobacter* results in hospitalization, and the death rate is lower than the case with salmonella infections. ERS estimates that each case requiring no doctor visit costs \$371.00 and each case leading to hospitalization costs \$794.00 on average.

An estimate can be made of the costs to society of 76 million annual cases of foodborne illness based on CDC incident data, ERS estimates of the average cost of cases from the five leading pathogens (\$1,964.00), and our estimates of the average costs of illnesses triggered by other known pathogens (\$395.00) and unknown pathogens (\$454). The result is a staggering \$39 billion dollars. The derivation of these estimates is presented in Table 5.2.

Table 5.2. Estimates of the Annual Number of Illnesses, Hospitalizations, Deaths, and Associated Costs Stemming from 76 Million Cases of Foodborne Illness					
	Number of Illnesses	Hospitalizations	Deaths	Average Cost per Case	Total Costs
Known Pathogens					
Five Leading Pathogens	3,513,694	33,710	1,604	\$ 1,964.00	\$ 6,900,895,016
Other Known Pathogens	10,301,230	27,144	205	\$ 395.09	\$ 4,069,912,961
Total Known	13,814,924	60,854	1,809	794.13	\$ 10,970,807,977
Unknown Pathogens	62,000,000	263,000	3,400	\$ 454.10	\$ 28,154,200,000
All Pathogens	75,814,924	384,708	7,018	\$ 516.06	\$ 39,125,007,977
Data Sources:	Number of illnesses, hospitalizations, and deaths from CDC data.				
	Average cost per case for "Five Leading Pathogens" from ERS analysis. Costs include medications, physician visits, hospital charges, and lost productivity from missing work.				
Assumptions:	Average cost per case for "Other Known" and "Unknown Pathogens" is the cost estimate for "Five Leading Pathogens" divided by an adjustment factor.				
	Adjustment factor for "Other Known Pathogens" is 4.971, and for "Unknown Pathogens" the factor is 4.325. (\$1,964 divided by 4.971 equals \$395.09).				
	Adjustment factors based on the number of hospitalizations and deaths as a percent of total illnesses for the "Five Leading Pathogens" relative to the comparable frequencies for "Other Known" and "Unknown Pathogens."				

In a summer 1999 article in *FoodReview*, the team of ERS experts working on the costs of foodborne disease published an article entitled "Assessing the Costs and Benefits of Pathogen Reduction." **ERS states that the costs associated with just seven major pathogens causing human illness ranges between \$6.6 billion and \$37.1 billion annually** (Crutchfield, et al., *FoodReview*, May-August, 1999). These pathogens account for just 3.9 million cases out of a total 76 million, or only one out of every 19. These findings reported by ERS suggest that our \$39 billion estimate of total costs is likely conservative.

Uncertainties and Caveats

There are many uncertainties in these estimates. As scientists gain better understanding of the links between foodborne pathogen illnesses and various health outcomes and complications, the projections can be sharpened. New information will lower the average cost associated with some pathogens and cases and raise others. In all likelihood, better information will, on average, push the estimates upward.

But one conclusion is unavoidable – foodborne pathogens from livestock and poultry impose on society very high costs as a result of millions of illnesses annually. Actual impacts probably fall somewhere in the range \$40 billion to \$80 billion. Even the low-end estimate equals almost half the annual farm value of all beef, pigs, milk, and poultry products sold by American farmers.

3. Potential Economic Benefits from Reducing the Incidence of Foodborne Pathogen Illnesses

The enormous scale of foodborne pathogen costs leads to an obvious and critical question -- To what extent can changes in the ways animals are raised reduce the reservoir of pathogens on the farm, in manure, and reaching people via food, drinking water, the air or direct contact?

No one knows the answer but the evidence is clear that significant reductions can, in fact, be made. As noted earlier, USDA has estimated that elimination of just one common practice on egg farms – induced molting – would reduce the incidence of salmonella cases in humans by 2 percent (April 30, 2000, *Washington Post*, citing a USDA Food Safety Inspection Service draft report).

One of the most serious foodborne pathogens is the *E. coli* 0157:H17 serotype, first recognized as a human pathogen in 1982. Nearly all human infections with *E. coli* 0157:H17 have been traced to consumption of beef and dairy products, with undercooked hamburger likely the leading cause (see the extensive review by Hussein, “On-farm factors can decrease the transmission of *E. coli* contamination,” *Feedstuffs*, 3/13/00).

The pathogen is widely spread around the world and in the U.S. beef and dairy cattle herds, but infection is typically at relatively low rates in a given herd, between a few percent and rarely greater than 10 percent. Infection rates are highest in the spring and late summer and young animals are known to be more susceptible. According to Hussein, an associate professor of veterinary medicine, “...environmental factors such as cold weather may impose difficulty for the horizontal transmission of *E. coli* 0157:H17 infection, reinfection or colonization.” (*Feedstuffs*, 3/13/00).

Several on-farm management factors have been shown to influence the prevalence of *E. coli* 0157:H17 and an animal’s tendency to shed the pathogens through manure. Ruminant manure application to pastures is a risk factor, in part because *E. coli* 0157:H17

retains its infectivity for long periods in manure, lasting for 21 months in a manure pile in one study (Hussein, *Feedstuffs*, 3/13/00). Longer periods of time between manure application on pastures and introducing grazing animals are recommended to lower reinfection rates, as is frequent cleansing of water troughs.

A review by Cornell University animal science professor Alice Pell identified a number of steps dairy farmers can take to reduce transmission and illnesses from foodborne pathogens found commonly on dairy farms (*J. Dairy Science*, 1997, 80:2673-2681). Pell cites several studies suggesting an *E. coli* 0157:H17 incidence on dairy farms between 1 percent and 5 percent. A few infected cattle are found on nearly all operations tested. To reduce pathogen incidence and spread, Pell recommends steps to:

“...ensure the provision of clean, unstressful environments to reduce disease susceptibility and the careful handling and spreading of manure from animals at risk for infection, especially young calves. Composting and drying manure decreases the number of viable pathogens. Environmental controls, such as filter strips, also reduce the risk from water contamination.”

Contaminated feed is often a source of infection. *E. coli* was found in 30 percent of the cattle feed samples tested in one 1998 study, although no *E. coli* 0157:H17 was among the isolates found. Cross-contamination from manure to on-farm raised or stored feed is a likely method of transmission. Increasing the portion of roughage in cattle diets toward the end of their stay in feedlots has been shown to reduce the prevalence of *E. coli*. According to Hussein's review in *Feedstuffs*, a combination of on-farm management practices and strategies can substantially reduce the prevalence of *E. coli* 0157:H17 pathogens in the nation's beef and dairy herd. He recommends further research to isolate the most cost-effective practices.

Further reductions are possible through implementation and refinement of HACCP (Hazard Analysis Critical Control Point) innovations in slaughterhouses. **A recent ERS study estimated that HACCP procedures could reduce the frequency of four leading foodborne pathogens leaving slaughterhouses on processed animal products by between 20 percent and 90 percent, with about a 50 percent reduction being viewed as plausible** (ERS, AER-791). Clearly, such a dramatic reduction could save the country billions, and certainly would be cost-effective, since USDA estimates the total annual cost of HACCP at a little over \$1.1 billion.

Based on the evidence and studies cited above on the impacts of scale and husbandry systems on disease, we estimate, conservatively, that at least one-third of human cases of foodborne illness could be prevented by on-farm innovations and management system changes designed to reduce pathogen reservoirs in farm animals and transmission from animals to animals, and animals to people. Many of the proven pathogen reduction strategies are clearly more likely to be cost-effective on moderate scale livestock and poultry farms since the two common themes in all studies is to reduce animal stress and exposure to other diseased animals, and the careful management of manure so that it does not cross-contaminate feed or animals via water, the air, or feed.

Further reductions are possible in the slaughterhouse as a result of skillful adoption of HACCP procedures. By more carefully handling uncooked meat and poultry to avoid cross-contamination, and by properly cooking food, further progress can be made. Together, the knowledge and technology almost certainly exists now to cut foodborne illnesses in half or more, saving the nation tens of billions annually. Plus, ongoing research is bound to lead to novel ways to prevent problems. For example, Agricultural Research Service scientists have discovered that *E. coli* 0157:H7 and *Salmonella typhimurian* bacteria in the digestive systems of beef cattle and hogs can be dramatically reduced right before slaughter by feeding sodium chlorate, and at a cost of about \$0.10 per hog. Treatments have reduced pathogen density 150-fold within just 16 hours (McGraw, 2001). Other novel strategies are sure to be discovered. When integrated with other, proven methods, the incidence of disease will start to decline.

While other externalities from animal agriculture are important and costly, none come close to the magnitude stemming from illnesses triggering, or made worse by foodborne pathogens. These costs are heightened by medical complications stemming from the growing prevalence of multiple-antibiotic resistant bacteria, our next topic.

C. Farm Animal Antibiotic Use and Public Health Consequences

The prevalence of antibiotic resistant human pathogens, many of which are of food origin, is increasing, as is the percentage of serotypes that are resistant to two or more antibiotics. Some are resistant to four or more. Because of the propensity of bacteria to share genes, resistance that emerges first on the farm can and does move into bacteria infecting people in multiple ways, times, and places.

In a report issued by the CDC in 2000, the proportion of pneumococcal bacteria resistant to three or more common antibiotics increased from 9 percent in 1995 to 14 percent in 1998. Over 30 percent of children under age 5 in the study were infected with bacteria resistant to penicillin. Another CDC study published in the *Journal of the American Medical Association* discussed 13 cases of salmonellosis in children where the pathogen was resistant to the drug of choice, ceftriaxone. The reference section contains an extensive list of recent articles in leading medical journals addressing the ever-increasing severity of the problem, and the toll it is taking in human lives and serious health complications.

Antibiotics and antimicrobials are heavily used in livestock and poultry production. Nontherapeutic doses through feed and water are delivered for growth promotion and disease prevention, and account for the lion's share of total national antibiotic use. The recent Union of Concerned Scientists (UCS) report *Hogging It: Estimates of Antimicrobial Abuse in Livestock* (Mellon et al., UCS, 2001), reached the following conclusions –

- Total nontherapeutic antimicrobial use in producing beef cattle, swine, and broiler chickens is 24.6 million pounds annually, up about 50 percent from 1985, with poultry accounting for most of the increase.
- About 3 million pounds of antibiotics are administered to people to treat human diseases.
- Seven pounds of antimicrobials are fed to essentially healthy livestock and poultry for every pound used to treat human disease.
- About 13.5 million pounds of antimicrobials fed to livestock are the same drugs that play important roles in human medicine.

1. Recent Evidence Settles a Decades-Long Debate

Since farmers began feeding low rates of antibiotics to livestock in the 1960s to promote growth and combat disease, scientists have worried that this practice would accelerate the emergence of resistant strains of bacteria, some of which might find their way from livestock to humans, and then complicate treatment of a variety of diseases. Lacking the tools to prove the linkages, the scientific community divided into two camps, with most veterinarians and animal scientists dismissing the linkage as unproven, while most public health and infectious disease physicians voiced concern and caution.

For three decades little changed. But in Europe in the early 1990s, where antibiotics were also used heavily in intensive livestock production, scientists began to apply new and powerful molecular tools to precisely identify bacterial pathogens making people sick in hospitals. These tools were used to trace bacterial serotypes back to the farms from which they originated. Several clear-cut cases were documented in the scientific literature, leading to a consensus in Europe that livestock use of antibiotics was a major source of multiple antibiotic resistant foodborne pathogens. Driven by a healthy dose of public concern, this new science was translated rapidly into regulatory actions. Steps were taken in the mid-1990s to stop the nontherapeutic use of more than a dozen antibiotics used in livestock and poultry production that also were important in treating human diseases.

Scientists in the U.S. and the CDC closely followed developments in Europe and have begun applying the same epidemiological research techniques. While the U.S. public health community has much catching up to do, a consensus has now emerged that steps are needed to curtail this problem. It is accepted that changes in on-farm antibiotic use must be among the remedial actions taken.

The UCS book *“Hogging It”* reviews recent biomedical literature from the U.S. and Europe on the evidence linking nontherapeutic use on farms to the emergence of multiple antibiotic resistant strains of bacteria causing human illness, including many serious and lethal cases. The severity of this problem is chilling and has triggered near panic in the infectious disease community, as well as unprecedented global cooperation,

through a multifaceted World Health Organization (WHO) initiative. Even the U.S. Food and Drug Administration – long a defender of nontherapeutic uses -- has recently acknowledged the problem is real. Across the U.S. government a broad-based review of current policy and research needs is underway and changes in regulatory policy are just a matter of time, but it might be a long time if the politics governing USDA and FDA actions on antibiotics prove as resistant to change as some fear.

2. The Costs of Resistance from Animal Use of Antibiotics

No one has estimated the costs to society stemming from the slipping efficacy of antibiotics in treating human diseases. There is also no way to accurately estimate the degree to which on-farm antibiotic use has contributed to the problem. The importance of developing sounder data to address both issues is high and rising as new and more virulent pathogens move around the world, causing a growing diversity of medical complications.

In the U.S. there are about 120 million courses of treatment with antibiotics prescribed by doctors through their offices (outpatient use) each year, and 80 million courses of treatment in hospitals (inpatient use). The prevalence of resistant bacteria has no doubt increased the costs of the average course of treatment in cases involving bacteria resistant to one or multiple drugs. It has forced doctors to use antibiotics with more significant side effects, which can be less reliable and are typically more costly than once-effective drugs. Higher dose rates are also generally necessary, and some patients will have to go to the hospital, who might have otherwise been adequately treated on an outpatient basis. Many hospital stays stretch on longer than they would otherwise to give doctors time to clear up lingering infections.

To place these costs into perspective, we have developed rough estimates of the magnitude of the impacts of antibiotic resistance on the cost of antibiotics administered on an outpatient and inpatient basis and on the costs of extended hospitalizations. We do so by estimating the costs of drug use, physician visits, and hospital charges under today's level of resistance, in contrast to estimates of what the costs would likely be if resistant pathogens were uncommon and all antibiotics worked roughly as well as when they were first introduced for treatment of human disease.

With today's levels of antibiotic resistance, an average outpatient course of treatment lasts 10 days and costs about \$80.00, with some newer drugs costing as much as \$150.00 per 10- to 14-day course of treatment. Doctor visits to diagnose the problem and get the prescription cost, on average, \$90.00. The total cost across 120 million illnesses and courses of treatment is \$20.4 billion, as shown in Table 5.3, and the average cost per patient is \$170.00, obviously a conservative estimate.

For patients in the hospital, who are sicker and typically more vulnerable to complications, the average course of treatment costs far more. Drug costs alone are estimated at \$24 billion. Under current levels of resistance, we estimate that the average stay in hospitals is 9 days, at an average cost of about \$2,000.00 per day. This includes

physician fees, infection-related diagnostic tests, and hospital charges. But not everyone receiving antibiotics in the hospital is admitted for treatment of an infection. Other illnesses, injuries, or surgery are responsible for a major share of the total costs of hospital stays. In our estimates, we assumed that on average one-fifth of the cost of hospital stays plus physician fees could be attributed to the infection triggering the need for the antibiotics. Based on this assumption, total inpatient antibiotic drug use and related hospital and physician costs are estimated at \$312 billion, or about \$3,900.00 per patient.

We also project the possible cost savings if antibiotic resistance were largely eliminated as a complicating factor in the treatment of human infectious diseases. We estimate that 20 million cases now resulting in hospitalization would be handled on an outpatient basis; hence, the number of outpatient courses of treatment increases by 20 million under the “Limited Resistance” scenario in Table 5.3.

The price of drugs would fall by over half because lower cost drugs would prove effective and lower doses would be required. We also assume the average stay in the hospital would be reduced two days, and the average cost of a day in the hospital would fall somewhat, reflecting the fewer complications when infectious diseases can be treated routinely. Under the “Limited Resistance” scenario, total costs would drop to \$161 billion, about one-half the costs stemming from illnesses given today’s level of resistance.

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The potential for \$161 billion in cost savings if antibiotic resistance could be largely eliminated does not include any estimate for lost productivity or death losses, which would add billions more to the estimate.

How Much Progress can Changes in Animal Agriculture Deliver?

No one knows the portion of resistance that is caused by human use – and misuse – of antibiotics, in contrast to use on the farm. In reality, the two sources of resistance are intertwined in complex ways that will never be definitively sorted out. Also, it is unrealistic to assume that resistance can be largely eliminated. Indeed, the more likely scenario is that resistance will grow more pervasive and broad-based. Hence, a more realistic version of Table 5.3 would estimate rising medical costs as a function of the upward trend in antibiotic resistance, in the absence of remedial actions that slow the spread of the problem.

In Europe, the frequency of resistant strains of some common foodborne pathogens has already started to decline following the mid-1990s ban on the nontherapeutic use of about a dozen important antibiotics. This encouraging development suggests that animal agriculture in the U.S. can in fact contribute significantly to a return to bacteria pathogen susceptibility to antibiotics. **If animal uses of antibiotics account for just 20 percent of the \$161 billion problem caused by antibiotic resistance (\$32 billion), and agriculture's contribution could be cut in half by changes in animal husbandry and drug use on the farm, the potential medical savings to the nation would be on the order of \$16 billion annually.**

The economic impact of withdrawing nontherapeutic animal agriculture uses of antibiotics key to human medicine might reach \$1 billion, but are likely much smaller. Moreover, because of technological change, new and better alternatives to the nontherapeutic use of antibiotics are bound to emerge and sustain animal productivity at its current levels as antibiotic use is phased down. The human medical costs of antibiotic resistance, however, are clearly rising and will continue to do so, perhaps much more quickly than in the recent past. The costs will become incalculable if a global pandemic emerges that is of bacterial origin, a prospect that infectious disease experts accept as only a matter of time.

The quicker society acts to bring alternative technologies onto the farm, coupled with a targeted phase out of the nontherapeutic use of key antibiotics, the greater the likely net economic benefits to society as a whole. In the end everyone will be much better off and in more ways than one.

D. Preventing and Responding to Animal Disease Outbreaks

Government programs and policies play a critical role in trying to prevent the introduction into the United States of new animal diseases and in attempts to contain damaging diseases when they gain a foothold in a production region previously unaffected. As the scale and concentration of animal operations have grown, the potential economic losses from a rapidly spreading disease have also risen, as have the importance and effort invested in biosecurity measures.

Efforts have been underway for years to either keep out of the U.S. or eradicate several diseases including brucellosis, Foot-and-Mouth Disease (FMD), swine pseudorabies, sheep scrapie, and recently, BSE (bovine spongiform encephalopathy, or Mad Cow Disease), West Nile virus, and Nipah virus.

To date, according to the USDA's Animal and Plant Health Inspection Service (APHIS), 13 serious livestock and poultry diseases have been eradicated from the United States. Unfortunately as many as five of these diseases have made a comeback in recent years somewhere in the world and may again plague U.S. animal producers. Even if they do not reinfect American farms, equally devastating new pathogens and diseases are emerging at an increasing rate worldwide, and they are moving around farther and faster. For these reasons, APHIS faces a daunting and vital set of challenges.

Ongoing APHIS eradication programs are trying to eliminate cattle and swine brucellosis, bovine tuberculosis, and pseudorabies in swine. Increased foreign travel and trade in animal products and live animals has accelerated the global movement of pathogens, including many that are resistant to multiple antibiotics. The U.S. exports over \$11 billion in animal products annually, trade that would be in jeopardy if any one of dozens of highly contagious diseases were to gain a foothold in the U.S.

The recent outbreak of Foot-and-Mouth Disease (FMD) in Great Britain has triggered panic and unprecedented steps to try and stop the spread of the disease, confirmed on 24 farms as of early March. Rural people are asked not to travel beyond their villages, and city people are discouraged from visiting the country. Court systems have been closed to keep people from congregating and officials may postpone the forthcoming national election to avoid spreading the disease at the polls.

Tens of thousands of animals exported from Britain in recent years are being destroyed, joining hundreds of thousands more in Great Britain. All meat and animal product exports from Great Britain have been stopped. This new crisis, on top of the British fixation with BSE over the last several years, is sure to drive home the message all is not well on the farm. A March 1, 2001 commentary by George Monbiot in "The Guardian" of London is entitled "Foot and Mouth Disease: Sins of the Superstores Visited Upon Us." In it he highlights the impacts of trade and globalization –

“There's no doubt that the modern food economy encourages long-distance transport. Between 1965 and 1998, the international trade in food tripled, to 600

million metric tons. In Britain, the transport of milk has increased 30-fold since 1980. To meet the demands of the global economy, livestock haulers routinely break the rules requiring them to rest, feed and water the animals they are transporting, in some cases all the way from Britain to Beirut.”

More than 100 people died in Yemen in late 2000 from Rift Valley fever, 1,800 animals died, and 7,800 fetuses were aborted (*Wall Street Journal*, March 2, 2001). The disease had leapt, for the first time, from Africa to the Middle East. According to the *Wall Street Journal* article entitled “Animal Ills Spread With a Spin of the Globe” –

“Just as more people are roaming the globe and spreading germs along the way, so are animals, sometimes with devastating results....The international meat trade grew an average of 9% annually over the past decade, according to the United Nations Food and Agriculture Organization in Rome.”

“Three out of four newly detected [human] diseases in recent years have animal origin, the ARS reports.”

To meet the new demands of the global food economy, APHIS has a field force of 250 veterinarians and 360 lay inspectors carrying out its animal health programs (from “Facts about APHIS” on its website). Given that there are some 370,000 confined animal feeding facilities in the U.S. and 12,000 very large ones, dozens of ports of entry, and millions of people flying to and from the U.S. annually, it is no wonder inspections are few and far between and that only the most obvious and costly problems get serious attention from APHIS.

1. The Pork Industry’s Multiple Threats

The pork industry’s current list of major threats is representative of the challenges facing other animal industries. Recent Foot-and-Mouth Disease (FMD) outbreaks in cattle and/or swine in Great Britain, Korea and Japan have heightened awareness of the continued risks facing producers. While the United States has not had FMD since 1929, Japanese producers had not experienced the disease since 1908 and Great Britain had been FMD-free since the 1940s.

E. coli infections have moved from beef feedlots to swine. A cholera epidemic in Taiwan swept the small nation’s pig farms and led to the killing of the entire herd. A new swine virus in Malaysia has been transmitted to humans. One million pigs were slaughtered and 100 people died due to the previously unknown Nipah virus. Public health officials worldwide are alarmed that the virus has already traveled 650 km across the South China Sea to Borneo. Antibodies for the virus have been found in humans that have had no known contact with pigs in Malaysia, indicating a foodborne route of exposure.

Fruit bats with huge geographic range, through much of Asia to Africa, are one known source of the disease, but pig-to pig transmission in intensive swine operations are

believed to account for its rapid spread. Scientists expect that other more virulent and possibly contagious Nipah-like viruses can be expected to emerge in the coming years. Malaysian scientists discovered two other previously unknown, so-far dormant viruses similar to Nipah. Charles Calisher, a microbiologist at Colorado State University, says the Nipah virus could be present in other bat populations outside Malaysia (Far Eastern Economic Review, 2000)

2. Essential Ingredients for Cost-Effective Containment of Animal Diseases

As part of its investment in water quality, the USDA provides cost-share assistance to farmers to install grass-waterway filter strips along streams, creeks, lakes, and rivers. Their purpose, and the justification for public funding, rests on their ability to filter out sediment, nutrients, and pesticides flowing off cropland, thereby improving water quality. The extent to which this goal is achieved by a given filter strip is a function of two factors – the design and width of the filter strip, and the volume of sediment, nutrients and pesticides flowing off nearby, up-slope cropland. A well-designed and properly installed filter strip can be literally overrun if farmers do not also pay attention to erosion control and chemical management needs.

The same reality governs the effectiveness of government efforts to avoid, contain, or eradicate animal diseases. The efficacy of efforts and the return to public expenditures are a function of both the effectiveness of steps taken and the level and mobility of disease pressure that the preventive measures are asked to contain.

The more animals in a given area, the more stressful the conditions they are raised in, the closer proximity of animals to cropland where manure from multiple farms is spread, the more difficult it is to prevent the spread of disease. In parts of the U.S., animal density is now so great that as a practical matter, the spread of disease cannot be stopped. As the likelihood of the spread of disease rises, the odds fall that containment efforts will work and the costs associated with a newly established disease, especially one capable of spreading fast, rises exponentially.

Across all of today's animal agriculture industries, USDA and the animal health community need to revisit animal health, husbandry and biosecurity provisions and policies, in particular mandatory set-backs between operations and maximum allowed density in a given geographic area. Most USDA quarantine and eradication program regulations evolved prior to the recent intensification of production and before the scope and seriousness of animal diseases reached today's proportions. Just imagine the immediate demands that APHIS would face if either BSE or Foot-and-Mouth Disease were found in the U.S.!

Dealing with Current Problems

There is compelling need for routine government-controlled monitoring of large-scale livestock operations to track disease incidence and severity, susceptibility of common pathogens to antibiotics and other drugs, and risks for movement of

pathogens off the farm. Such routine monitoring will help trigger necessary steps on operations with emerging disease problems, so that an outbreak can hopefully be contained on a given operation, protecting neighboring farmers and the public.

The data generated by such a program will also play a critical role in tracking antibiotic resistance and establishing linkages between farm management and animal disease practices and the transmission of antibiotic resistance pathogens to people. The recent USDA-NAHMS *Salmonella enterica* survey of egg layer farms produced several clear-cut insights on the impacts of scale and management on disease prevalence. The 1999 beef feedlot survey also has provided a solid foundation to build on. **Similar surveys should be undertaken in other livestock industries and the scope of all surveys should expand to routinely include major diseases and foodborne pathogens, and an expanded set of indicators of animal health status and disease control efforts.**

On farms where problems are found, producers should be required by state and/or federal law to develop and aggressively implement remedial action plans. Compliance should not be voluntary and noncompliance should trigger severe consequences.

Plans should be designed to meet clear minimal performance standards for prevention and containment of potentially costly problems. The data indicating a problem, the remedial plan, and future monitoring data should all be publicly available, and USDA and states should take steps to assure that local veterinarians, other livestock producers, and buyers are aware of any hazards on a given farm.

Operations that fail to meet minimal performance standards within a reasonable amount of time should be shut down. Before permits are reissued, such operations must demonstrate why changes in facilities and/or management will prove successful, and they should commit to a more frequent and intensive monitoring program to confirm that new efforts have been successful. Large-scale operations should pay the full costs of public monitoring and permit reviews via permit and compliance review fees. To help reduce the scale and concentration of operations, the USDA and states should offer new incentives, or lower fees to moderate scale producers in selected areas.

While invasive, costly and controversial, such dramatic changes in animal disease policy and prevention procedures will ultimately be unavoidable if current trends continue. Changes are inevitable because the costs of not doing so will become unbearable to both the public and private sectors.

3. Limiting Future Problems

Better understanding is needed to isolate how and why the movement of livestock and animal products spreads disease. The role of human vectors needs further study, as does movement through water and air. In the meantime, states, with support from the USDA, CDC, and FDA, need to revisit their permitting processes to assure that no new operations or animals are introduced into an area where animal density has already

reached or exceeds the threshold beyond which disease prevention becomes, for all practical purposes, impossible, regardless of how effectively a given farmer manages their herd or flock.

Most permitting processes now focus on adherence to setbacks, water quality protection, and manure storage and management. In many regions, the evidence supports a significant increase in minimal set-backs and efforts to reduce current levels of animal densities in some regions. Manure management and order control, the topic of the last chapter, clearly must change for many reasons in addition to helping slow the spread of disease.

The scope of permits must be expanded and made more quantitative by incorporating verifiable performance indicators. For the benefit of both farmers and consumers, the government must play a more active – and aggressive – role in assuring compliance and enforcement.

Biosecurity procedures and requirements should become core modules in the permitting process, especially in areas with a high level of animal density. Operator responsibilities toward area-wide disease prevention and containment need to be spelled out, as do obligations to participate in ongoing USDA-NAHMS monitoring and analytical efforts.

The USDA also needs to develop and experiment with new policy tools to reduce animal densities in those regions where thresholds for disease prevention and environmentally sound manure utilization have been exceeded. And animal producer groups need to study, and then recommend to Congress, new ways to assure that the operations responsible for introducing a costly disease into an area bear a fair share of the costs incurred by other farmers who, through no fault of their own, face new infections, losses, and costs.