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Putting Meat on the Table: Industrial Farm Animal Production in America

A Report of the Pew
Commission on Industrial
Farm Animal Production

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Foreword by

John Carlin,
Former Governor
of Kansas

I have witnessed dramatic changes in animal agriculture over the past several decades. When I was growing up, my family operated a dairy farm, which not only raised cows to produce milk, but crops to feed the cows and wheat as a cash crop. When I took over management of the farm from my father in the mid-sixties, on average we milked about 40 cows and farmed about 800 acres. We were one of some 30 such dairy operations in Saline County, Kansas. Today in Saline County and most Kansas counties, it is nearly impossible to find that kind of diversified farm. Most have given way to large, highly specialized, and highly productive animal producing operations. In Saline County today, there is only one dairy farm, yet it and similar operations across the state produce more milk from fewer cows statewide than I and all of my peers did when I was actively farming.

Industrial farm animal production (IFAP) is a complex subject involving individuals, communities, private enterprises and corporations large and small, consumers, federal and state regulators, and the public at large. All Americans have a stake in the quality of our food, and we all benefit from a safe and affordable food supply. We care about the well-being of rural communities, the integrity of our environment, the public's health, and the health and welfare of animals. Many disciplines contribute to the development and analysis of IFAP—including economics, food science, animal sciences, agronomy, biology, genetics, nutrition, ethics, agricultural engineering, and veterinary medicine. The industrial farm has brought about tremendous increases in short-term farm efficiency and affordable food, but its rapid development has also resulted in serious unintended consequences and questions about its long-term sustainability.

I initially hesitated to get involved in the work of the Commission, given that the nature of partisan politics today makes the discussion of any issue facing our country extremely challenging. In the end, I accepted the chairmanship because there is so much at stake for both agriculture and the public at large. The Pew Commission on Industrial Farm Animal Production (PCIFAP) sought to develop recommendations that protect what is best about American agriculture and to help to ensure its sustainability for the future. Our work focuses on four areas of concern that we believe are key to that future: public health, environment, animal welfare, and the vitality of rural communities; specifically, we focus on how these areas have been impacted by industrial farm animal production.

The Commission consists of a very diverse group of individuals, remarkably accomplished in their fields, who worked together to achieve consensus on potential solutions to the challenge of assuring a safe and sustainable food supply. We sought broad input from stakeholders and citizens around the country. We were granted the resources needed to do our work, and the independence to ensure that our conclusions were carefully drawn and objective in their assessment of the available information informed by the Commissioners' own expertise and experience. I thank each and every one for their valuable service and all citizens who contributed to the process.

Finally, we were supported by a group of staff who worked tirelessly to ensure that Commissioners had access to the most current information and expertise in the fields of concern to our deliberations. We thank them for their hard work, their patience, and their good humor.

John W. Carlin

Chairman

Preface by

Robert P. Martin,
Executive Director,
Pew Commission
on Industrial Farm
Animal Production

Over the last 50 years, the method of producing food animals in the United States has changed from the extensive system of small and medium-sized farms owned by a single family to a system of large, intensive operations where the animals are housed in large numbers in enclosed structures that resemble industrial buildings more than they do a traditional barn. That change has happened primarily out of view of consumers but has come at a cost to the environment and a negative impact on public health, rural communities, and the health and well-being of the animals themselves.

The Pew Commission on Industrial Farm Animal Production (PCIFAP) was funded by a grant from The Pew Charitable Trusts to the Johns Hopkins Bloomberg School of Public Health to investigate the problems associated with industrial farm animal production (IFAP) operations and to make recommendations to solve them. Fifteen Commissioners with diverse backgrounds began meeting in early 2006 to start their evidence-based review of the problems caused by IFAP.

Over the next two years, the Commission conducted 11 meetings and received thousands of pages of material submitted by a wide range of stakeholders and interested parties. Two hearings were held to hear from the general public with an interest in IFAP issues. Eight technical reports were commissioned from leading academics to provide information in the Commission's areas of interest. The Commissioners themselves brought expertise in animal agriculture, public health, animal health, medicine, ethics, public policy, and rural sociology to the table. In addition, they visited broiler, hog, dairy, egg, and swine IFAP operations, as well as a large cattle feedlot.

There have been some serious obstacles to the Commission completing its review and approving consensus recommendations. The agriculture industry is not monolithic, and the formation of this Commission was greeted by industrial agriculture with responses ranging from open hostility to wary cooperation. In fact, while some industrial agriculture representatives were recommending potential authors for the technical reports to Commission staff, other industrial agriculture representatives were discouraging those same authors from assisting us by threatening to withhold research funding for their college or university. We found significant influence by the industry at every turn: in academic research, agriculture policy development, government regulation, and enforcement.

At the end of his second term, President Dwight Eisenhower warned the nation about the dangers of the military-industrial complex—an unhealthy alliance between the defense industry, the Pentagon, and their friends on Capitol Hill. Now, the agro-industrial complex—an alliance of agriculture commodity groups, scientists at academic institutions who are paid by the industry, and their friends on Capitol Hill—is a concern in animal food production in the 21st century.

The present system of producing food animals in the United States is not sustainable and presents an unacceptable level of risk to public health and damage to the environment, as well as unnecessary harm to the animals we raise for food.

The story that follows is the Commission's overview of these critical issues and consensus recommendations on how to improve our system of production.

Robert P. Martin

Robert P. Martin
Executive Director

How the Current System Developed

Industrial farm animal production (IFAP) encompasses all aspects of breeding, feeding, raising, and processing animals or their products for human consumption. Producers rely on high-throughput production to grow thousands of animals of one species (often only a few breeds of that species and only one genotype within the breed) and for one purpose (such as pigs, layer hens, broiler chickens, turkeys, beef, or dairy cattle).

IFAP's strategies and management systems are a product of the post–Industrial Revolution era, but unlike other industrial systems, IFAP is dependent on complex biological and ecological systems for its basic raw material. And the monoculture common to IFAP facilities has diminished important biological and genetic diversity in pursuit of higher yields and greater efficiency (Steinfeld et al., 2006).

The origins of agriculture go back more than 10,000 years to the beginning of the Neolithic era, when humans first began to cultivate crops and domesticate plants and animals. While there were many starts and stops along the way, agriculture provided the technology to achieve a more reliable food supply in support of larger human populations. With agriculture came concepts of personal property and personal inheritance, and hierarchical societies were organized. In short, crop cultivation led to a global revolution for humankind, marked by the emergence of complex societies and the use of technology.

The goal of agriculture then, as now, was to meet human demand for food, and as the population grew, early agriculturalists found new ways to increase yield, decrease costs of production, and sustain productivity. Over the centuries, improved agricultural methods brought about enormous yield gains, all to keep up with the needs of an ever-increasing human population. In the 18th century, for example, it took nearly five acres of land to feed one person for one year, whereas today it takes just half an acre (Trewavas, 2002)—a tenfold increase in productivity.

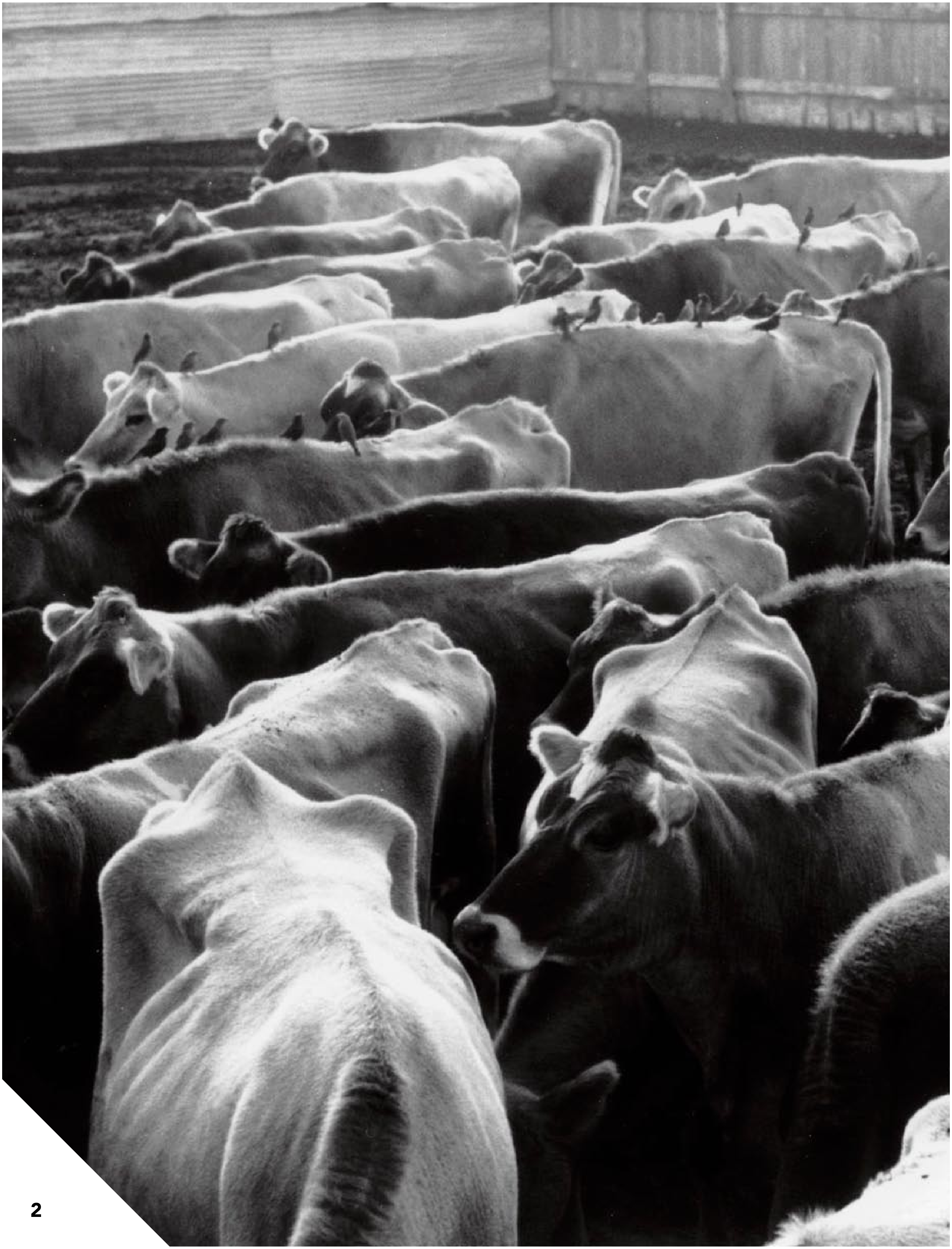
There is reason to wonder, however, whether these dramatic gains, and particularly those of the last 50 years, can be sustained for the next 50 years as the world's human population doubles, climate change shifts rainfall patterns and intensifies drought cycles, fossil fuels become more expensive, and the developing nations of the world rapidly improve their standards of living.

Enormous Yield Gains

Agriculture in North America predated the arrival of the first Europeans. The peoples of the Americas had long been cultivating crops such as corn, tobacco, and potatoes—crops that even today represent more than half of the value of crops produced in the United States. They developed the technology to fertilize crops as a means to meet the nutrient needs of their crops in the relatively poor soils of much of the Americas. The first European settlers—often after their own crops and farming methods failed—learned to grow crops from the original peoples of the Americas.

Subsistence farming was the nation's primary occupation well into the 1800s. In 1863, for example, there were more than six million farms and 870 million acres under cultivation. The mechanization of agriculture began in the 1840s with Cyrus McCormick's invention of the reaper, which increased farm yields and made it possible to move from subsistence farming to commercial agriculture. McCormick's reaper was a miracle—it could harvest five to six acres daily compared with the two acres covered by farmers using the most advanced hand tools of the day. In anticipation of great demand, McCormick headed west to the young prairie town of Chicago, where he set up a factory and, by 1860, sold a quarter of a million reapers. The development of other farm machines followed in rapid succession: the automatic wire binder, the threshing machine, and the reaper-thresher, or combine. Mechanical planters, cutters, and huskers appeared, as did cream separators, manure spreaders, potato planters, hay driers, poultry incubators, and hundreds of other inventions.

New technologies for transportation and food preservation soon emerged. The railroad and refrigeration systems allowed farmers to get their products to markets across great distances to serve the rapidly growing cities of the day. Locomotives carried cattle to stockyards in Kansas City and Chicago where they were sold and slaughtered. The growing urban centers created large



and growing markets, which benefited from the railroads and refrigerated railcars that made year-round transport of fresh and frozen meat products feasible. Expanding production to meet growing demand was facilitated by the agriculture policy of the federal government, which focused on increasing crop yields.

Agriculture in the Twentieth Century

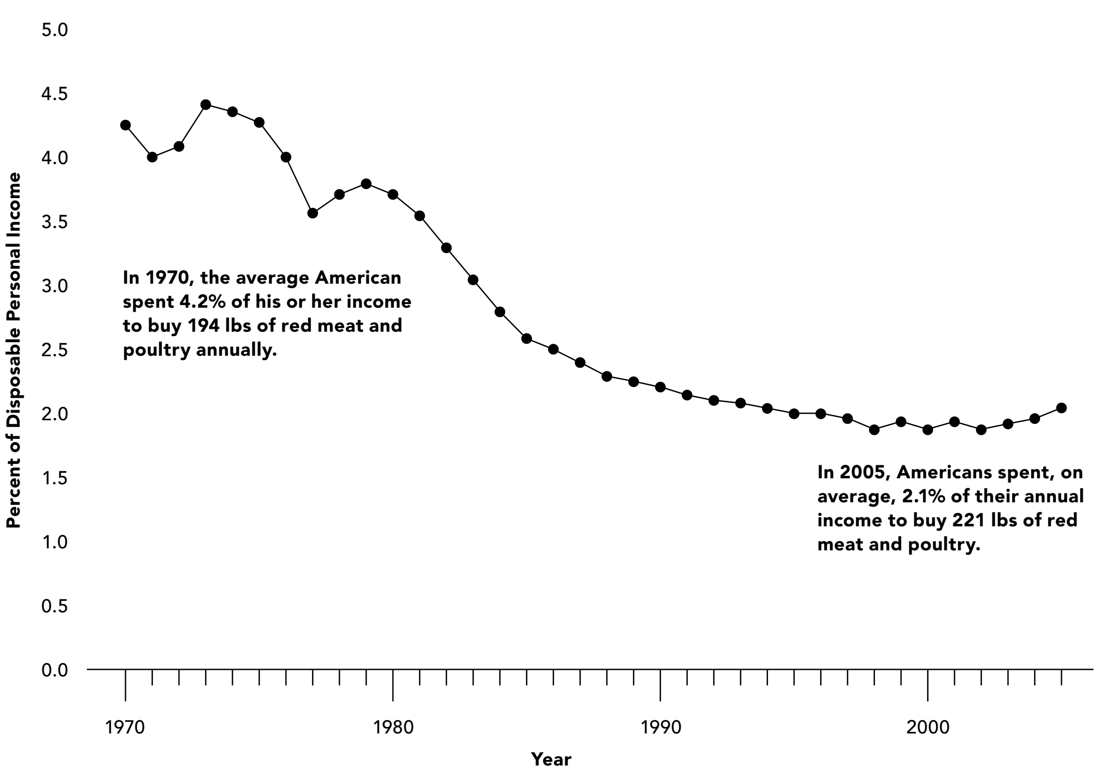
Farm yields reached a plateau in the first half of the 20th century, slowed by global conflict, the Dust Bowl, and the Great Depression. After World War II, America's new affluence and growing concern for feeding the world's poor led to the "Green Revolution," the worldwide transformation of agriculture that led to significant increases in agricultural production from 1940 through the 1960s. This transformation relied on a regime of genetic selection, irrigation, and chemical fertilizers and pesticides developed by researchers such as Norman Borlaug and funded by a consortium of donors led by the Ford and Rockefeller foundations.

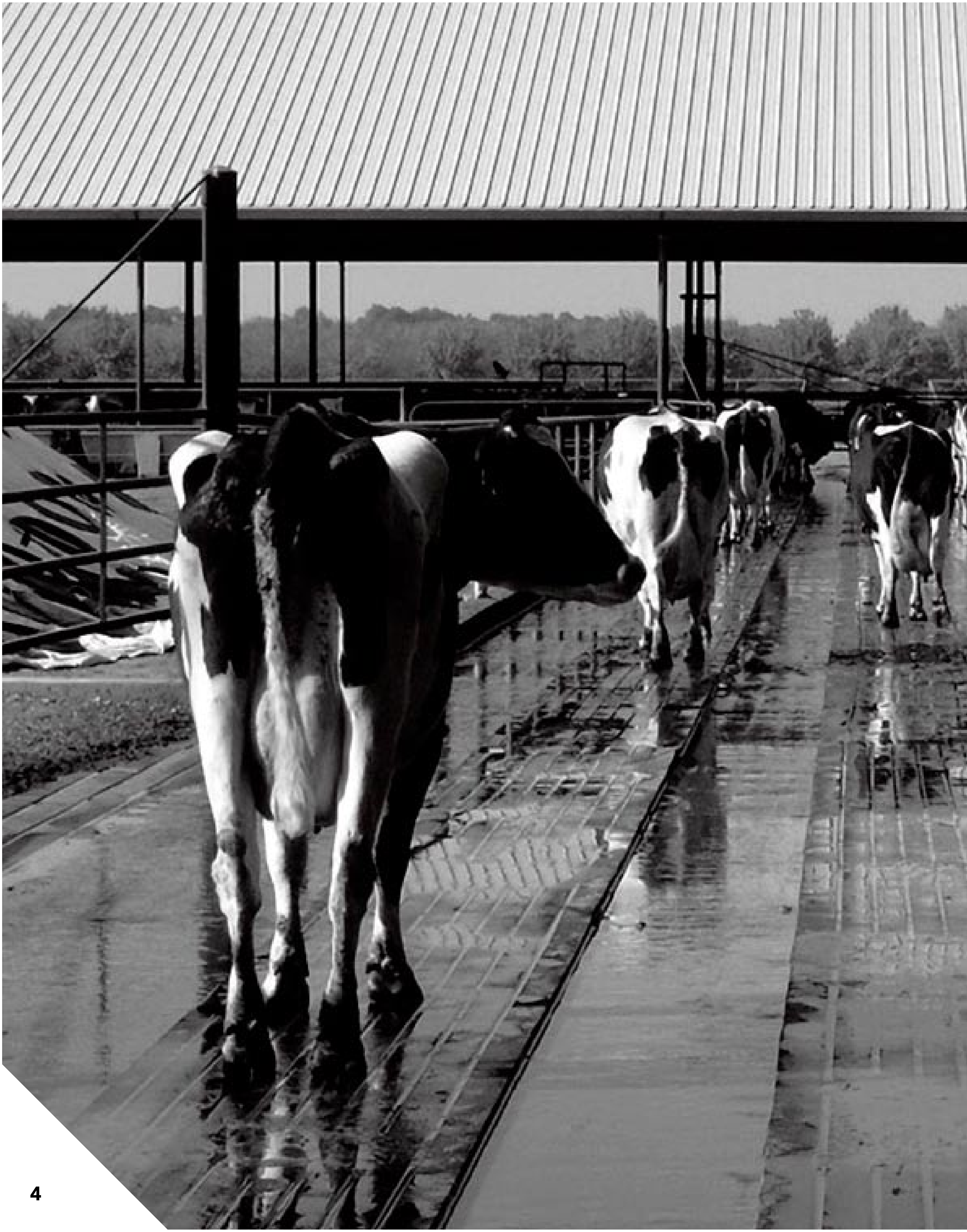
The Green Revolution dramatically increased agricultural productivity, even outpacing the demands of the rapidly growing world population. The massive increase in corn yields from the 1940s through the 1980s provides a case in point: a farmer in 1940 might have expected to get 70–80 bushels of corn per acre, whereas by 1980, farms routinely produced 200 bushels per acre, thanks to genetic selection, chemical fertilizer and pesticides, and irrigation regimes developed by Green Revolution scientists. Similarly, the developing world has seen cereal production—not only corn, but also wheat and rice—increase dramatically, with a doubling in yields over the last 40 years.

As a result of these significant increases in output, corn and grains became inexpensive and abundant, suitable as a staple to feed not only humans but animals as well. Inexpensive corn thus made large-scale animal agriculture more profitable and facilitated the evolution of intensive livestock feeding from an opportunistic method of marketing corn to a profitable industry.

The Green Revolution would later prove to have unwanted ecological impacts, such as aquifer depletion, groundwater contamination, and excess nutrient runoff, largely because of its reliance on monoculture crops, irrigation, application of pesticides, and use of nitrogen and phosphorous fertilizers (Tilman et al., 2002). These unwanted environmental consequences now threaten to reverse many of the yield increases attributed to the Green Revolution in much of North America.

American Meat Expenditures, 1970–2005 (Source: Livestock Marketing Information Center)





The Animal Production Farm as Factory

Intensive animal production began in the 1930s with America's highly mechanized swine slaughterhouses. Henry Ford even credited the slaughterhouses for giving him the idea to take the swine "disassembly" line idea and put it to work as an assembly line for automobile manufacturing. Later, the ready availability of inexpensive grain and the rapid growth of an efficient transportation system made the United States the birthplace for intensive animal agriculture.

Paralleling the crop yield increases of the Green Revolution, new technologies in farm animal management emerged that made it feasible to raise livestock in higher concentrations than were possible before. As with corn and cereal grains, modern industrial food animal production systems resulted in significant gains in production efficiency. For example, since 1960, milk production has doubled, meat production has tripled, and egg production has increased fourfold (Delgado, 2003). While some of these increases are due to greater numbers of animals, genetic selection for improved production, coupled with specially formulated feeds that include additives of synthetic compounds, have contributed significantly as well. The measure of an animal's efficiency in converting feed mass into increased body mass—the feed conversion ratio—has improved for all food animal species. The change has been most dramatic in chickens: in 1950, it took 84 days to produce a 5-pound chicken whereas today it takes just 45 days (HSUS, 2006a).

Intensive animal production and processing have brought about significant change in American agriculture over the last two decades. The current trend in animal agriculture is to grow more in less space, use cost-efficient feed, and replace labor with technology to the extent possible. This trend toward consolidation, simplification, and specialization is consistent with many sectors of the American industrial economy. The diversified, independent, family-owned farms of 40 years ago that produced a variety of crops and a few animals are disappearing as an economic entity, replaced by much larger, and often highly leveraged, farm factories. The animals that many of these farms produce are owned by the meat packing companies from the time they are born or hatched right through their arrival at the processing plant and from there to market. The packaged food products are marketed far from the farm itself.

These trends have been accompanied by significant changes in the role of the farmer. More and more animal farmers have contracts with "vertically integrated"[1] meat packing companies to provide housing and facilities to raise the animals from infancy to the time they go to the slaughterhouse. The grower does not own the animals and frequently does not grow the crops to feed them. The integrator (company) controls all phases of production, including what and when the animals are fed. The poultry industry was the first to integrate, beginning during World War II with War Department contracts to supply meat for the troops. Much later, Smithfield Farms applied the vertical integration model to raising pork on a large scale. Today, the swine and poultry industries are the most vertically integrated, with a small number of companies overseeing most of the chicken meat and egg production in the United States. In contrast, the beef cattle and dairy industries exhibit very little or no vertical integration.

Under the modern-day contracts between integrators and growers, the latter are usually responsible for disposition of the animal waste and the carcasses of animals that die before shipment to the processor. The costs of pollution and waste management are also the grower's responsibility. Rules governing waste handling and disposal methods are defined by federal and state agencies. Because state regulatory agencies are free to set their own standards as long as they are at least as stringent as the federal rules, waste handling and disposal systems often vary from state to state. Because the integrators are few in number and control much if not all of the market, the grower often has little market power and may not be able to demand a price high enough to cover the costs of waste disposal and environmental degradation. These environmental costs are thereby "externalized" to the general society and are not captured in the costs of production nor reflected in the retail price of the product.

Accompanying the trend to vertical integration is a marked trend toward larger operations. Depending on their size and the operator's choice, these industrial farm animal production facilities may be called animal feeding operations (AFOs) or concentrated animal feeding operations (CAFOs) for US Environmental Protection Agency (EPA) regulatory purposes. The EPA defines an AFO as a lot or facility where (1) animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in a 12-month period; and (2) crops, vegetation, forage growth, or postharvest residues are not sustained in the normal growing season over any portion of the lot or facility. CAFOs are distinguished from the more generic AFOs by their larger number of animals or by either choosing or having that designation imposed because of the way they handle their animal waste. A facility of a sufficient size to be called a CAFO can opt out of that designation if it so chooses by stating that it does not discharge into navigable waters or directly into waters of the United States. For the purposes of this report, the term industrial farm animal production (IFAP) refers to the most intensive practices (such practices include gestation and farrowing crates in swine production, battery cages for egg-laying hens, and the like) regardless of the size of the facility. Facilities of many different sizes can be industrial, not just those designated as CAFOs by the EPA.[2]

Regardless of whether a farm is officially listed as a CAFO, IFAP has greatly increased the number of animals per operation. To illustrate, over the last 14 years, the average number of animals per swine operation has increased 2.8 times, for egg production 2.5 times, for broilers 2.3 times, and for cattle 1.6 times (Tilman et al., 2002). More animals mean greater economies of scale and lower cost per unit. In addition, IFAP facility operators, in many cases, gain greater control over the factors that influence production such as weather, disease, and nutrition. Thus, production of the desired end product typically requires less time.

But the economic efficiency of IFAP systems may not be entirely attributable to animal production efficiencies. Nor are the economies of scale that result from the confinement of large numbers of animals entirely responsible for the apparent economic success of the IFAP system. Rather, according to a recent Tufts University study, the overproduction of agricultural crops such as corn and soybeans due to US agricultural policy since 1996 has, until recently, driven the market price of those commodities well below their cost of production (Starmer and Wise, 2007a), resulting in a substantial discount to IFAP facility operators for their feed. The Tufts researchers also point out that, because of weak environmental enforcement, IFAP facilities receive a further subsidy in the form of externalized environmental costs. In total, the researchers estimate that the current hog IFAP facility receives a subsidy worth just over $10 per hundredweight, or just over $24 for the average hog, when compared with the true costs of production (Starmer and Wise, 2007a; Starmer and Wise, 2007b).

Despite their proven efficiency in producing food animals, IFAP facilities have a number of inherent and unique risks that may affect their sustainability. While some CAFOs have been sited properly with regard to local geological features, watersheds, and ecological sensitivity, others are located in fragile ecosystems, such as on flood plains in North Carolina and over shallow drinking water aquifers in the Delmarva Peninsula and northeastern Arkansas. The waste management practices of IFAP facilities can have substantial adverse affects on air, water, and soils. Another major risk stems from the routine use of specially formulated feeds that incorporate antibiotics, other antimicrobials, and hormones to prevent disease and induce rapid growth. The use of low doses of antibiotics as food additives facilitates the rapid evolution and proliferation of antibiotic-resistant strains of bacteria. The resulting potential for "resistance reservoirs" and interspecies transfer of resistance determinants is a high-priority public health concern. Finally, IFAP facilities rely on selective breeding to enhance specific traits such as growth rate, meat texture, and taste. This practice, however, results in a high degree of inbreeding, which reduces biological and genetic diversity and represents a global threat to food security, according to the Food and Agriculture Organization (FAO) of the United Nations (Steinfeld et al., 2006).

The potential health and environmental impacts of IFAP take on more urgent concern in the context of the global market for meat and meat products, considering that world population is expected to increase from the current four to five billion to nine to ten billion by 2050. Most of that growth will occur in low- and middle-income countries, where rising standards of living are accelerating the "nutrition transition" from a diet of grains, beans, and other legumes to one with more animal protein. The demand for meat and poultry is therefore expected to increase nearly 35% by 2015 (Steinfeld et al., 2006). To meet that rising demand, the CAFO model has become increasingly attractive. The spread of IFAP to the developing world brings the benefit of rapid production of meat, but at the cost of environmental and public health, costs that may be exacerbated by institutional weaknesses and governance problems common in developing countries.

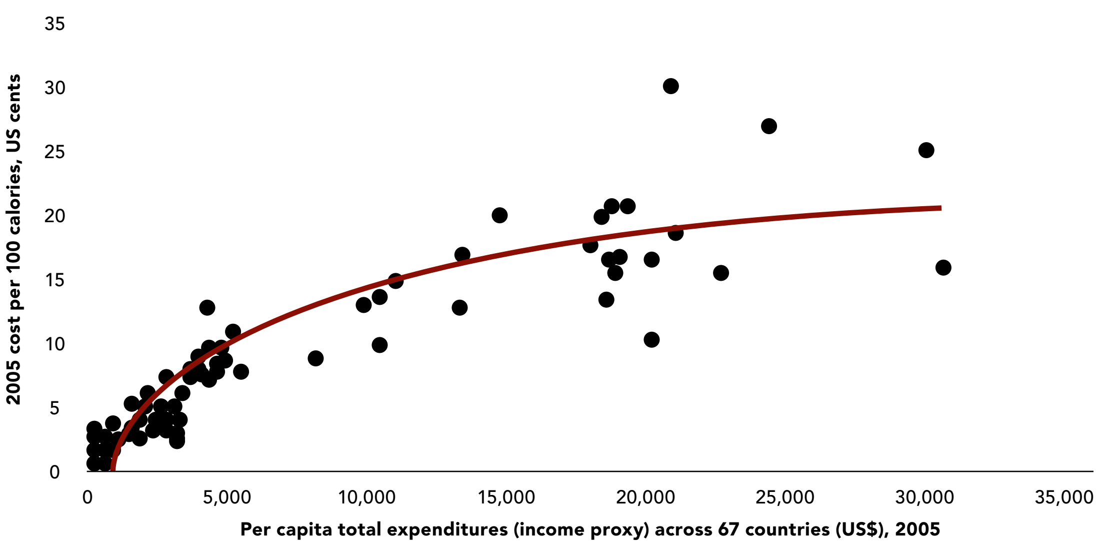
Commissioners' Conclusions

Animal agriculture has experienced "warp speed" growth over the last 50 years, with intensification resulting in an almost logarithmic increase in numbers. The availability of high-yield and inexpensive grains has fueled this increase and allowed for continually increasing rates of growth in order to feed the burgeoning human population. However, diminished fossil fuel supplies, global climate change, declining freshwater availability, and reduced availability of arable land all suggest that agricultural productivity gains in the next 50 years may be far less dramatic than the rates of change seen over the last 100 years.

As discussed, the transformation of traditional animal husbandry to the industrial food animal production model and the widespread adoption of IFAP facilities have led to widely available and affordable meat, poultry, dairy, and eggs. As a result, animal-derived food products are now inexpensive relative to disposable income, a major reason that Americans eat more of them on a per capita basis than anywhere else in the world. According to the US Department of Agriculture (USDA), the average cost of all food in the United States is less than ten percent of the average American's net income, even though on a cost-per-calorie basis Americans are paying more than the citizens of many other countries (Frazão et al., 2008).

While industrial farm animal production has benefits, it brings with it growing concerns for public health, the environment, animal welfare, and impacts on rural communities. In the sections that follow, we examine the unintended consequences of intensive animal agriculture and its systems. The Commission's goal is to understand those impacts and to propose recommendations to address them in ways that can ensure a safe system of animal agriculture while satisfying the meat and poultry needs of a nation that will soon reach 400 million Americans.

Cost per calorie rises as income levels rise (Source: consumption expenditure data from Euromonitor International 2006; cost per calorie calculated based on calorie consumption data from FAOSTAT 2007 [Frazão et al., 2008])



The Global Impact of the US Industrial Food Animal Production Model

The concentrated animal feeding operation (CAFO) model of production in the United States has developed over the years into a fine-tuned factory operation. Recently, the CAFO model has begun to spread to all corners of the world, especially the developing world. This spread brings many of the benefits that made it successful in the developed world, but also the problems. Those problems are often magnified by structural deficiencies that may exist in a country where law and government cannot keep pace with the country's adoption of animal production and other new technologies.

Developing countries adopt the CAFO model for two reasons. The first is that as people become wealthier, they eat more meat. From the 1970s through the 1990s, the consumption of meat in the developing world increased by 70 million metric tons (Delgado et al., 1999). These countries therefore need to produce more animal protein than ever before. And as populations grow, especially in Asia, land becomes scarce and the CAFO model becomes more attractive (Tao, 2003). Second, multinational corporations involved in the animal protein industry scour the world looking for countries with cheap labor and large expanses of land available to cultivate feed for food animals (Martin, 2004). When they find these areas, they bring along the production model that served them well in developed countries.

This all sounds well and good if the CAFO model allows a country to increase its level of development and feed its citizens, but often these countries are not equipped to deal with the problems that can be associated with CAFOs. For example, CAFOs produce large amounts of pollution if they are not managed and regulated properly. Even in many areas of the United States, we are barely able to deal with the harmful effects of CAFOs. In the developing world, governments and workers often do not have the ability or resources to enforce environmental, worker safety, or animal welfare laws, if they even exist (Tao, 2003). Or if a country does have the capacity, it often chooses not to enforce regulations in the belief that the economic benefits of a CAFO offset any detrimental impacts (Neirenberg, 2003).

But unregulated CAFO facilities can have disastrous consequences for the people living and working around them. Rivers used for washing and drinking may be polluted. Workers may be exposed to diseases and other hazards that they neither recognize nor understand because of their limited education.

As the Commission looks at the impact of the industrial model in the United States, we must not forget that these types of operations are being built all around the globe, often on a larger scale and with less regulation.

A villager locks the truck barrier after pigs loaded in a pig farm on January 17, 2008, in the outskirts of Lishu County of Jilin Province, northeast China. Jilin Provincial government earmarks 5.9 million yuan toward sow subsidies; each sow will gain 100 yuan, in a bid to curb the soaring pork price, according to local media.

Public Health

The potential public health effects associated with IFAP must be examined in the context of its potential effects on individuals and the population as a whole. These effects include disease and the transmission of disease, the potential for the spread of pathogens from animals to humans, and mental and social impacts. The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being" (WHO, 1992). This definition is widely recognized in the developed world and is increasingly being adopted by American employers.

In IFAP systems, large numbers of animals are raised together, usually in confinement buildings, which may increase the likelihood for health issues with the potential to affect humans, carried either by the animals or the large quantities of animal waste. The IFAP facilities are frequently concentrated in areas where they can affect human population centers. Animal waste, which harbors a number of pathogens and chemical contaminants, is usually left untreated or minimally treated, often sprayed on fields as fertilizer, raising the potential for contamination of air, water, and soils. Occasionally, the impact can be far worse. In one recent example, farm animal waste runoff from IFAP facilities was among the suspected causes of a 2006 *Escherichia coli* outbreak in which three people died and nearly 200 were sickened (CDC, 2006).

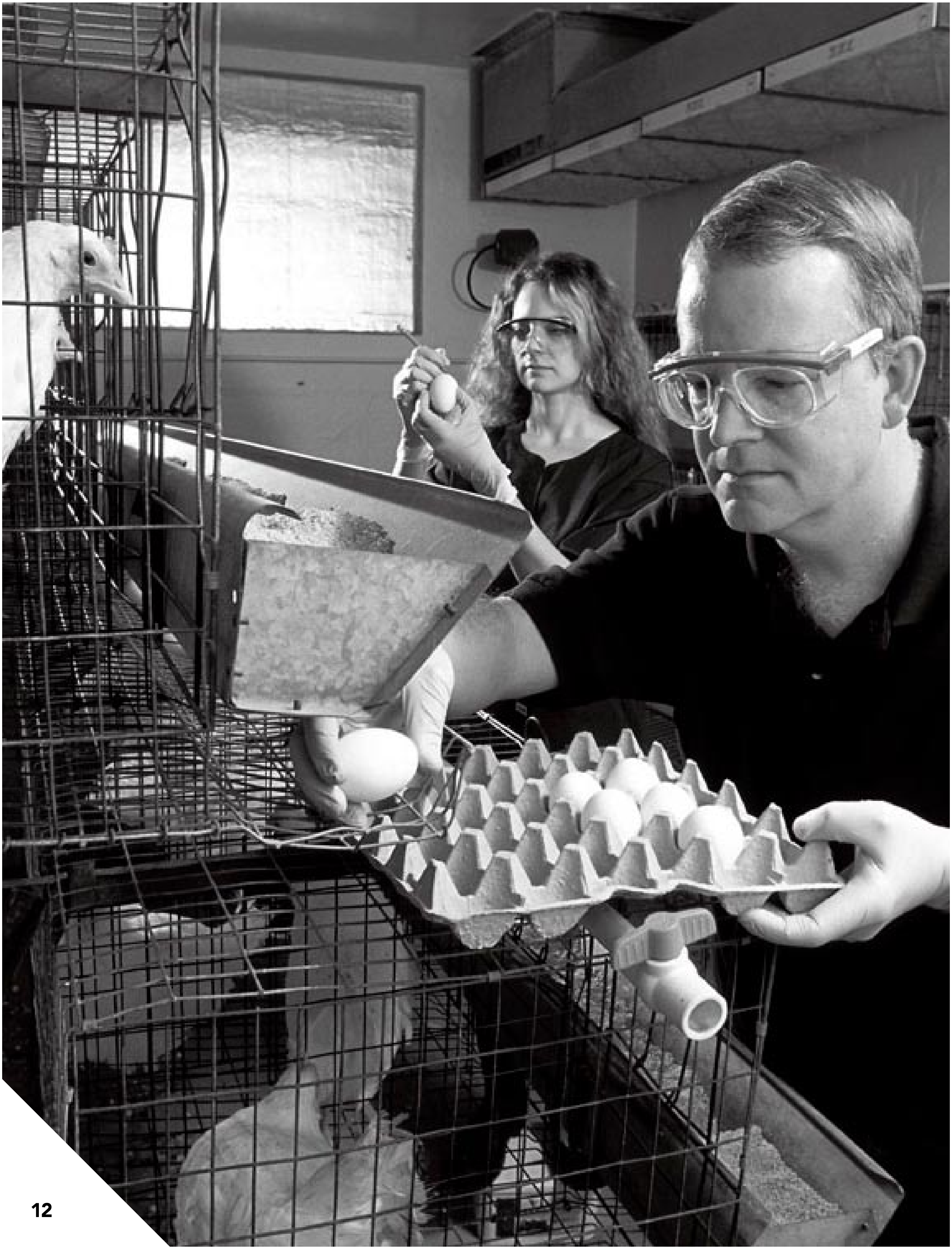
Affected Populations

Health risks increase depending on the rate of exposure, which can vary widely. Those engaged directly with livestock production, such as farmers, farm workers, and their families, typically have more frequent and more concentrated exposures to chemical or infectious agents. For others with less continuous exposure to livestock and livestock facilities, the risk levels decline accordingly.

Direct exposure is not the only health risk, however; health impacts often reach far beyond the IFAP facility. Groundwater contamination, for example, can extend throughout the aquifer, affecting drinking water supplies at some distance from the source of contamination. Infectious agents, such as a novel (or new) avian influenza virus, that arise in an IFAP facility may be transmissible from person to person in a community setting and well beyond. An infectious agent that originates at an IFAP facility may persist through meat processing and contaminate consumer food animal products, resulting in a serious disease outbreak far from the IFAP facility.

Monitoring is a basic component of strategies to protect the public from harmful effects of contamination or disease, yet IFAP monitoring systems are inadequate. Current animal identification and meat product labeling practices make it difficult or impossible to trace infections to the source. Likewise, IFAP workers, who may serve as vectors carrying potential disease-causing organisms from the animals they work with to the larger community, do not usually participate in public health monitoring, disease reporting, and surveillance programs because, as an agricultural activity, IFAP is often exempt. Furthermore, migrant and visiting workers, many of whom are undocumented, present a particular challenge to adequate monitoring and surveillance because their legal status often makes them unwilling to participate in health monitoring programs.

In general, public health concerns associated with IFAP include heightened risks of pathogens (disease- and nondisease-causing) passed from animals to humans; the emergence of microbes resistant to antibiotics and antimicrobials, due in large part to widespread use of



antimicrobials for nontherapeutic purposes; food-borne disease; worker health concerns; and dispersed impacts on the adjacent community at large.

Pathogen Transfer

The potential for pathogen transfer from animals to humans is increased in IFAP because so many animals are raised together in confined areas. IFAP feed and animal management methods successfully maximize the efficiency of meat or poultry production and shorten the time it takes to reach market weight, but they also create a number of opportunities for pathogen transmission to humans. Three factors account for the increased risk: prolonged worker contact with animals; increased pathogen transmission in a herd or flock; and increased opportunities for the generation of antibiotic-resistant bacteria or new strains of pathogens. Stresses induced by confinement may also increase the likelihood of infection and illness in animal populations.

Fifty years ago, a US farmer who raised pigs or chickens might be exposed to several dozen animals for less than an hour a day. Today's confinement facility worker is often exposed to thousands of pigs or tens of thousands of chickens for eight or more hours each day. And whereas sick or dying pigs might have been a relatively rare exposure event 50 years ago, today's agricultural workers care for sick or dying animals daily in their routine care of much larger herds and flocks. This prolonged contact with livestock, both healthy and ill, increases agricultural workers' risks of infection with zoonotic pathogens.

Infectious Disease

Numerous known infectious diseases can be transmitted between humans and animals; in fact, of the more than 1,400 documented human pathogens, about 64% are zoonotic (Woolhouse and Gowtage-Sequeria, 2005; Woolhouse et al., 2001). In addition, new strains and types of infectious and transmissible agents are found every year. Among the many ways that infectious agents can evolve to become more virulent or to infect people are numerous transmission events and co-infection with several strains of pathogens. For this reason, industrial farm animal production facilities that house large numbers of animals in very close quarters can be a source of new or more infectious agents. Healthy or asymptomatic animals may carry microbial agents that can infect and sicken humans, who may then spread the infection to the community before it is discovered in the animal population.

Generation of Novel Viruses

While transmission of new or novel viruses from animals to humans, such as avian or swine influenza, seems a rather infrequent event today (Gray et al., 2007; Myers, Olsen et al., 2007), the continual cycling of viruses and other animal pathogens in large herds or flocks increases opportunities for the generation of novel viruses through mutation or recombinant events that could result in more efficient human-to-human transmission. In addition, as noted earlier, agricultural workers serve as a bridging population between their communities and the animals in large confinement facilities (Myers et al., 2006; Saenz et al., 2006). Such novel viruses not only put the workers and animals at risk of infection but also may increase the risk of disease transmission to the communities where the workers live.

Food-Borne Infection

Food production has always involved the risk of microbial contamination that can spread disease to humans, and that risk is certainly not unique to IFAP. However, the scale and methods common to IFAP can significantly affect pathogen contamination of consumer food products. All areas of meat, poultry, egg, and dairy production (e.g., manure handling practices, meat processing, transportation, and animal rendering) can contribute to zoonotic disease and food contamination (Gilchrist et al., 2007). Several recent and high-profile recalls involving *E. Coli* O157:H7 and *Salmonella enterica* serve as dramatic reminders of the risk.

Food-borne pathogens can have dire consequences when they do reach human hosts. A 1999 report estimated that *E. Coli* O157:H7 infections caused approximately 73,000 illnesses each year, leading to over 2,000 hospitalizations and 60 deaths each year in the United States (Mead et al., 1999). Costs associated with *E. Coli* O157:H7–related illnesses in the United States were estimated at $405 million annually: $370 million for deaths, $30 million for medical care, and $5 million for lost productivity (Frenzen et al., 2005). Animal manure, especially from cattle, is the primary source of these bacteria, and consumption of food and water contaminated with animal wastes is a major route of human infection.

Because of the large numbers of animals in a typical IFAP facility, pathogens can infect hundreds or thousands of animals even though the infection rate may be fairly low as a share of the total population. In some cases, it may be very difficult to detect the pathogen; *Salmonella enterica* (SE), for example, is known to colonize the intestinal tract of birds without causing obvious disease (Suzuki, 1994), although the infected hen ovaries then transfer the organism to the egg contents. Although the frequency of SE contamination in eggs is low (fewer than 1 in 20,000 eggs), the large numbers of eggs—65 billion—produced in the United States each year means that contaminated eggs represent a significant source for human exposure. Underscoring this point, the Centers for Disease Control and Prevention (CDC) estimated that SE-contaminated eggs accounted for approximately 180,000 illnesses in the United States in 2000 (Schroeder

Zoonotic disease:
A disease caused by a microbial agent that normally exists in animals but that can infect humans.

et al., 2005). The potential advantage of IFAP in this circumstance is that concentrated production and processing in fewer, larger facilities can result in improved product safety if regulations are properly instituted and vigilantly enforced.

Feed and Pathogen Risk

Feed formulation further influences pathogen risk because the feeds for confined animals are significantly different from the forage traditionally available to poultry, swine, or cattle. These feeds have been modified to:

- Reduce the time needed to reach market weight;
- Increase the efficiency of feed conversion—the amount of food converted to animal protein (rather than manure); and
- Ensure the survivability and uniformity of animals.

Other changes in modern animal feeds are the extensive recycling of animal fats and proteins through rendering and the addition of industrial and animal wastes as well as antimicrobials (AMs), including arsenic-derived compounds (arsenicals). In some cases, these additives can be dangerous to human health, as illustrated by the bovine spongiform encephalopathy (BSE) crisis in Britain in the early 1990s—scientists discovered that it resulted from the inclusion of brain and brainstem parts in the renderings that went into animal feeds. Since that discovery, great care has been taken to eliminate brain and spinal cord material from animal renderings. However, the ongoing addition of antimicrobial agents to IFAP livestock foodstuffs to promote growth also promotes the emergence of resistant strains of pathogens, presenting a significant risk to human health.

Nontherapeutic Antimicrobial Use and Resistance

The use of antibiotics for growth promotion began in the 1940s when the poultry industry discovered that the use of tetracycline fermentation byproducts resulted in improved growth (Stokstad and Jukes, 1958–1959). Though the mechanism of this action was never fully understood, the practice of adding low levels of antibiotics and, more recently, growth hormones to stimulate growth and improve production and performance has continued over the ensuing 50 years.

In the 1990s, the public became aware of the threat of antimicrobial resistance as the number of drug-resistant infections increased in humans. However, antimicrobial resistance has been observed almost since the discovery of penicillin. In 2000, a WHO report on infectious diseases expressed alarm at the spread of multidrug-resistant infectious disease agents and noted that a major source of antimicrobial-resistant bacteria was food:

> Since the discovery of the growth-promoting and disease-fighting capabilities of antibiotics, farmers, fish-farmers and livestock producers have used antimicrobials in everything from apples to aquaculture. Currently, only half of all antibiotics are slated for human consumption. The other 50% are used to treat sick animals, as growth promoters in livestock, and to rid cultivated foodstuffs of various destructive organisms. This ongoing and often low-level dosing for growth and prophylaxis inevitably results in the development of resistance in bacteria in or near livestock, and also heightens fears of new resistant strains "jumping" between species… (WHO, 2000)

Despite increased recognition of the problem, the Infectious Disease Society of America (ISDA) recently declared antibiotic-resistant infections to be an epidemic in the United States (Spellberg et al., 2008). The CDC estimated that 2 million people contract resistant infections annually and, of those, 90,000 die. A decade ago, the Institute of Medicine estimated that antimicrobial resistance costs the United States between $4 and $5 billion annually, and these costs are certainly higher now as the problem of resistance has grown and intensified worldwide (Harrison et al., 1998).

Antimicrobial resistance: **The result of microbial changes that reduce or eliminate the effectiveness of drugs.**

Because bacteria reproduce rapidly, resistance can develop relatively quickly in the presence of antimicrobial agents, and once resistance genes appear in the bacterial gene pool, they can be transferred to related and unrelated bacteria. Therefore, increased exposure to antimicrobials (particularly at low levels) increases the pool of resistant organisms and the risk of antimicrobial-resistant infections. Consider the following:

- Antimicrobials are readily available online or through direct purchase from the manufacturer or distributor, allowing unrestricted access by farmers to pharmaceuticals and chemicals without a prescription or veterinarian's oversight; and
- Some classes of antibiotics that are used to treat life-threatening infections in humans, such as penicillins and tetracyclines, are allowed in animal feeds to promote animal growth.

Groups attempting to estimate the amount of antimicrobials used in food animal production are often thwarted by varying definitions of "therapeutic," "nontherapeutic," and "growth-promoting." For example, the Union of Concerned Scientists estimated that 70% of antimicrobials in the United States are used in food animal production, whereas the Animal Health Institute estimated closer to 30% (AHI, 2002; Mellon et al., 2001). Others have not bothered with an estimate because of the lack of both clear definitions and data (Mellon et al., 2001; WHO, 2000). A universally accepted definition of the various types of use is necessary to estimate antimicrobial use and to formulate policy governing the use of antimicrobials in food animals. The lack of publicly available validated information on the volume of antimicrobial use as a feed additive leaves policymakers uninformed about the true state of antimicrobial use in food animal production and its relationship to the growing problem of antimicrobial resistance.

Supporters of the use of antibiotics as growth promoters maintain that their use, along with other technologies, results in more affordable meat products for consumers, decreased production costs, and less impact on the environment as fewer animals are required to produce a unit of meat product. However, it is not clear that the use of antimicrobials in food is cost-effective, either in terms of increased health care costs as a result of resistant infections, or for the facility itself (Graham et al., 2007). Antimicrobial-resistant bacteria have been found both in and downwind of IFAP facilities (e.g., swine) but not upwind (Gibbs et al., 2004). Several groups have reviewed the association between the use of low-level antimicrobials in food animal production and the development of antimicrobial resistance in humans (Teuber, 2001; Smith, Harris et al., 2002).

Whatever the direct evidence, it is certain that the exposure of bacteria to antimicrobial agents selects resistant bacteria that can replicate and persist. Such bacteria from IFAP facilities can reach humans through many routes, both direct (through food, water, air, or contact) and indirect (via transmission of resistance in the environmental pool of bacteria).

Endotoxin:
A toxin that is present in a bacteria cell and is released when the cell disintegrates. It is sometimes responsible for the characteristic symptoms of a disease, such as botulism.

Occupational Health Impacts of Industrial Farm Animal Production

IFAP facilities generate toxic dust and gases that may cause temporary or chronic respiratory irritation among workers and operators. IFAP workers experience symptoms similar to those experienced by grain handlers: acute and chronic bronchitis, nonallergic asthma–like syndrome, mucous membrane irritation, and noninfectious sinusitis. An individual's specific response depends on characteristics of the inhaled irritants and on the individual's susceptibility. In general, the symptoms are more frequent and severe among smokers (Donham and Gustafson, 1982; Markowitz et al., 1985; Marmion et al., 1990) and among workers in large swine operations (who work longer hours inside IFAP buildings) or in buildings with high levels of dusts and gases (Donham et al., 2000; Donham et al., 1995; Reynolds et al., 1996). Evidence also suggests that increasing exposure to IFAP irritants leads to increased airway sensitivity (Donham and Gustafson, 1982; Donham et al., 1989).

Another, more episodic, bioaerosol-related problem experienced by about 30% of IFAP facility workers is organic dust toxic syndrome (ODTS) (Do Pico, 1986; Donham et al., 1990), which is thought to be caused mainly by inhaled endotoxin and usually occurs in workers exposed to high levels of dust for four or more hours (Rylander, 1987). Although its onset may be delayed, the symptoms are more severe than those described above: fever, malaise, muscle aches, headache, cough, and tightness of the chest.

In addition to dust, irritants such as gases are generated inside farm buildings from the decomposition of animal urine and feces (ammonia, hydrogen sulfide, and methane, among others) (Donham and Gustafson, 1982; Donham and Popendorf, 1985; Donham et al., 1995). The combination of dusts and gases in IFAP facilities can rise to concentrations that may be acutely hazardous to both human and animal health (Donham and Gustafson, 1982).

Decomposing manure produces at least 160 different gases, of which hydrogen sulfide (H_2S), ammonia, carbon dioxide, methane, and carbon monoxide are the most pervasive (Donham et al., 1982a; Donham and Gustafson, 1982; Donham et al., 1982b; Donham and Popendorf, 1985; Donham et al., 1988). These gases may seep from pits under the building or they may be released by bacterial action in the urine and feces on the confinement house floor (one study showed that the latter accounted for 40% of the ammonia measured in-building [Donham and Gustafson, 1982]).

Possibly the most dangerous gas common to IFAP facilities is hydrogen sulfide. It can be released rapidly when liquid manure slurry is agitated, an operation commonly performed to suspend solids so that pits can be emptied by pumping (Donham et al., 1982b; Osbern and Crapo, 1981). During agitation, H_2S levels can soar within seconds from the usual ambient levels of less than 5 ppm to lethal levels of over 500 ppm (Donham et al., 1982b; Donham et al., 1988). Generally, the greater the agitation, the more rapid and larger amount of H_2S released. Animals and workers have died or become seriously ill in swine IFAP facilities when H_2S has risen from agitated manure in pits under the building. Hydrogen sulfide exposure is most hazardous when the manure pits are located beneath the houses, but an acutely toxic environment can result if gases from outside storage facilities backflow into a building (due to inadequate gas traps or other design faults) or if a worker enters a confined storage structure where gases have accumulated.

Antimicrobial Resistance
Life-threatening bacteria are becoming more dangerous and drug resistant because of imprudent antibiotic use in humans as well as animals, yet the federal government response to protect the efficacy of these drugs has been limited. For instance, the Food and Drug Administration (FDA) is moving ahead with approval of cefquinome, a highly potent antibiotic, for use in cattle despite strong opposition from the Centers for Disease Control and Prevention (CDC), the American Medical Association, and FDA's own advisory board. Health experts are concerned about the approval of drugs from this class of medicines for animal use because they are one of the last defenses against many grave human infections. Moreover, in this instance, the drug proposed is to combat a form of cow pneumonia for which several other treatment agents are available.

Community Health Effects and Vulnerable Populations

Communities near IFAP facilities are subject to air emissions that, although lower in concentration, may significantly affect certain segments of the population. Those most vulnerable—children, the elderly, individuals with chronic or acute pulmonary or heart disorders—are at particular risk.

The impact on the health of those living near IFAP facilities has increasingly been the subject of epidemiological research. Adverse community health effects from exposure to IFAP air emissions fall into two categories: (1) respiratory symptoms, disease, and impaired function, and (2) neurobehavioral symptoms and impaired function.

Respiratory Health

Four large epidemiological studies have demonstrated strong and consistent associations between IFAP air pollution and asthma. Merchant and colleagues, in a countywide prospective study of 1,000 Iowa families, reported a high prevalence of asthma among farm children living on farms that raise swine (44.1%) and, of those, on the farms that add antibiotics to feed (55.8%) (Merchant et al., 2005). Most of the children lived on family-owned IFAP facilities, and many either did chores or were exposed as bystanders to occupational levels of IFAP air pollution.

Mirabelli and colleagues published two papers describing a study of 226 North Carolina schools ranging from 0.2 to 42 miles from the nearest IFAP facility (Mirabelli et al., 2006a; Mirabelli et al., 2006b). Children living within three miles of an IFAP facility had significantly higher rates of doctor-diagnosed asthma, used more asthma medication, and had more asthma-related emergency room visits and/or hospitalizations than children who lived more than three miles from an IFAP facility. Their research also showed that exposure to livestock odor varied by racial and economic characteristics, indicating an environmental justice issue among the state's swine farms (Mirabelli et al., 2006a).

Sigurdarson and Kline studied children from kindergarten through fifth grade in two rural Iowa schools, one located half a mile from an IFAP facility and the other distant from any large-scale agricultural operation (Sigurdarson and Kline, 2006). Children in the school near the facility had a significantly increased prevalence of doctor-diagnosed asthma, but there was no difference between the two populations in the severity of asthma. Potential biases among children living close to the IFAP included children who were more likely to live on a farm (direct IFAP exposure was not assessed) and who more often lived in houses where parents smoked, but neither of these confounders explained the increase in asthma prevalence. The authors noted that physicians responsible for the medical care of these two groups of children differed and, therefore, did not rule out physician bias in asthma diagnosis.

Radon and colleagues conducted a 2002–2004 survey among all adults (18 to 45) living in four rural German towns with a high density of IFAP (Radon et al., 2007). Questionnaire data were available for 6,937 (68%) eligible adults. Exposure was estimated by collecting data on odor annoyance and by geocoding data on the number of IFAP facilities within 1,530 feet of each home. To control for occupational health effects, the researchers limited their analyses to adults without private or professional contact with farming environments. The prevalence of self-reported asthma symptoms and nasal allergies increased with self-reported odor annoyance, and the number of IFAP facilities was a predictor of self-reported wheeze and decreased FEV1 (forced expiratory volume in the first second; see definition). Although odor varied from day to day, the study reported reasonable test-retest reliability of the question on odor annoyance in the home environment. Sources of bias in this study include a somewhat dated (2000) registry of IFAP facilities and possible exposure misclassification.

These recent, well-controlled studies are consistent in finding associations between proximity to IFAP facilities and both asthma symptoms and doctor-diagnosed asthma, although they all use proxies for environmental exposure to IFAP emissions. Taken together, however, they provide reason to increase awareness of asthma risks in communities near IFAP facilities, to better inform rural doctors of standards for asthma diagnosis and of the reported association with IFAP facilities, and to pursue local and state environmental measures to minimize risks to children and adults living near IFAP facilities.

FEV1 (forced expiratory volume in the first second): **The volume of air that can be forced out in one second after taking a deep breath, an important measure of pulmonary function.**

Neurobehavioral Outcomes

Volatile organic compounds are important components of the thousands of gases, vapors, and aerosols present in IFAP facilities. More than 24 odorous chemicals (often referred to as odorants) have been identified in IFAP emissions (Cole et al., 2000). Valeric acids, mercaptans, and amines are particularly odorous, even in minuscule concentrations; ammonia and hydrogen sulfide are also pungently aromatic. Many of these compounds are known to be toxic to the nervous system in sufficient concentration. It is thus not surprising that the few studies that have examined neurobehavioral issues among residents living near IFAP facilities have documented increased rates of neurobehavioral symptoms such as depression.

Schiffman and colleagues studied North Carolina residents who lived in the vicinity of intensive swine operations and then compared findings from this group to matched control subjects who did not live near IFAP facilities (Schiffman et al., 1995). They found more negative mood states (e.g., tension, depression, anger, reduced vigor, fatigue, and confusion) among those living close to IFAP facilities. In a study of chronic (non-IFAP or IFAP) occupational exposures to hydrogen sulfide, Kilburn found that such exposures might lead to neuropsychiatric abnormalities, including impaired balance, hearing,

memory, mood, intellectual function, and visual field performance (Kilburn, 1997).

Reports have documented that there is great variability among odors from IFAP facilities, that odorous gases may be transformed through interactions with other gases and particulates between the source and the receptor (Peters and Blackwood, 1977), and that there is variability in odor persistence (the "persistence factor"), defined as the relative time that odorous gases remain perceptible (Summer, 1971). There remains a need to combine quantitative measures of odors with environmental measures of a suite of odorants in well-designed, controlled studies of neurobehavioral symptoms and signs in community-based studies.

Conclusions

The Commissioners note that the same techniques that have increased the productivity of animal agriculture have also contributed to public health concerns associated with IFAP. These concerns—antimicrobial resistance, zoonotic disease transfer to humans, and occupational and community health impacts that stem from the dusts and gases produced by IFAP facilities—are not unique to industrial farm animal production or even agriculture. The industrial economy causes significant ecological disruption, and that disruption is a major cause of disease. Microbes have always existed, will continue to exist, and will learn to adapt faster. It is the size and concentration of IFAP facilities and their juxtaposition with human populations that make IFAP a particular concern.

The Commission recommends that the federal government and animal agriculture industry address the causes of these public health concerns, particularly in the area of antimicrobial resistance, in order to reduce risks to the general public. The headlines from the fall of 2006 when *E. Coli* contaminated spinach made its way to the consumer market are fresh in the public's mind (CDC, 2006). The Commission's recommendations in this area are intended to bring about greater public protection without imposing an undue burden on the animal agriculture industry.


TECH

Methicillin (Antibiotic)-Resistant Staphylococcus aureus (MRSA)

Staphylococcus aureus is a common bacterium that causes superficial infections and occasionally invasive infections that can be fatal. Strains of *S. aureus* that are resistant to the antibiotic methicillin and related antibiotics commonly used to treat it are referred to as methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA and other staphylococci may be found on human skin, in the nose (where it can reside without causing symptoms), and on objects in the environment, and can be passed from person to person through close contact. MRSA is usually subcategorized as either hospital-acquired or community-acquired, not only because of where the infection was acquired, but also because different strains of the bacteria appear to be responsible for the different types of infections.

MRSA has become the most frequent cause of skin and soft tissue infections in patients seeking care in US emergency rooms (Moran et al., 2006). It can also cause severe and sometimes fatal invasive disease (Zetola et al., 2005). A recent study from the Centers for Disease Control and Prevention (CDC), reported in the *Journal of the American Medical Association* (*JAMA*), showed a rise in invasive MRSA infections both within and outside of health care settings in the United States in 2005. In particular, the authors noted a rise in community-acquired invasive MRSA, although it is still less prevalent than the hospital-acquired strain (Klevens et al., 2007). They cite MRSA as a major emerging public health problem.

Pigs and some other animals can also carry staphylococci (including MRSA) on their bodies (known as "colonization"). MRSA colonization in pigs was first studied in the Netherlands, where it was found that pig farmers were 760 times more likely to be colonized with MRSA than people in the general population (Voss et al., 2005). In addition, the study documented transmission of MRSA between pigs, pig farmers, and their families (Huijsdens et al., 2006; Voss et al., 2005). A separate study in the journal *Veterinary Microbiology* looked at the prevalence of MRSA in pigs and pig farmers in Ontario, Canada (Khanna et al., 2007). This study found that MRSA is common in pigs on farms in Ontario: it was present in 24.9% of all pigs sampled and in 20% of the farmers (the prevalence in the study was 45%). In addition, there was a significant correlation between the presence of MRSA in pigs and humans on farms (Khanna et al., 2007). The strains found in both pigs and farmers in Ontario were mainly of a type that has been found in pigs in Europe, as well as a strain commonly found in US health care facilities.

S. aureus has also been isolated, at varying levels, from meat in Egypt (Bakr et al., 2004), Switzerland (Schraft et al., 1992), and Japan (Kitai et al., 2005). Analysis of the strains of bacteria isolated from these meat products suggested that they were of human origin, probably due to contamination during processing. A recent study from the Netherlands, however, found low levels of MRSA strains in meat that were probably of animal (farm) origin (van Loo et al., 2007). Proper cooking of the meat kills the bacteria, but there is a risk of transmission to workers in processing plants and to consumers before the meat is cooked.

The growing importance of MRSA as a public health problem in the United States and elsewhere, as well as the growing body of evidence suggesting transmission between farm animals and humans and among humans, makes it particularly relevant to the discussion of antimicrobial use in food animals (Witte et al., 2007).

Environmental Risks

Industrial farm animal production (IFAP) stands in sharp contrast to previous animal farming methods because of its emphasis on production efficiency and cost minimization. For most of the past 10,000 years, agricultural practice and animal husbandry were more or less sustainable, as measured by the balance between agricultural inputs and outputs and ecosystem health, given the human population and rate of consumption. IFAP systems, on the other hand, have shifted to a focus on growing animals as units of protein production. Rather than balancing the natural productivity of the land to produce crops to feed animals, IFAP imports feed and medicines to ensure that the animals make it to market weight in the shortest time possible. Animals and their waste are concentrated and may well exceed the capacity of the land to produce feed or absorb the waste. Not surprisingly, the rapid ascendance of IFAP has produced unintended and often unanticipated environmental and public health concerns.

Storage and disposal of manure and animal waste are among the most significant challenges for IFAP operators. By any estimate, the amount of farm animal waste produced annually in the United States is enormous; the United States Department of Agriculture (USDA) estimates around 500 million tons of manure are produced annually by operations that confine livestock and poultry—three times the EPA estimate of 150 million tons of human sanitary waste produced annually in the US (EPA, 2007b). And in comparison to the lesser amount of human waste, the management and disposal of animal wastes are poorly regulated.

Until the late 1950s, manures typically were either deposited directly by animals on pastures or processed in solid form and collected along with bedding (usually hay or straw) from animal housing facilities for application to the land as a crop nutrient. There were no regulated rates of application, seasonal restrictions, or requirements for the reporting, analysis, or monitoring of applied manures. This lack of protection may have been without consequence before IFAP because animal farmers managed fewer animals, widely dispersed among agricultural lands, and relied on natural ecosystems for attenuating pathogens and absorbing or diluting nutrients. But as the number of animals on individual farms increased, the need for more efficient and regulated methods of manure management grew in importance.

As in large human settlements, improper management of the highly concentrated feces produced by IFAP facilities can and does overwhelm natural cleansing processes. Because of the large concentrations of animals and their manure, what was once a valuable byproduct is now a waste that requires proper disposal. As a result, animal feeding operations in the United States, whether IFAP or not, now use a number of manure management strategies depending on the type of operation and state and federal regulations.

Nutrient and Chemical Contaminants in the Water

Ground application of untreated manure is a common disposal method and a relatively inexpensive alternative to chemical fertilizers because nitrogen and phosphorus, essential nutrients for plant growth, are present in high concentrations in animal waste. Ground application of IFAP waste can exceed the ecological capacity of the land to absorb all the nutrients (Arbuckle and Downing, 2001). Application of untreated animal waste on cropland can contribute to excessive nutrient loading, contaminate surface waters, and stimulate bacteria and algal growth and subsequent reductions in dissolved oxygen concentrations in surface waters (Rabalais et al., 1996).

Nutrient load in water supplies is commonly assessed by biochemical oxygen demand (BOD), a measure of organic and inorganic substances subject to aerobic microbial metabolism. Very high BOD levels indicate significant waterborne contamination and difficulties for aquatic life. Highly concentrated manure, such as swine waste slurries, exhibit a BOD of 20,000 to 30,000 mg per liter (Webb and Archer, 1994), which

is about 75 times more concentrated than raw human sewage and more than 500 times more concentrated than the treated effluent from the average municipal wastewater treatment facility. Algal blooms, a common response to the high nutrient loads in agricultural runoff, rapidly deplete oxygen as the algae die and decompose aerobically.

Agricultural runoff laden with chemicals (synthetic fertilizers and pesticides) and nutrients is suspected as a major culprit responsible for many "dead zones" in both inland and marine waters, affecting an estimated 173,000 miles of US waterways (Cook, 1998). Animal farming is also estimated to account for 55% of soil and sediment erosion, and more than 30% of the nitrogen and phosphorus loading in the nation's drinking water resources (Steinfeld et al., 2006).

IFAP facilities in high-risk areas such as floodplains are particularly vulnerable to extreme weather events that increase the risk, and quantity, of runoff. Flood events overwhelm the storage capacity of IFAP liquid manure lagoons and cause catastrophic contamination that results in very large fish kills.

Beyond nitrogen and phosphorus, waterborne chemical contaminants associated with IFAP facilities include pesticides, heavy metals, and antibiotics and hormones. Pesticides control insect infestations and fungal growth. Heavy metals, especially zinc and copper, are added as micronutrients to the animal diet. Antibiotics are used not only to prevent and treat bacterial infections for animals held in close quarters, but also as growth promoters. Pharmaceuticals, such as tylosin, a macrolide antibiotic widely used for therapeutics (disease treatment) and growth promotion in swine, beef cattle, and poultry, decays rapidly in the environment but persists in surface waters of agricultural watersheds (Song et al., 2007).

Nitrate is another important drinking water contaminant, regulated under EPA's Safe Drinking Water Act. Its effects on humans include diseases such as hyperthyroidism (Seffner, 1995; Tajtakova et al., 2006) and insulin-dependent diabetes (Kostraba et al., 1992), as well as increased risk of adverse reproductive outcomes and neurodevelopmental defects (Arbuckle et al., 1988; Burkholder et al., 2007). The US EPA sets allowable limits for nitrate of 10 mg/l in public drinking water supplies and requires tertiary treatment or amendment with groundwater before distribution (EPA, 2006).

The presence of agricultural chemicals in surface waters contributes to the growth of cyanobacteria and other microorganisms that may be especially harmful to people with depressed or immature immune systems (Rao et al., 1995; Shi et al., 2004).

It is also recognized that ammonia emissions from livestock contribute significantly to the eutrophication and acidification of soils and waters. Eutrophication is an excessive richness of nutrients in a body of water, mostly nitrates and phosphates from erosion and runoff of surrounding lands, that causes a dense growth of plant life and the death of animal life due to lack of oxygen. Some level of eutrophication occurs naturally, but this process can be accelerated by human activities. Acidification can put stress on species diversity in the natural environment. Reduction of ammonia emissions from CAFOs requires covering of manure storage tanks and reservoirs and the direct injection of controlled quantities of manure slurry into soil only during the growing season. Land application of manure during winter months or rainy weather leads to significant runoff into surface waters.

Legislating Animal Waste Management: North Carolina

As the numbers of large industrial livestock and poultry farms increase across the country, so do concerns about animal waste disposal and its effects on public health and the environment. To address these concerns, several state and local lawmakers have passed or proposed laws aimed directly at concentrated animal feeding operations (CAFOs) in hopes of protecting local waters and limiting the risks of pollution.

Lawmakers in North Carolina, the nation's second-largest hog producer—producing almost 10 million swine a year—struggled for years to pass legislation that would help reduce the water and air pollution caused by IFAP operations. Most of the state's hog farmers are concentrated in a few counties in the coastal plain region; according to the *Raleigh News & Observer*, there are more than 2,300 farms registered in the state, most of them in rural eastern North Carolina.

In the late 1990s, state lawmakers were the first in the nation to institute a temporary statewide moratorium on the construction of new hog waste lagoons and spray fields as primary methods of waste management, and in September 2007, they made the ban permanent ("Senate enacts ban on new hog-waste lagoons," *The News & Observer*, April 19, 2007). The law not only bans the construction of new lagoons but requires that new waste management systems meet strict environmental performance standards. It does not change requirements for existing lagoons, but provides monetary assistance for farmers to voluntarily convert to alternative waste management systems. However, Deborah Johnson, chief executive officer of the North Carolina Pork Council, told the *National Hog Farmer*, "Unless some new technological breakthrough happens, we will have lagoons and spray fields for the foreseeable future" ("North Carolina Keeps Swine Lagoons," *National Hog Farmer*: July 26, 2007).

The new law also established a pilot program that helps farmers convert methane emissions from covered lagoons to electricity. Some environmental and community advocates are concerned, however, that the methane program will discourage farmers who use lagoons from investing in alternative waste disposal systems.

Water Stress

Like other aspects of IFAP (such as manure disposal), crop production for animal feed places enormous demand on water resources: 87% of the use of freshwater in the US is used in agriculture, primarily irrigation (Pimentel et al., 1997). For example, it takes nearly 420 gallons of water to produce one pound of grain-fed broiler chicken (Pimentel et al., 1997). IFAP operations in arid or semiarid regions are thus of particular concern because of their high water demand on the limited supply of water, much of it from aquifers that may have limited recharge capacity. The 174,000-square-mile Ogallala aquifer, for example, is a fossil aquifer that dates back to the last ice age and underlies parts of Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas. Irrigation has reduced the Ogallala by more than half, and current depletion rates exceed 3.3 feet per year of water table level (McMichael, 1993; Soule and Piper, 1992). Because the aquifer's very slow recharge rate is vastly outstripped by irrigation and other human needs, the aquifer is at risk of being fully depleted, threatening not only agriculture but drinking water supplies for a huge area of the United States.

Greenhouse Gases and Other Air Pollutants

Globally, greenhouse gas emissions from all livestock operations account for 18% of anthropogenic greenhouse gas emissions, exceeding those from the transportation sector (Steinfeld et al., 2006). Agriculture accounts for 7.4% of the total US release of greenhouse gases (EPA, 2007a). Animals produce greenhouse gases such as methane and carbon dioxide during the digestion process. Other greenhouse gases, primarily nitrous oxide, arise mainly from the microbial degradation of manure. Additional emissions result from degradation processes in uncovered waste lagoons and anaerobic digesters. The global warming potential of these emissions, compared to a value of one for carbon dioxide, is 62 for methane and 275 for nitrous oxide on a 20-year time horizon. The US EPA Greenhouse Gas Inventory Report data for agricultural inputs are summarized below.

Emission control solutions are now being examined by the EPA, along with possible opportunities for carbon credits and credit trading (Jensen, 2006).

Air quality degradation is also a problem in and around IFAP facilities because of the localized release of significant quantities of toxic gases, odorous substances, and particulates and bioaerosols that contain a variety of microorganisms and human pathogens (further discussed in the public health section of this report). These compounds arise from feed, animals, manure, and microorganisms. Highly noxious odors are associated with vapor phase chemicals and compounds adherent to particles. These agents emanate from livestock facilities, waste storage reservoirs, and manure application sites, and all can be transported aerially from IFAP facilities to neighbors or neighboring communities.

Some of the most objectionable compounds are the organic acids, which include acetic acid, butyric acids, valeric acids, caproic acids, and propanoic acid; sulfur-containing compounds such as hydrogen sulfide and dimethyl sulfide; and nitrogen-containing compounds including ammonia, methyl amines, methyl pyrazines, skatoles, and indoles. Smells associated with these compounds are described as similar to those of rotten eggs or rotting vegetables (hydrogen sulfide, dimethyl sulfide), rancid butter (butyric acids), and feces (valeric acid, skatole, indole).

Biofilters

Biofilters are a method for reducing air emissions from IFAP facilities. They are fairly simple to construct and operate, successfully mitigate air emissions, and they are cost effective.

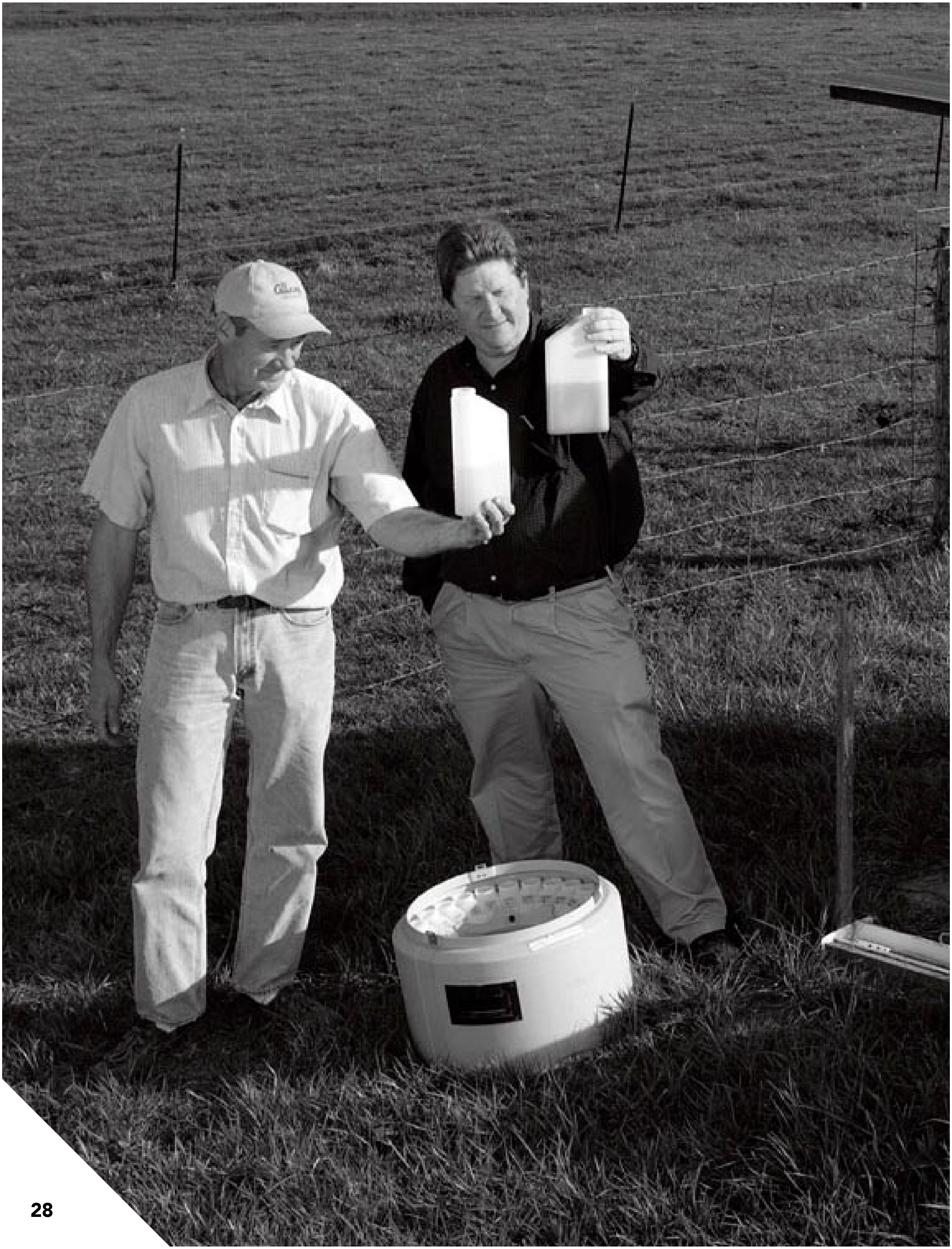
The filters can be made from several kinds of material, but they are most often a mixture of compost and woodchips wrapped in a fabric. The fabric keeps the filter from clogging and must be replaced periodically. Most biofilters operate in conjunction with a system to sprinkle water on the filter and fans to blow air through it.

The filters work by converting the compounds in the air into water and carbon dioxide. Air from inside the pit or barn is forced through the filter and then out into the atmosphere.

Biofilters can reduce odor and ammonia emissions by over 80%.

US Greenhouse Gas Inventory for Agricultural Emissions (Source: EPA, 2007a)

Greenhouse Gas	Source	Thousand Tons	Thousand Tons CO_2 Equivalent
Methane (CH_4)	Total	8,459.14	17,770
	Enteric fermentation	5,886.34	12,360
	Manure management	2,167.14	4,550
	Other	406.75	860
Nitrous Oxide (N_2O)	Total	1,333.80	41,350
	Agriculture soil management	1,298.52	40,250
	Manure management	34.17	1,050
	Other	2.20	60



Energy

IFAP is more energy intensive than the traditional practice of raising food animals (e.g., cows grazing on pastures), requiring disproportionately large inputs of fossil fuel, industrial fertilizers, and other synthetic chemicals. For example, the ratio of fossil fuel energy inputs per unit of food energy produced—not including food processing and distribution—averages 3:1 for all US agricultural products combined, but for industrially produced meat products the ratio can be as high as 35:1 (beef produced in feedlots generally has a particularly unfavorable energy balance) (Horrigan et al., 2002).

Commissioners' Conclusions

The number of farms that raise livestock has fallen dramatically while the total number of farm animals raised in the US each year has remained relatively constant (Gollehon et al., 2001). IFAP has made this possible with significant gains in production efficiency by most measures: on a per animal basis, today's farm animal requires less feed, produces less manure, and reaches market weight much faster than farm animals produced on the small family farm of 50 years ago. The result is that the price consumers pay for meat, poultry, dairy, and egg products at the grocery store or in restaurants is cheaper in real terms (adjusted for inflation) than it was even several years ago.

The downside of IFAP practices is that they have produced an expanding array of deleterious environmental effects on local and regional water, air, and soil resources. Those effects impose costs on the society at large that are not "internalized" in the price paid at the retail counter for meat, poultry, dairy, or egg products.

The large concentration of animals on the typical industrial farm presents a major waste management problem. The volumes of manure are so large that traditional land disposal methods can be impractical and environmentally threatening. Excess nutrients in manure contaminate surface and groundwater resources. Today, over a million people are estimated to take their drinking water from groundwater that shows moderate or severe contamination with nitrogen-containing pollutants (Nolan and Hitt, 2006), mostly due to the heavy use of agricultural fertilizers and high rates of application of animal waste.

The location of IFAP facilities near each other and the waste they discharge untreated into the environment exacerbate their environmental impact. A single hog IFAP facility, for example, produces manure in an amount equivalent to the sewage flow of an entire American town. Pound for pound, pigs produce four times the waste of a human. Consequently, a single IFAP housing 5,000 pigs produces the same volume of raw sewage as a town of 20,000, but the IFAP facility does not have a sewage treatment plant (Walker et al., 2005). The Commission believes that to protect against further environmental degradation, there is a need for better management practices, more protective zoning, and improved monitoring and enforcement of IFAP facilities. In addition, the Commission recommends a full life cycle analysis to fully assess the ecological impacts of IFAP facilities.

Impacts of Animal Agriculture in Yakima Valley, Washington

The state of Washington has some of the toughest environmental protection laws in the country, but you wouldn't know it if you live in Yakima Valley, says longtime resident and family farmer, Helen Reddout. Reddout is credited by many as one of the first environmentalists to bring national attention to the issue of industrialized animal agriculture and its effects on the environment and public health.

Reddout has called Yakima Valley home for more than 50 years. She raised her family, tended her cherry trees, and taught at the local school for most of that time. It wasn't until a large dairy operation opened near her family farm that Reddout became an outspoken critic of what she calls "factory farms."

Reddout remembers the first time she was directly affected by a concentrated animal feeding operation. It was 2:00 in the morning when she was awakened by what she describes as a "hideous smell oozing from the window." Her neighbor was using nearby land as a spray field to dispose of manure. The next morning, "There in the middle of the field was a manure gun spraying huge streams of gray-green sewage onto the already oversaturated field … the ammonia smell was so strong it made me gasp." When she noticed much of the liquid manure was running off into a drainage ditch, Reddout began to worry about her well water. Subsequent tests revealed her drinking well was contaminated with nitrates, although whether her neighbor is directly to blame has not been proved.

In Washington, as in many other parts of the United States, the number of dairies is shrinking while their size is increasing. Between 1989 and 2002, the number of dairies in western Washington dropped from more than 1,000 to about 500 while the average herd grew from 30 cows in the 1950s to 350 today. As of 2002, there were just 160 dairies in eastern Washington, 71 of them in Yakima County alone.

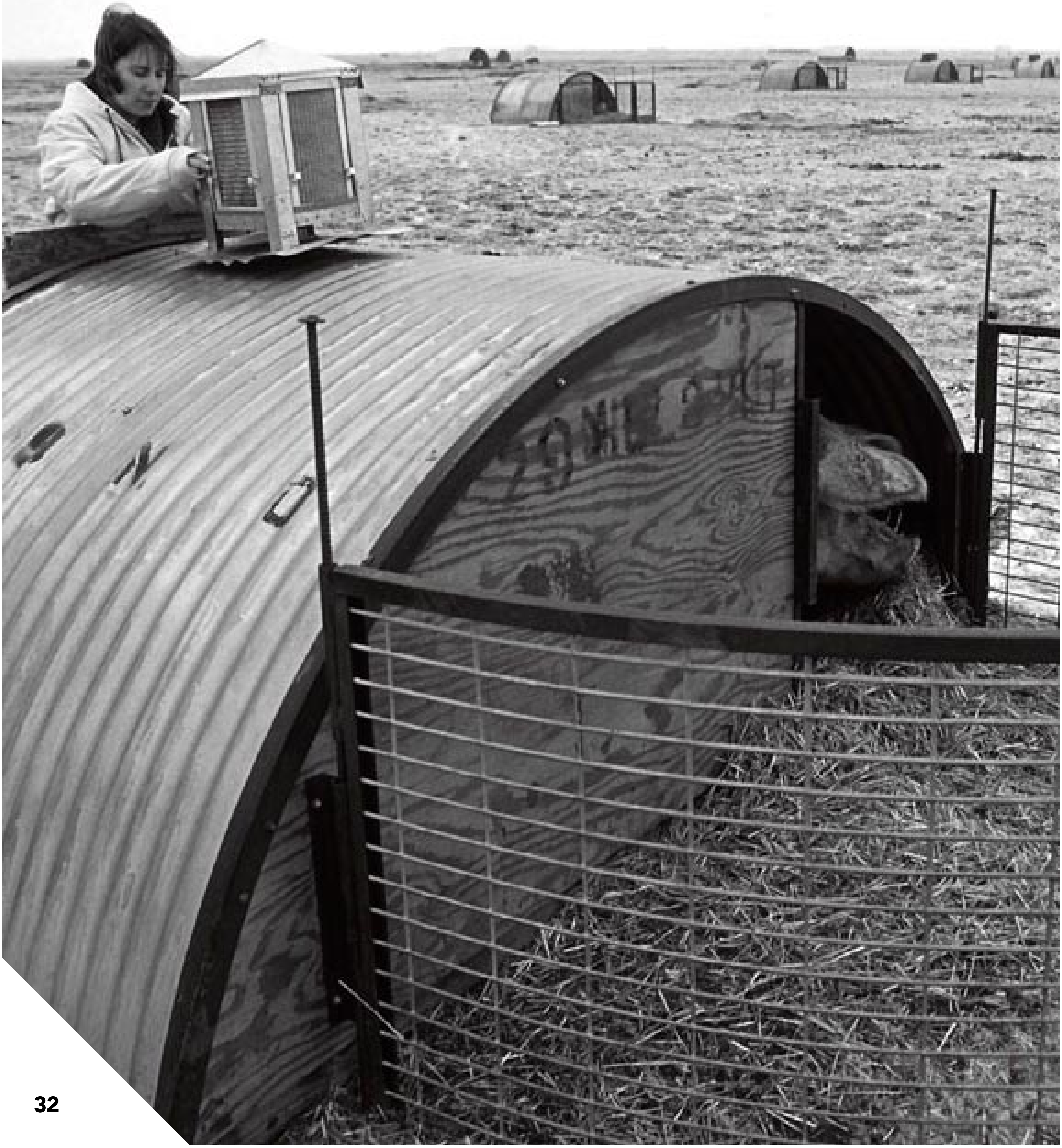
Dairy industry leaders point out that most Washington dairies are run in accordance to the law, arguing that a small number of "bad actors" are unfairly used to demonize the industry.

Animal Welfare

Before the emergence of industrial farm animal production systems, the ethic of animal husbandry held that good care of animals was wholly consistent with the interests of the farmer. Most animals were raised on diversified farms that produced both crops and several species of animals, which generally had access to the pasture or barnyard whenever weather conditions permitted. For the most part, husbandry was considered the responsibility of the producer.

More than 100 years later, farms in the 21st century have become highly specialized systems and no longer produce more than one crop and several species of livestock. Farms producing both crops and livestock still exist, but they are no longer the norm. Now, crop growers sell to feed mills that formulate engineered feeds to sell to farmers who raise and feed livestock. The supply chain has thus evolved to a series of distinct production processes connected through economic transactions. Consumers are now at the extreme end of this supply chain, yet they are increasingly concerned that farm animals are afforded a decent life. Unfortunately, it can be difficult to define what actually constitutes a decent life for animals because doing so includes both ethical (value-based) and scientific (empirical) components.

Increasing public awareness of the conditions prevalent in confinement agriculture (e.g., gestation and farrowing crates for swine, battery cages for layers) has led to consumer demand for changes in animal treatment. A poll conducted by Oklahoma State University and the American Farm Bureau Federation found that 75% of the public would like to see government mandates for basic animal welfare measures (http://asp.okstate.edu./baileynorwood/aw2/aw2main.htm). Possibly as a defensive response, the food animal industry has made changes that are easily marketed and that are aimed at changing public perception. Smithfield, for example, announced recently that it would eliminate the use of gestation crates in its hog-rearing operations, and the United Egg Producers have published standards for the treatment of laying hens.



An Alternative Hog Production System

Alternatives to the present concentrated animal feeding operation (CAFO) model of raising hogs vary widely by region. But although they differ in design, alternative systems share one common element: they all increase both labor and animal husbandry required to manage the animals, whereas the traditional CAFO is designed to require as little animal husbandry training as possible.

This sidebar focuses on the hoop barn, the most prevalent alternative system for raising hogs in the United States. It is similar to a traditional CAFO in that the hogs are kept in a confined space to facilitate management and speed up growth compared to the pigs in a natural, feral environment, but it differs in important ways.

A hoop barn, whether it is used for gestation, farrowing, or finishing, is a semipermanent structure that sits on sidewalls 4 to 6 feet high and made of wood or concrete. On top of the wall, a UV-resistant tarp stretched over a hoop-shaped metal frame forms the roof of the structure. The floor is concrete or a combination of dirt and concrete. The minimalist nature of the structure makes it appealing to producers for several reasons: it costs much less than a traditional wood truss building; it can be used for other purposes, such as equipment storage; and it can be removed relatively easily if need be. A hoop barn can last up to 10 years, versus a traditional confinement barn, which lasts about 15 years.

Ventilation systems in hoop barns are much simpler than in traditional confinement structures. Rather than mechanical fans to control temperature and ventilation, the hoop barn uses natural ventilation by leaving the ends of the barn open during the summer months. Hoop barns also have a space between the side wall and the tarp, which acts as a natural ventilator to bring in fresh air. In winter, electric heaters (often suspended from the metal frame) provide heat. Deep bedding also helps insulate the pigs by allowing them to nest and burrow. The aerobic process that occurs when the bedding mixes with the hogs' dung also creates heat. However, given the relatively lightweight nature of the tarp, hoop barns are not appropriate for extremely cold climates because it is difficult to keep the temperature inside at or near either a comfortable temperature for the animals or the ideal temperature for their weight gain.

Deep bedding is used to handle manure instead of liquid or scrape handling systems. Hoop barns are generally separated into two sections, one for feeding and one for watering. The dirt floor section is bedded with straw, cornstalks, or some other bedding material often derived from crop or field residue materials. The bedding helps insulate the animals in winter and also absorbs moisture from urine and binds with feces. The combined bedding and manure product is then either composted and stored or cast on fields to dry. After drying, it is spread and often disked into the field, so the possibility of manure runoff into streams is reduced.

Hoop barn systems are much cheaper to build than a fixed structure, but there are other costs, such as bedding and animal management, that are not incurred in a traditional confinement system.

The information in this piece is adapted from, *Hoop Barns for Grow-Finish Swine, Midwest Plan Service*, September 2004, page 20.

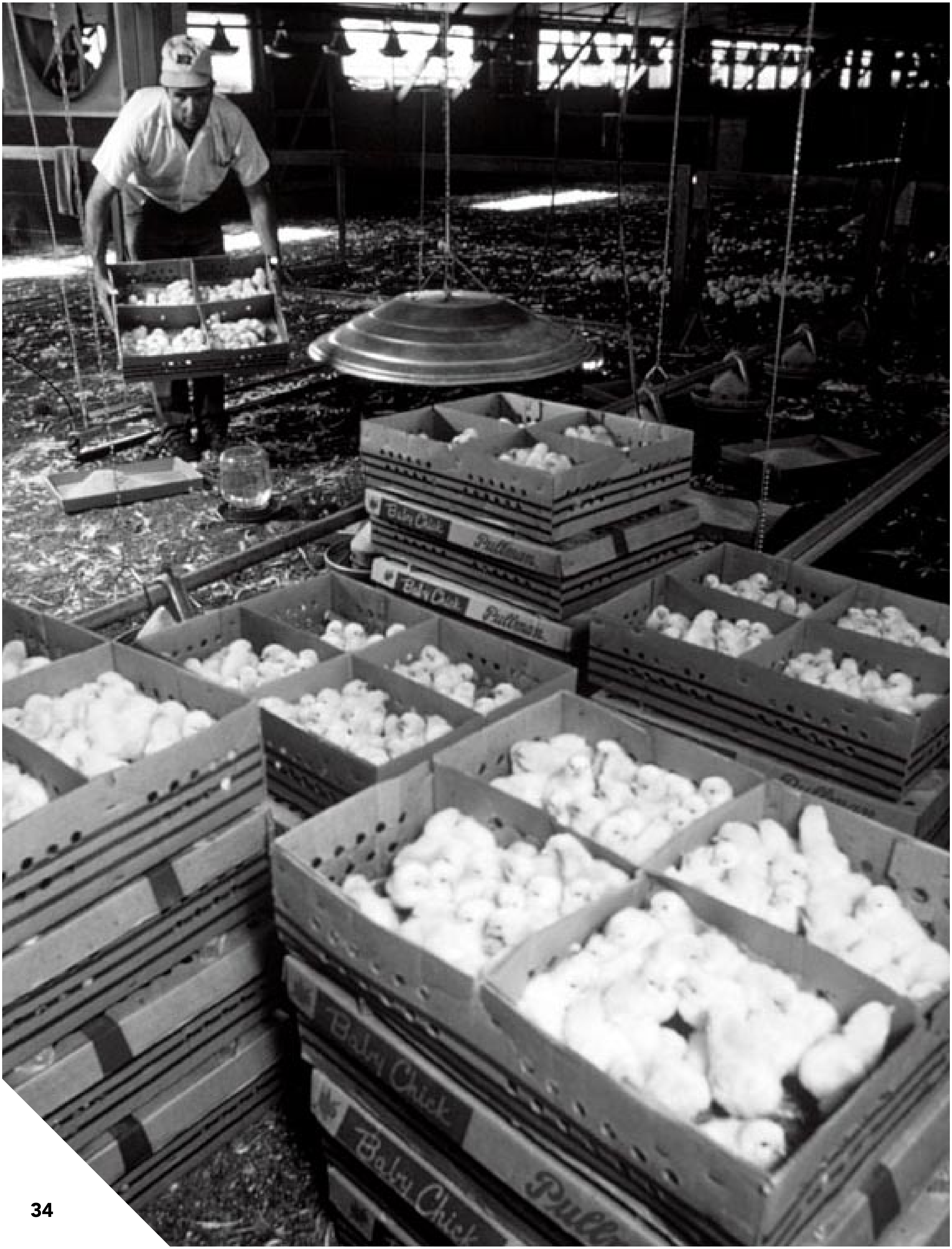
Impacts of Confinement on Animal Welfare

Today's concentrated animal production systems are dedicated to producing meat as cheaply as possible while achieving certain standards of taste, texture, and efficiency. Confinement systems are designed to produce animals of marketable weight in less time and with a lower incidence of some diseases. When the animals are confined indoors, discomfort due to weather is reduced. The downside is that animals are kept in more crowded conditions, are subject to a number of chronic and production-related diseases, and are unable to exhibit natural behaviors. In addition, the animals are often physically altered or restrained to prevent injury to themselves or IFAP workers.

Confinement animals are generally raised indoors and, in some cases (e.g., poultry, laying hens, hogs), the group size when raised indoors is larger than outdoors. In other cases (e.g., veal crates or gestation crates for sows), animals are separated and confined to spaces that provide for only minimal movement. The fundamental welfare concern is the ability of the animal to express natural behaviors—for example, having natural materials to walk or lie on, having enough floor space to move around with some freedom, and rooting (for hogs). Crates, battery cages, and other such systems fail to allow for even these minimal natural behaviors.

Other animal management practices that have been questioned include feeding and nutrition. For example, beef cattle finished in feedlots are typically fed grains rather than forage (grass, hay, and other roughage), even though their digestive systems are designed to metabolize forage diets. The result is that beef cattle put on weight faster, but they also often experience internal abscesses. Some laying hens still have their feed restricted at regular intervals in order to induce molting to encourage egg laying (although this practice is mostly phased out, according to United Egg Producers (UEP) standards).

Most animals are physically altered without pain relief when raised in concentrated, confined production systems (as well as in some more open systems), even though it is widely accepted that such alteration causes pain. For example, hogs have their tails docked to avoid tail biting by other hogs in close proximity. Laying hens and broilers have their toenails, spurs, and beaks clipped. Dairy cows may have their horns removed or their tails docked. The purpose of such alteration is to avoid injury to the animal,


Baby Chick
Pullman
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or to make it easier to handle, or to meet market demands on alteration, such as castration of bulls raised for beef, and so these practices are common throughout animal agriculture, not just in CAFOs and IFAP.

The Five Freedoms

Contemporary concerns about the welfare of intensively farmed animals are generally considered to have originated with the 1964 publication of *Animal Machines* by Ruth Harrison of the United Kingdom. The book is widely regarded as having the same formative effect on the animal welfare movement as Rachel Carson's 1962 book, *Silent Spring*, had on the modern environmental movement. Harrison described what she called a "new type of farming …[with] animals living out their lives in darkness and immobility without the sight of the sun, of a generation of men who see in the animal they rear only its conversion to human food."

A year after Harrison's book was published, the Brambell Committee Report (1965) described criteria for the scientific investigation of farm animal welfare. The committee, made up of leading veterinarians, animal scientists, and biologists in the United Kingdom (UK), defined welfare as including both physical and mental well-being (Command Paper 2836). The report emphasized that the evaluation of animal welfare must include "scientific evidence available concerning the feelings of the animals that can be derived from their structure and functions and also from their behavior."

The emphasis on behavior and feelings was radical for its time (even in 2007, debate continues on this subject among animal scientists), but in 1997 the Farm Animal Welfare Council (FAWC), an independent advisory body established by the British government in 1979, adopted the principles of the Brambell report as the "Five Freedoms," which became the basis for guidelines and codes of practice for various organizations around the world. These five freedoms are described as follows:

> The welfare of an animal includes its physical and mental state and we consider that good animal welfare implies both fitness and a sense of well-being. Any animal kept by man must, at least, be protected from unnecessary suffering.
>
> An animal's welfare, whether on farm, in transit, at market or at a place of slaughter, should be considered in terms of the *'five freedoms.'* These freedoms define ideal states rather than standards for acceptable welfare. They form a logical and comprehensive framework for analysis of welfare within any system together with the steps and compromises necessary to safeguard and improve welfare within the proper constraints of an effective livestock industry.
>
> 1. *Freedom from Hunger and Thirst*—by ready access to fresh water and a diet to maintain full health and vigor.
> 2. *Freedom from Discomfort*—by providing an appropriate environment including shelter and a comfortable resting area.
> 3. *Freedom from Pain, Injury or Disease*—by prevention or rapid diagnosis and treatment.
> 4. *Freedom to Express Normal Behavior*—by providing sufficient space, proper facilities, and company of the animals' own kind.
> 5. *Freedom from Fear and Distress*—by ensuring conditions and treatment that avoid mental suffering.

Source: (FAWC, 2007) at http://www.fawc.org.uk/freedoms.htm

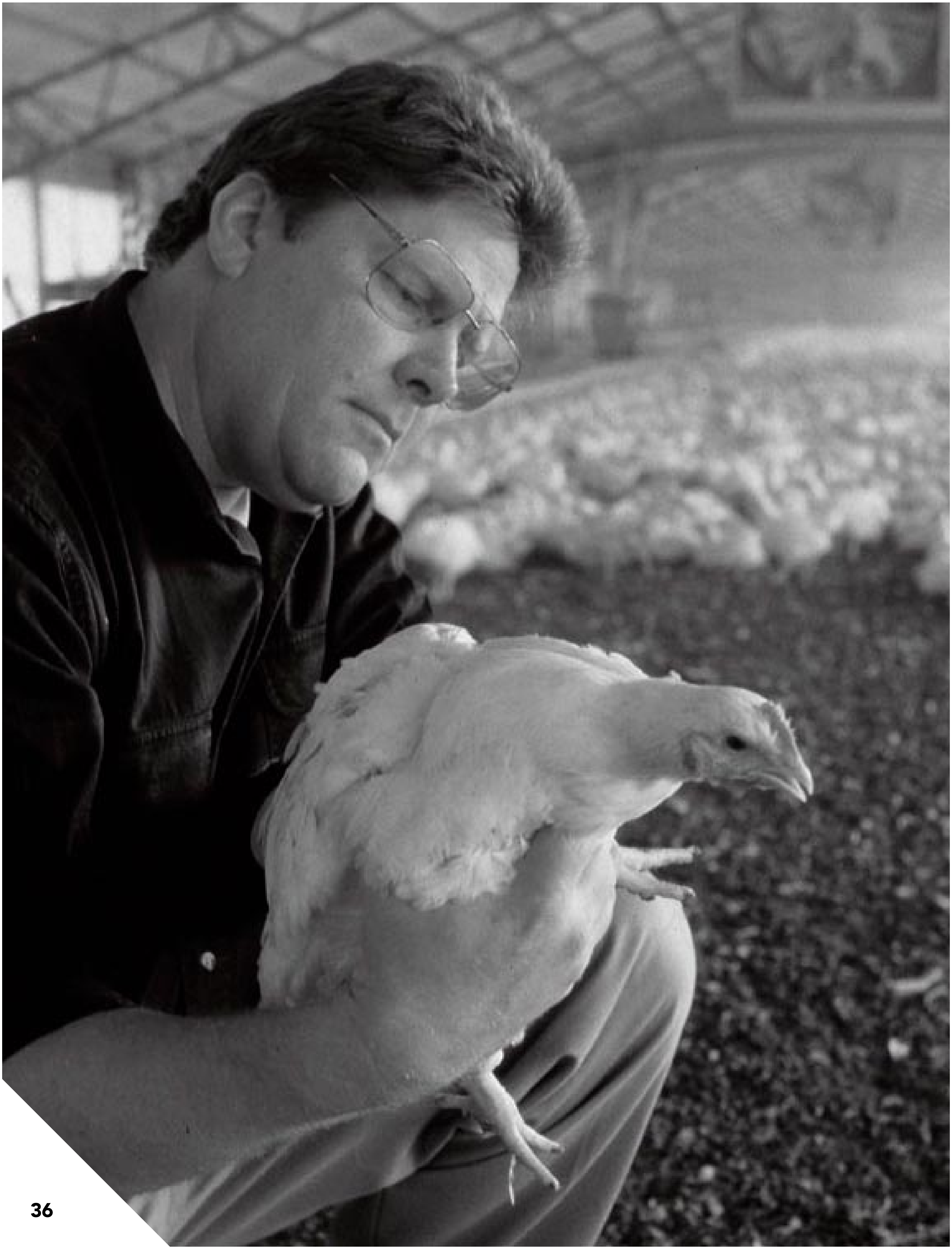
Animal husbandry methods designed to accommodate these five freedoms, particularly when it comes to housing characteristics, result in minimal cost to the consumer. More recently, scientists and advocates in the European Union have refined the five freedoms and further clarified the requirements for basic animal well-being. These are listed in the table on page 37.

Theses criteria are intended to be taken in their entirety. Consequently, animals raised in conditions that meet the "Good Feeding" criteria but not the "Appropriate Behavior" criteria would not be considered to have good welfare. In the United States, the "Appropriate Behavior" criteria seem to be the hardest to satisfy and generally are not met for food animals. Fully implementing these criteria will require the education of both consumers and producers.

Voluntary Standards and Certification

Consumer concern for humane treatment of food-producing animals is growing and has prompted change in the industry. Retailers and restaurateurs are particularly sensitive to consumer concerns and have begun insisting on minimal animal welfare standards that they can report to their customers. Consolidation in the grocery and restaurant industries—10 grocery and 15 restaurant companies control the majority of sales in animal products—has brought those sectors the market power to demand change from their suppliers.

McDonald's and Wal-Mart are among those calling for at least minimal standards for animal well-being from their suppliers. McDonald's, for example, began auditing packing plants several years ago to ensure that cattle were handled and killed humanely according to the voluntary standards developed by the American Meat Institute[4] (see table on page 37). Later, McDonald's appointed an animal welfare committee of outside experts and established on-farm standards for their suppliers, beginning with laying hens. Other retailers, such as Whole Foods, adopted more stringent standards to accommodate the interests of their customer base. Their competitors quickly followed suit, and in 2000 the trade associations of supermarkets (the Food Marketing Institute, FMI) and chain restaurants (National Council of Chain Restaurants, NCCR) consolidated their recently established animal welfare expert committees to create a coordinated and uniform



program. Following their lead, other retailers and food animal producers have adopted standards of their own (see table on page 39).

However, when an affected industry defines, monitors, and enforces voluntary standards, it is vulnerable to charges of "the fox guarding the hen house." So in the spirit of Ronald Reagan's "trust but verify" admonition, third-party certification and labeling (in which the label is granted by an independent organization) have become increasingly common. Such labels allow consumers both in the United States and abroad to know that the products they buy are consistent with their concerns for environmental sustainability, social equity, and/or humane animal treatment. Some examples of third-party certification and labeling include Fair Trade certification of commodities, a designation that indicates sustainably grown coffee, for example, and the payment of a just wage to growers; and the Forest Stewardship Council's Certified Sustainable Forest Products have made significant inroads into the marketplace for lumber. Consumer preference for such labeling has been strong enough that many commodity producers and retailers seek out certification to protect their market share and increase market penetration.

Several third-party certification programs focus primarily on animal welfare. The largest of these is Certified Humane Raised and Handled. This International Standards Organization (ISO) Guide 65 certified labeling program, modeled on the Freedom Foods program established by the Royal Society for Prevention of Cruelty to Animals in the United Kingdom, has the support of 27 humane organizations around the world. Since its inception in 2003, it has grown to cover more than 14 million animals produced by 60 meat, poultry, dairy, or egg suppliers as well as 20 restaurants and supermarket chains that feature certified products.

All of these standards seek to address consumer concerns for the humane treatment of animals. Advocacy by animal protection groups has been effective in raising awareness in this area, and sensitivity to issues that affect animal well-being continues to grow.

European Union Criteria for Animal Well-Being (Source: European Union Animal Welfare Quality Program: http://www.welfarequality.net/everyone/36059)

Welfare Criteria	Welfare Principles	Meaning
Good feeding	Absence of prolonged hunger	Animals should not suffer from prolonged hunger
	Absence of prolonged thirst	Animals should not suffer from prolonged thirst
Good housing	Comfort around resting	Animals should be comfortable, especially within their lying areas
	Thermal comfort	Animals should be in good thermal environment
	Ease of movement	Animals should be able to move around freely
Good health	Absence of injuries	Animals should not be physically injured
	Absence of disease	Animals should be free of disease
	Absence of pain induced by management procedures	Animals should not suffer from pain induced by inappropriate management
Appropriate behavior	Expression of social behaviors	Animals should be allowed to express natural, non-harmful, social behaviors.
	Expression of other behaviors	Animals should have the possibility of expressing other intuitively desirable natural behaviors, such as exploration and play
	Good human-animal relationship	Good human-animal relationships are beneficial to the welfare of animals
	Absence of general fear	Animals should not experience negative emotions such as fear, distress, frustration, or apathy

Legislation

Reliance on voluntary standards alone is not likely to fully meet the public's concern for the welfare of industrial farm animals. Voluntary standards applied in other industries (forestry, for example) have been limited by the loopholes allowed in the standards. Similarly, because the food animal industry has an economic stake in ensuring that such voluntary standards result in the least cost, and consequently, additional measures are likely to be needed to ensure a decent minimally life for animals raised for food. Surveys such as those conducted by the Humane Society and the Farm Bureau (reported earlier in this chapter) clearly reveal a growing social ethic among consumers that compels the animal agriculture industry to address public concerns about animal welfare.

At the present time, federal regulation of the treatment of farm animals is minimal, consisting of only two major laws. The first is the Twenty-Eight Hour Law, which was passed in 1873 and requires that, after 28 hours of interstate travel by rail, steam, sail, or "vessels of any description," livestock be unloaded and fed, watered, and rested for at least five consecutive hours before the resumption of transport. While generally thought of as a law to address animal cruelty, its motivation was in large part to reduce animal losses in transit. Strengthened in 1906 after publication of Upton Sinclair's *The Jungle*, the law was amended again in 1994 to apply to animals transported by "rail carrier, express carrier, or common carrier (except by air or water)." However, USDA did not agree to regulate truck transport (the major means of transport for livestock) until 2006, after animal protection groups protested (HSUS, 2006b) and the courts ruled that USDA could no longer apply "regulatory discretion" to truck transport. The second federal law is the Humane Methods of Slaughter Act (HSA), which was passed in 1958 and stipulated that livestock be rendered insensible to pain before slaughter. The HSA did not cite poultry, however, so poultry processing plants are excluded from USDA enforcement.

All other attempts to pass federal laws setting standards for farm animal housing, transport, or slaughter have been unsuccessful, with the exception of the federal standards for the transport of slaughter horses, authorized under the 1996 Farm Bill. Indeed, few bills dealing with on-farm animal welfare regulation have been introduced in Congress and most have failed. This absence of regulation stands in sharp contrast to the federal oversight of certain mammals (including farm animals) used in biomedical research, teaching, and testing, the use and care of which are extensively regulated under the provisions of the 1966 Animal Welfare Act.[5]

Perhaps because of the lack of federal regulation, there has been increasing emphasis on the introduction of state and local regulation. All states have some form of animal cruelty legislation and enforcement is becoming stricter, with more significant fines for violations. However, 25 states specifically exempt farm animals from animal cruelty laws, and in 30 states certain "normal" farm practices are exempted. Concerned citizens and advocates are therefore using mechanisms other than cruelty charges in an attempt to regulate or outlaw certain practices. For example, several states now have laws banning sow gestation crates: a voter referendum on a constitutional amendment banned them in Florida in 2002, a similar initiative (which also banned the use of veal crates) passed in Arizona in 2006, and the Oregon legislature also recently passed a state law banning crates. The production of foie gras was outlawed in California by legislative vote in 2004, and the city of Chicago in 2006 banned the sale of foie gras in restaurants. Several states have referendums on their ballots in 2008 that propose banning the use of battery cages to house laying hens.

In 1996, New Jersey became the first (and only) state to require its Department of Agriculture to write comprehensive standards for the "humane raising, keeping, care, treatment, marketing, and sale of domestic livestock." But the department's proposed regulations were not issued until 2004, and animal protection groups immediately criticized them as endorsing the status quo, although the preface to the standards makes it clear that the intent was to provide minimal requirements for the prosecution of animal cruelty cases. Animal protection groups have filed suit against the state of New Jersey, and it is unclear whether or not (or when) the proposed regulations will be finalized and enforced.

Commissioners' Conclusions

The Pew Commission on Industrial Farm Animal Production considers animal well-being an essential component of a safe and sustainable production system for farm animals. Food animals that are treated well and provided with at least minimum accommodation of their natural behaviors and physical needs are healthier and safer for human consumption. After reviewing the literature, visiting production facilities, and listening to producers themselves, the Commission believes that the most intensive confinement systems, such as restrictive veal crates, hog gestation pens, restrictive farrowing crates, and battery cages for poultry, all prevent the animal from a normal range of movement and constitute inhumane treatment.

Growing public awareness and concern for the treatment of food animals has brought increased demands for standards to ensure at least minimal protection of animal welfare. These demands have been expressed through pressure on retail and restaurant operators for standards that can be audited and certified. The Commissioners believe that the demand for such standards will increase in the next several years and that it will be incumbent upon meat, poultry, egg, and dairy producers to meet that demand and demonstrate that food animals are treated humanely throughout their lifetimes, up to and including the method of slaughter. Further, producers who are able to incorporate animal husbandry practices that assure better treatment for animals are likely to benefit in increased profit and market share as consumers express their preference at the grocery store.

Major US Animal Welfare Standards (Source: Mench et al., 2008)

Source	Scope	Program/Document	Purpose
American Meat Institute	Livestock slaughter plants	*Recommended Animal Handling Guidelines	Guidelines
		Audit Guide	Voluntary audit
American Sheep Industry	Sheep	Sheep Care Guide	Guidelines
Animal Welfare Institute	Pigs, beef cattle and calves, rabbits, ducks, sheep	Animal Friendly Standards (for each species)	Voluntary guidelines for small family farmers
Certified Humane Raised and Handled	Egg-laying hens, broilers, turkeys, beef, dairy, sheep, swine	(detailed standards for each species)	ISO-certified third-party labeling program
Free Farmed (AHA)	Egg-laying hens, broilers, turkeys, beef, dairy, sheep, swine	(detailed standards for each species)	third-party labeling program
Milk and Dairy Beef Quality Assurance Program	Dairy	*Caring for Dairy Animals Technical Reference Guide	Guideline and self-evaluation; voluntary certification
		On-The-Dairy Self-Evaluation Guide	
National Cattlemen's Beef Association	Beef Cattle	*Guidelines for Care and Handling of Beef Cattle	Voluntary guidelines
National Chicken Council	Broiler chickens	*Animal Welfare Guidelines	Voluntary guidelines
		Audit Checklist	Voluntary audit
National Organic Standards	All livestock and poultry	National Organic Standards and Guidelines	USDA labeling program; main focus is organic although includes some animal husbandry standards
Pork Board	Pigs	Swine Welfare Assurance Program, which includes the *Swine Care Handbook	Self-education program for producers; auditing program to be developed
United Egg Producers	Caged layers	*Animal Husbandry Guidelines for US Egg Laying Flocks	Guidelines for caged hens
		UEP Certified Program	Third-party auditing and labeling program

*Approved by FMI-NCCR as guidelines appropriate for the development of retail auditing programs. Individual retailers may also have their own standards and/or auditing programs, which may differ significantly from the programs approved by the FMI-NCCR committee.

Rural America

Asked to describe rural life, people are likely to talk of pastoral landscapes, open spaces, a slower pace of life, a place where people are friendlier. In short, "rural" evokes an idyllic image of life, a counterpoint to the intense pace of urban life.

But the realities of rural life are somewhat different. A dominant feature of life in much of rural America is persistent poverty. In 2005, more than 15% of the rural population (73 million people) earned family incomes of less than $19,800, which is below the official poverty line. Most of the nearly 400 US counties that are classified as poor are also rural (USDA-ERS, 2008).

The Rural Economy

Rural America has long been this country's main supplier of raw materials. In the past few decades, however, global trade liberalization has made American manufacturing less competitive vis-à-vis developing world manufacturing centers resulting in less demand for raw materials and fewer rural jobs. US manufacturing employment peaked in 1979 at nearly 20 million jobs and fell to 14 million by 2004 as increased substitution of capital for labor and labor productivity gains, as well as consumers' continuing appetite for goods made more cheaply abroad, took their toll.

But persistent rural poverty is the result of many factors, not only a lack of employment opportunities. Rural poverty rates have always been higher than urban rates. And rural poverty is more enduring: federally designated "persistent" poverty areas, defined by the USDA Economic Research Service as areas with consistently high poverty rates for at least 30 years, are all rural. Analysts suggest the following causes of rural poverty:

- *Educational attainment:* Adults in rural America are less likely to have a college degree than urban residents, and the quality of rural educational systems often falls short, especially in low-wealth counties; both factors limit the ability of rural workers to secure good jobs and of rural counties to attract and create quality jobs.
- *Lack of opportunity:* Rural areas often lack economic diversity and rely on a limited number of industries (e.g., extractive industries), which can limit job advancement and make rural jobs more vulnerable to market forces and corporate restructuring.
- *Infrastructure:* From child care facilities to public transportation to information technology, rural infrastructure is often inadequate and serves as a barrier to the recruitment of companies and jobs.
- *Discrimination:* Whether on the basis of race or ethnicity, social class, or gender, discrimination persists in some rural areas, blocking access to opportunity among underserved population groups.

Given the lack of economic opportunity in rural America, it is not surprising that local policymakers have looked to IFAP facilities as an opportunity to promote economic development. Many such facilities were sited in poor counties as a job creation strategy, often lured to those locations with promises of significant tax abatement and other benefits. But higher rates of poverty are equally prevalent in areas of high IFAP concentration, an association confirmed by Durrenberger and Thu's finding of higher rates of food stamp use in Iowa counties with industrialized hog production (Durrenberger and Thu, 1996).

The economic disparity between industrial farm communities and those that retain locally owned farms may be due, at least in part, to the degree to which money stays in the community. Locally owned and controlled farms tend to buy their supplies and services locally, thus supporting a variety of local businesses. This phenomenon is known as the economic "multiplier" effect, estimated at approximately seven dollars per dollar earned by the locally owned farm. In contrast, IFAP facilities under contract to integrators have a much lower multiplier effect because their purchases of feed, supplies, and services tend to leave the community, going to suppliers and service providers mandated by the integrators. Researchers in Michigan documented the magnitude of this difference by tracking local purchases of supplies for swine production. Abeles-Allison and Connor found that local expenditures per hog were $67 for the small, locally owned farms and $46 for the larger, industrialized farms (the $21 difference is largely due to the larger farms' purchases of bulk feed from outside the community) (Abeles-Allison and Connor, 1990).

The IFAP trend toward consolidation among meat packing companies and meat packer control of livestock production through contracts with farmers to grow the animals, rather than buying the animals at the slaughterhouse, has put the farmer at a disadvantage. The incentive for both meat packers and farmers is to gain control of markets and thus reduce the fluctuation and uncertainty of prices. But the high degree of consolidation in the meat packing industry has created a near monopoly in that sector. According to the Organization for Competitive Markets, a national nonprofit public policy research organization headquartered in Lincoln, Nebraska, the falling numbers of farmers across the country are due, in large part, to the growth of food-processing monopolies.

The combination of meat packers' ownership of livestock and rigid contract relationships with the farmers who raise the livestock eliminates open market competition and drives down prices paid to growers. Often, a producer without a contract with a packer cannot sell livestock at all; and the packers' high degree of market control allows them to exert market pressure that drives down prices. The farmers, who now need contracts to sell the animals they produce, are in the position of being price takers. According to a USDA report, only nine percent of hogs were sold on the open market from 2002 to 2005, while 62% of cattle were sold on the open market during the same period. The price decline attributable to that degree of control by packers was estimated (for cattle) to be approximately $5.75 per hundredweight, or $69 less per head (on a 1,200-pound animal) than the free market price (USDA-ERS, 2001). For hogs, the picture is decidedly more dismal.

Industrial Agriculture and Quality of Life

As long ago as the 1930s, government and academic researchers began investigating the extent to which large industrialized farms affect their communities. One of the first studies was conducted by sociologist E.D. Tetreau, who found that large-scale, hired labor–dependent farms were associated with poor social and economic well-being in rural Arizona communities (Tetreau, 1940).

In the early 1940s, the United States Department of Agriculture (USDA) sponsored a research project on the effects of industrialized farming using a matched pair of California communities: Arvin, where large, absentee-owned, nonfamily farms were more numerous, and Dinuba, where locally owned, family-operated farms were more numerous. The research was led by Walter Goldschmidt, a USDA anthropologist who systematically documented the relationship between large-scale farming and its impact on a variety of community quality of life indicators such as size of the middle class, family income levels and poverty rates, quality of public schools, and strength of civil society organizations (such as churches and civic organizations).

Across the board, the indicators measured by Goldschmidt showed that Arvin's quality of life was lower than Dinuba's. Arvin's residents also had less local control over public decisions, what he called a "lack of democratic decision making," as local government was susceptible to influence by outside agribusiness interests (Goldschmidt, 1946; Goldschmidt, 1978). Goldschmidt concluded that large-scale industrialized farms create a variety of social problems for communities, a finding that many other studies have confirmed. Decades later, California revisited Arvin and Dinuba in its Small Farm Viability Project and concluded that the disparity between the two communities observed by Goldschmidt had increased—the economic and social gaps had widened (1977).

Similar effects have been reported in other studies, such as a 1988 study of family-farm and industrial agricultural communities in 98 industrial-farm counties in California, Arizona, Texas, and Florida. The study found that farm size (in acres), gross farm sales, and high levels of mechanization "significantly predict declining community conditions not merely at the local agricultural community level, but in the entire county" (MacCannell, 1988).

A further significant IFAP impact on quality of life is the smell, which can have dramatic consequences for surrounding communities, where lives are rooted in enjoying the outdoors (Thu, 2002). The siting of large-scale livestock facilities near homes disrupts rural life as the freedom and independence associated with life oriented toward the outdoors gives way to feelings of violation, isolation, and infringement. Social gatherings are affected through the disruption of routines that normally provide a sense of belonging and identity—backyard barbecues, church attendance, and visits with friends and family (Donham et al., 2007).

Contract Broiler Production System

Most broiler chickens (also called fryers or frying chickens) raised in the United States are produced under contract arrangements with integrated poultry producing companies. These companies typically control almost every aspect of production—they own the breeder flocks, hatcheries, chickens, feed mills, processing plants, and marketing arrangements.

Contract growers produce the chickens from hatchlings to marketable size in broiler houses using equipment that meets the specifications of the integrator. The producer owns or leases the land and the facilities to raise the broilers, and the integrator owns the chickens and feed. Growers are also responsible for management of the litter (the combination of manure and bedding materials) as well as for the taxes, utilities, and insurance. The amount of litter produced annually for a broiler facility can be substantial; for example, a broiler farm that has four houses (each containing between 28,000 and 30,000 chickens) and that markets 4-pound broilers could generate approximately 340 tons of manure per year (Dozier III et al., 2001). The litter can be stored using several methods depending on the length of storage and quantity of litter produced. Covered or uncovered stockpile, stockpile with ground liner, and roofed storage structures are the three basic options for litter storage. The primary goals of storing broiler litter are to prevent nutrient runoff and leaching and to minimize insect and odor problems.

Capital costs are high for growing broilers, and lenders typically offer 10- to 12-year loans with terms that result in payments as high as 60% of the grower's gross income, making it impossible for them to decide to grow other crops once they take out the loan (Mississippi State University Extension Service, 1997).

IFAP Impacts on Rural Social Capital

Sociologists consider social capital—mutual trust, reciprocity, and shared norms and identity—the foundation of community and an important ingredient in measuring quality of life. Communities with higher levels of social capital tend to have better indicators of quality of life—lower poverty rates, fewer incidents of violent crime, and stronger democratic institutions. Social capital also emerges as an internal resource in instances of controversy.

The social fabric of communities undergoes significant change as industrialized farms replace family farms. These changes are consistent with those seen in communities with high concentrations of poverty regardless of whether they are rural or urban. Because capital-intensive agriculture relies more on technology than on labor, there are fewer jobs for local people and more low-paid, itinerant jobs, which go to migrant laborers who are willing to work for low wages (Gilles and Dalecki, 1988; Goldschmidt, 1978; Harris and Gilbert, 1982). Other indicators of social disruption include increases in stress, sociopsychological problems, and teen pregnancies.

For these and other reasons, IFAP facilities frequently generate controversy and thus threaten community social capital—and the rifts that develop among community members can be deep and long-standing (DeLind et al., 1995). For example, there have been reports of threats to IFAP facility neighbors in North Carolina (Wing and Wolf, 2000). In an in-depth study of six rural counties in southern Minnesota, Wright and colleagues (Wright et al., 2001) identified three patterns indicative of the decline in social capital that accompanied the siting of IFAP facilities in these communities:

- widening gaps between IFAP and non-IFAP producers;
- harassment of vocal opponents of IFAP facilities; and
- perceptions by both CAFO supporters and opponents of hostility, neglect, or inattention by public institutions that resulted in perpetuation of an adversarial and inequitable community climate.

All sides involved in controversies over IFAP facilities tend to frame their issues and identities in terms of rights and entitlements, as described in McMillan and Schulman's research on the hog industry in North Carolina (McMillan and Schulman, 2003). Producers defend their property rights, including the right to earn a living from their land, while neighbors defend their right to enjoy their own property. DeLind reports that in response to local opposition to corporate IFAP facilities in Parma Township, Michigan, agriculture industry advocates such as the American Farm Bureau and the National Pork Producers Council defended the right of IFAP facilities to exist without regulation by appealing to the "right to farm" (DeLind et al., 1995).

Such controversy, cast in stark terms of rights, pits neighbor against neighbor and threatens core rural values of honesty, respect, and reciprocity. IFAP facility neighbors consider it a violation of respect when their concerns are labeled emotional, perceptual, and subjective, or are dismissed as invalid or unscientific. Recent findings presented by Kleiner, Rikoon, and Seipel are illustrative. Their study reports that in two northern Missouri counties where large, corporate-owned swine IFAP facilities dominate, citizens expressed more negative attitudes about trust, neighborliness, community division, networks of acquaintanceship, democratic values, and community involvement. In contrast, a county dominated by independently owned swine operations had the most positive attitudes about trust, neighborliness, community division, and networks of acquaintanceship (et al., 2000).

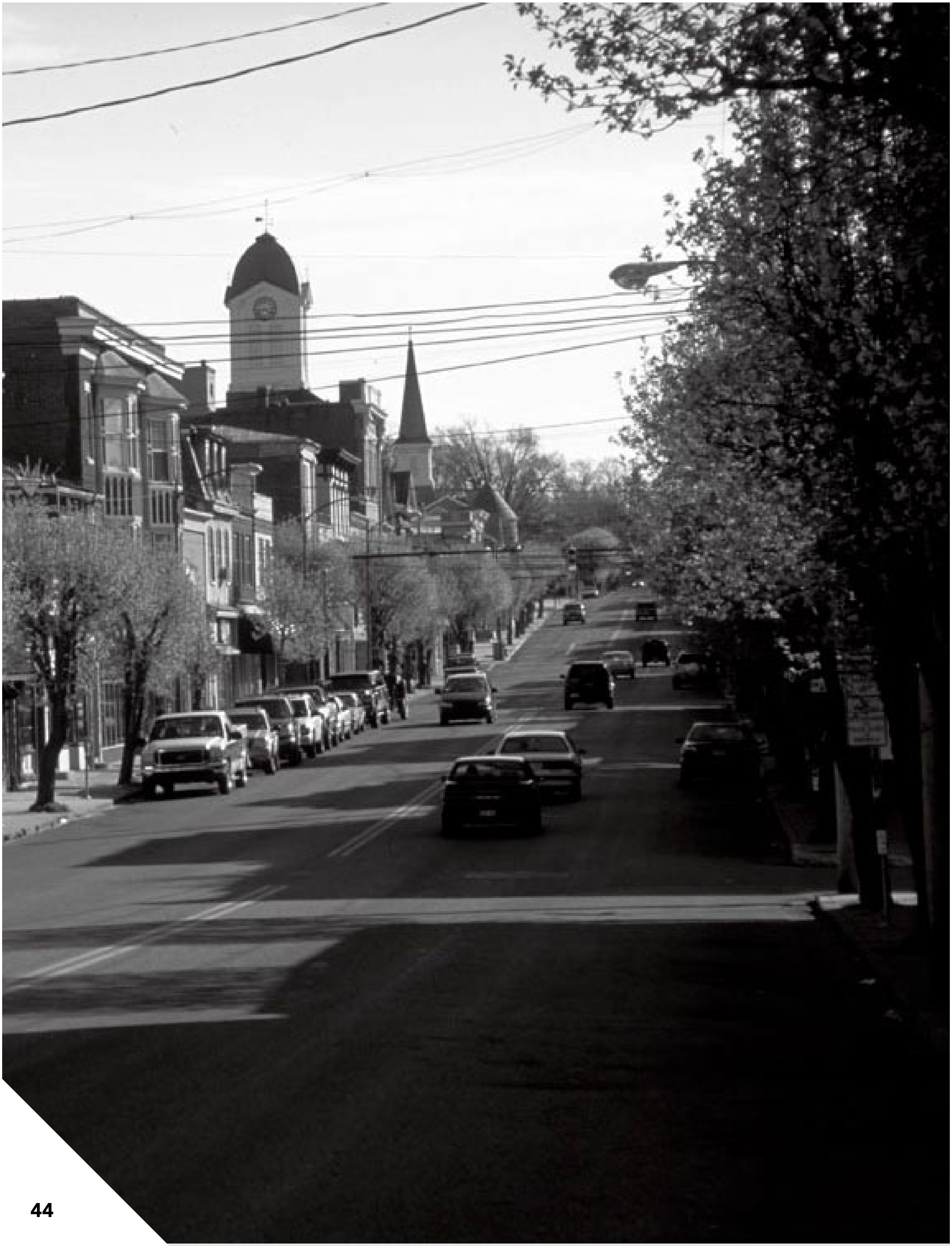
Clash of Values Between Family Farmers and IFAP Facility Owners

In the small town of Bode, Iowa, two couples, Clarence and Caroline Bormann (both age 78) and the late Leonard and Cecilia (age 70) McGuire, were lifelong Iowa family farmers—row crop and livestock producers—and neighbors. When a neighboring farm constructed an industrial hog facility to be run jointly with Land O' Lakes, the two couples grew concerned about the potential public health and environmental implications of such a facility, with a liquid manure lagoon, so close to their homes. In 1994, they took action against the farm to prevent its designation as an "Agricultural Area," which afforded protection from "nuisance suits."

Despite numerous meetings and discussions, construction continued. The facility operators refused to limit or reduce the facility's potential impact on the neighbors or the surrounding environment. Instead, they sought statutory protection by having the land designated an "Agricultural Area" by the County Board of Supervisors. After two applications, more than three public hearings, and two district court rulings, the "Agricultural Area" status was approved.

But this approval was short-lived. The couples appealed the legality of the designation to the Iowa Supreme Court, arguing that it violated the Constitutional prohibition against the taking of private property by the government without payment of just compensation. In a strongly worded opinion, the Iowa Supreme Court agreed and declared the nuisance protection portion of the statute "flagrantly unconstitutional."

The hog farm owner and corporate partner, together with state and national agricultural industry associations, sought to have the decision of the Iowa Supreme Court overturned by the United States Supreme Court. For more than four years, the Bormanns and McGuires pursued their cause (at their own expense). On December 21, 1998, an appeal was filed, with the backing of various Iowa and national production groups, to the US Supreme Court. Finally, in 1999, the United States Supreme Court denied the pork groups' appeal and allowed the Iowa Supreme Court ruling in favor of the farmers to stand.



An Alternative: Community-Supported Agriculture*

Community-supported agriculture (CSA) is a way to connect local farmers with local consumers, develop a regional food supply, and strengthen local economies.

The roots of CSA go back 30 years to Japan, where a group of women grew concerned about increasing imports and decreasing farm population, and so initiated a direct growing and purchasing relationship with local farms. They called this relationship "teikei" or "putting the farmer's face on food." By the 1980s, the concept had traveled to Europe, and then to the United States, where in 1985 it was called community-supported agriculture at the Indian Line Farm in Massachusetts. By 2005, there were more than 1,500 CSA farms in the United States and Canada.

CSA is a commitment between a farm and a community of supporters that provides a direct link between the production and consumption of food. CSA members cover a farm's yearly operating budget by purchasing a share of the season's harvest, supporting the farm throughout the season, sharing both the costs and the bounty with the farmer. The farmer or grower (often with the assistance of a core group of the community) creates a budget for the annual production costs (e.g., salaries, distribution costs, investments for seed and tools, land payments, machinery maintenance), and this budget is allocated among the people for whom the farm will provide. This calculation determines the cost of each "share" of the harvest. One share usually provides for the weekly vegetable needs for a family of four, but CSA farms may also offer flowers, fruit, meat, honey, eggs, and dairy products.

Community members sign up and pay for their share either in a lump sum in the early spring (before planting) or over the course of the growing season. They then receive a weekly "bounty" from the farm throughout the growing season. The types of products received vary depending on both the region and the type of farm(s) involved, but crops are planted in succession in order to ensure a weekly delivery to each member. The week's harvest is measured or counted and divided equally among the members. The produce is usually delivered to a specific location in the community at a specific time, although some farms may provide home delivery for an extra fee and some members go to the farm(s) to pick up their share. Arrangements vary by the type of CSA.

Most CSA farms/groups strive for sustainability, both economically and ecologically. The farms are typically more diversified in order to provide a variety of products over the growing season, an explicit goal of some CSA networks. The direct marketing of CSA allows farmers to get the fairest price for their product while enabling the consumers to know what farmer grew their food and how it was grown. In some cases, CSA farms may offer apprenticeships to community members who wish to learn about farming and help in the production of their own food.

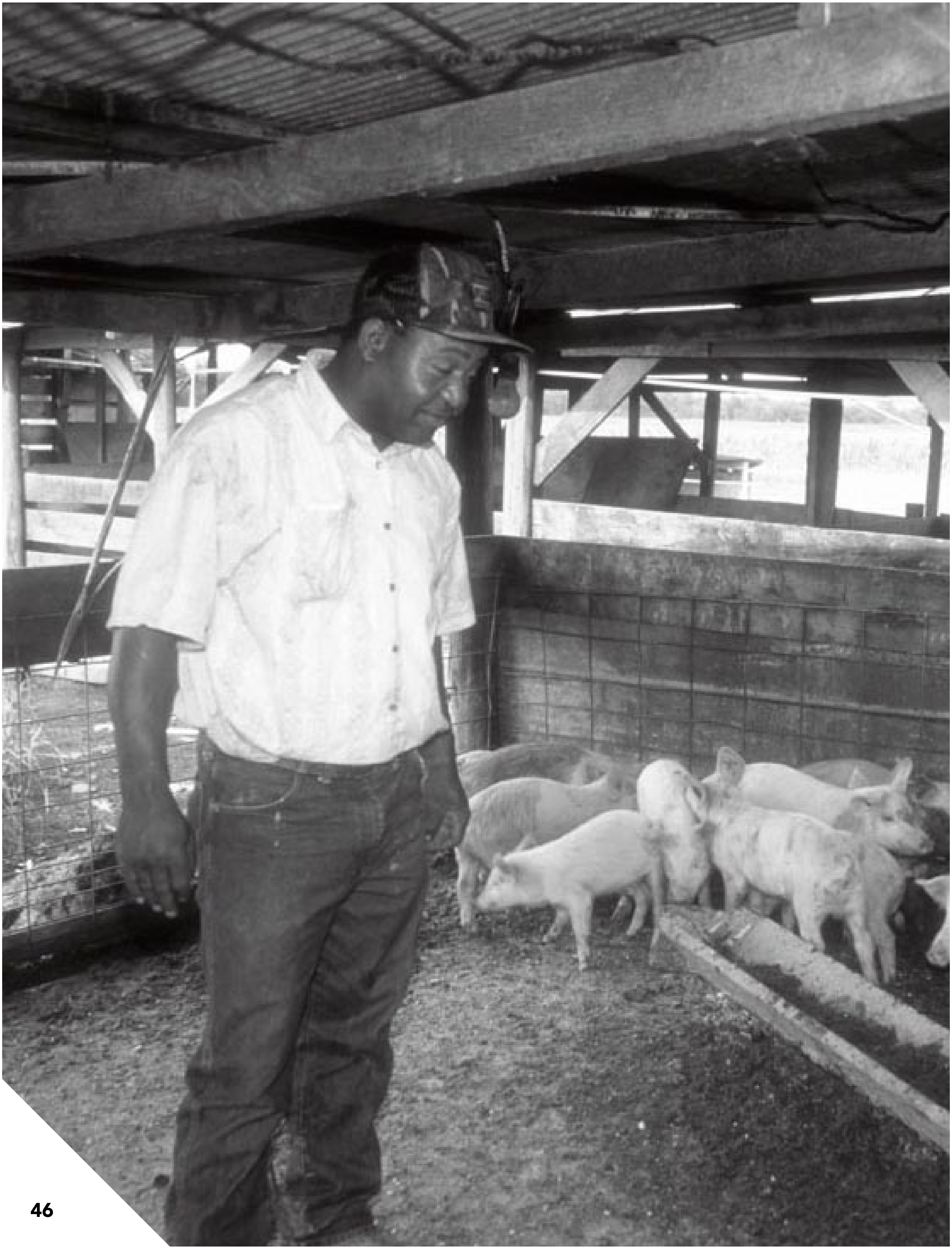
The popularity of CSA has increased in the last five years as interest in eating food from sources closer to home has been spurred by Alisa Smith and James MacKinnon's *Hundred Mile Diet* (and associated website and movement), food contamination problems in imported foods, and books like *Animal, Vegetable, Mineral: A Year in the Life of Food* by Barbara Kingsolver. With the rising demand for local food, many restaurants and cafeterias have begun entering into agreements with local farms as well. CSA may also provide products for farmers' markets, roadside stands, or independent grocers in order to build farm sales and bolster the farms' economic viability.

Both farmers and communities benefit from CSA because it:

- keeps local food dollars in the local economy;
- encourages communication among farmers;
- creates a dialogue between farmers and consumers;
- promotes a shared sense of social responsibility and land stewardship among farmers and consumers;
- supports an area's biodiversity; and
- fosters the diversity of agriculture through the preservation of both small farms and a wide variety of crops.

And, not least, the "guaranteed market" of a CSA allows farmers to invest their time in doing the best job they can raising their crops instead of searching for buyers.

*The information in this piece is adapted from the writings of Robyn Van En, CSA of North America (CSANA); Liz Manes, Colorado State University Cooperative Extension; and Cathy Roth, University of Massachusetts Extension Agroecology Program.



The True Cost of Meat

Much has been written about the social costs—environmental, social, and human health—of our huge appetite for meat versus other sources of protein. One thing is clear, Americans eat more meat per person than any other society on the planet, and part of the reason for that is its apparent low cost. Whether that low cost at the grocery store actually represents the full cost to society of producing that steak or chicken cutlet has been the subject of numerous scholarly papers and much public advocacy. This sidebar examines one dimension of that controversy, the externalities associated with industrial hog production.

Externalities are costs or benefits resulting from a decision or activity that is not reflected in the transaction cost (price). The price for a pound of hamburger reflects the direct cost to the grocery store, including their allowance for profit (mark-up), the cost the store paid to the distributor, the distributor's cost for buying the meat from the slaughterhouse, and so on down the line to the farmer who raised the animal. Along the way, there are a number of costs that may not be fully "internalized" or reflected in the price paid by the consumer. Those are the subject of this essay.

Economists at Tufts University's Global Development and Environment Institute looked at two kinds of externalities, crop subsidies and environmental impact, associated with industrialized swine production. The 1996 Farm Bill established a system of crop subsidies intended to support high production levels while holding commodity prices down. According to the Tufts researchers, from 1997 until 2005, market prices for soybeans and corn were less than the cost to produce the crop, but federal subsidies more than made up for the difference (Starmer and Wise, 2007a). The emergence of the corn ethanol market in 2005 erased the disparity between production costs and market price for corn, thus eliminating the subsidy.

Corn and soybeans are the principal ingredients in commercial feed for hogs. The low cost of corn and soybeans made possible by federal subsidies saved industrialized swine producers $947 million annually from 1997 through 2005, or $8.5 billion over that entire period. Non-industrialized swine producers did not enjoy the same savings because they grew crops to produce their own feed and did not receive the subsidy. With about 60 million hogs produced annually and more than 70% of those produced in industrialized operations, the value of the subsidy through 2005 was more than $22 per animal each year. The bottom line? American taxpayers paid industrial hog producers nearly 12 cents per pound, dressed weight, for every hog produced each year from 1997 through 2005.

When looking at the environmental externalities, the Tufts researchers found that the numbers of animals on the typical industrial farm produced far more manure than the agronomic capacity of the land to absorb the nutrients contained in the manure. The result is that land application of the manure often results in surface and groundwater contamination, placing the burden of cleanup on the adjacent communities. Waste treatment, beyond lagoon storage, would add costs ranging from $2.55 to $4 per hundred weight on a typical industrial hog farm (Starmer and Wise, 2007b). Those environmental costs are currently born by society as a whole.

None of the external costs discussed above are reflected in the price paid at the retail counter for a pound of pork. The story would be similar if we were to look at the cost of chicken, eggs, or beef. The appeal of industrial farm animal production systems may wane, however, as the increasing demand for alternative energy places upward pressure on commodity prices.


ORGANIC, SUSTAINABLE,
PASTURE-RAISED MEATS
ORGANIC DRY-AGED BEEF
GRASS-FED, FREE-RANGE BUFFALO (BISON),
100% PASTURE-RAISED HERITAGE PORK,
GRASS-FED LAMB, NITRITE FREE SAUSAGE,
JERKY, MEAT STICKS AND BACON
WITH SMALL, LOCAL RANCHERS AND FARMERS TO OFFER THE
MOST SUSTAINABLY RAISED MEATS AVAILABLE

Commissioners' Conclusions

The industrialization of American agriculture has transformed the character of agriculture itself and, in so doing, the social fabric of rural America. The family-owned farm producing a diverse mix of crops and food animals is largely gone as an economic entity, replaced by large farm factories that produce just one animal species or crop.

Research consistently shows that the social and economic well-being of rural communities benefits from larger numbers of farmers rather than fewer farms that produce increased volumes. In rural communities where fewer, larger farms have replaced smaller, locally owned farms, residents have experienced lower family income, higher poverty rates, lower retail sales, reduced housing quality, and persistent low wages for farm workers.

The food animal industry's shift to a system of captive supply transactions controlled by production contracts has shifted economic power from farmers to livestock processors. Farmers have relinquished their once autonomous animal husbandry decision-making authority in exchange for contracts that provide assured payment but require substantial capital investment. Once the commitment is made to such capital investment, many farmers have no choice but to continue to produce until the loan is paid off. Such contracts make access to open and competitive markets nearly impossible for most hog and poultry producers, who must contract with integrators (meat packing companies) if they are to sell their product.

Quality of life in rural communities has also declined, partly because of the entrenched poverty and lack of economic opportunity, but also because the linkages that once bound locally owned farms with the community have dissolved in many places and the social fabric of many communities has begun to fray. These changes are evident in negative attitudes about trust, neighborliness, community division, networks of acquaintanceship, democratic values, and community involvement, as well as increased crime and teen pregnancy rates, civil suits, and stress.

Although proponents of the industrialization of livestock agriculture point to its increased economic efficiency and hail IFAP as the future of livestock agriculture, the Commission is concerned that the benefits may not accrue in the same way to affected rural communities. In fact, industrialization actually draws investment and wealth away from communities with IFAP facilities. Along with the adverse social and economic impacts, individual farmers often find themselves with fewer options because of the capital investment required to meet specifications and terms dictated by their production contracts.

Conclusion: Toward Sustainable Animal Agriculture

**On behalf of the Commission
by Fred Kirschenmann, PhD,
Distinguished Fellow
at the Leopold Center
for Sustainable Agriculture,
Iowa State University,
and North Dakota rancher**

Sustainability is a futuristic concept. *Webster's* dictionary defines the verb "sustain" as "to maintain," "to keep in existence," "to keep going." By definition, then, sustainability is a journey, an ongoing process, not a prescription or a set of instructions. So when we ask, "How do we sustain animal agriculture?" we are asking how to manage animal agriculture so that it can be maintained indefinitely and what changes are necessary to accomplish that goal.

Sustainable animal agriculture requires that we envision the challenges and changes the future will bring. In his extensive studies of past civilizations, Jared Diamond has observed that civilizations that correctly assessed their current situations, anticipated changes, and started preparing for those changes were the ones that thrived—they were sustainable. Civilizations that failed in these efforts were the ones that collapsed—they were not sustainable (Diamond, 1999; Diamond, 2005).

What is true for civilizations is likely also true for business enterprises. So this report would not be complete without an assessment of some of the changes likely to emerge in the decades ahead and recommendations to address those changes.

To begin, it is important to recognize that our food production system today operates in the general framework of the industrial economy, which begins from the assumptions that natural resources and other inputs to fuel economic activities are unlimited and that nature provides unlimited sinks to absorb the wastes thrown off by that economic activity. Our modern food system, including industrial animal agriculture, is part of that economy.

Herman E. Daly has warned for some time that this economy is not sustainable, that we must recognize that human economies are *subsystems* of larger ecosystems and must adapt to function within ecosystem constraints (Daly, 1999).[6] Because the natural resources that have fueled our food and agriculture systems are now in a state of depletion and nature's sinks are saturated, Daly's prediction may soon be realized.

This insight is not new, however. As early as 1945, Aldo Leopold recognized both the attractiveness and vulnerability of industrial agriculture (Leopold, 1999):

> It was inevitable and no doubt desirable that the tremendous momentum of industrialization should have spread to farm life. It is clear to me, however, that it has overshot the mark, in the sense that it is generating new insecurities, economic and ecological, in place of those it was meant to abolish. In its extreme form, it is humanly desolate and economically unstable. These extremes will some day die of their own too-much, not because they are bad for wildlife, but because they are bad for the farmers.

In these early years of the 21st century, the insecurities Leopold perceived are beginning to manifest themselves and compel us to reevaluate current crop and animal production methods.

Among the many changes likely in the next 50 years, we believe the following three will be especially challenging to the US industrial food and agriculture system: the depletion of stored *energy* and *water* resources, and changing *climate*. These changes will be especially challenging because America's successful industrial economy of the past century was based on the availability of *cheap* energy, a relatively *stable* climate, and *abundant* fresh water, and current methods have assumed the continued availability of these resources.

The end of cheap energy may well be the first limited resource to force change in industrial food animal production as IFAP systems are almost entirely dependent on fossil fuels. The nitrogen used for fertilizer to produce animal feed is derived from natural gas. Phosphorus and potash are mined, processed, and transported to farms with petroleum energy. Pesticides are manufactured from petroleum resources. Farm equipment is manufactured and operated with petroleum energy. Feed is produced and trucked to concentrated animal operations with fossil fuels. Manure is collected and hauled to distant locations with fossil fuels.

When fossil fuels were cheap, these inputs to the process of agricultural production were available at very low cost. But independent scholars agree that oil

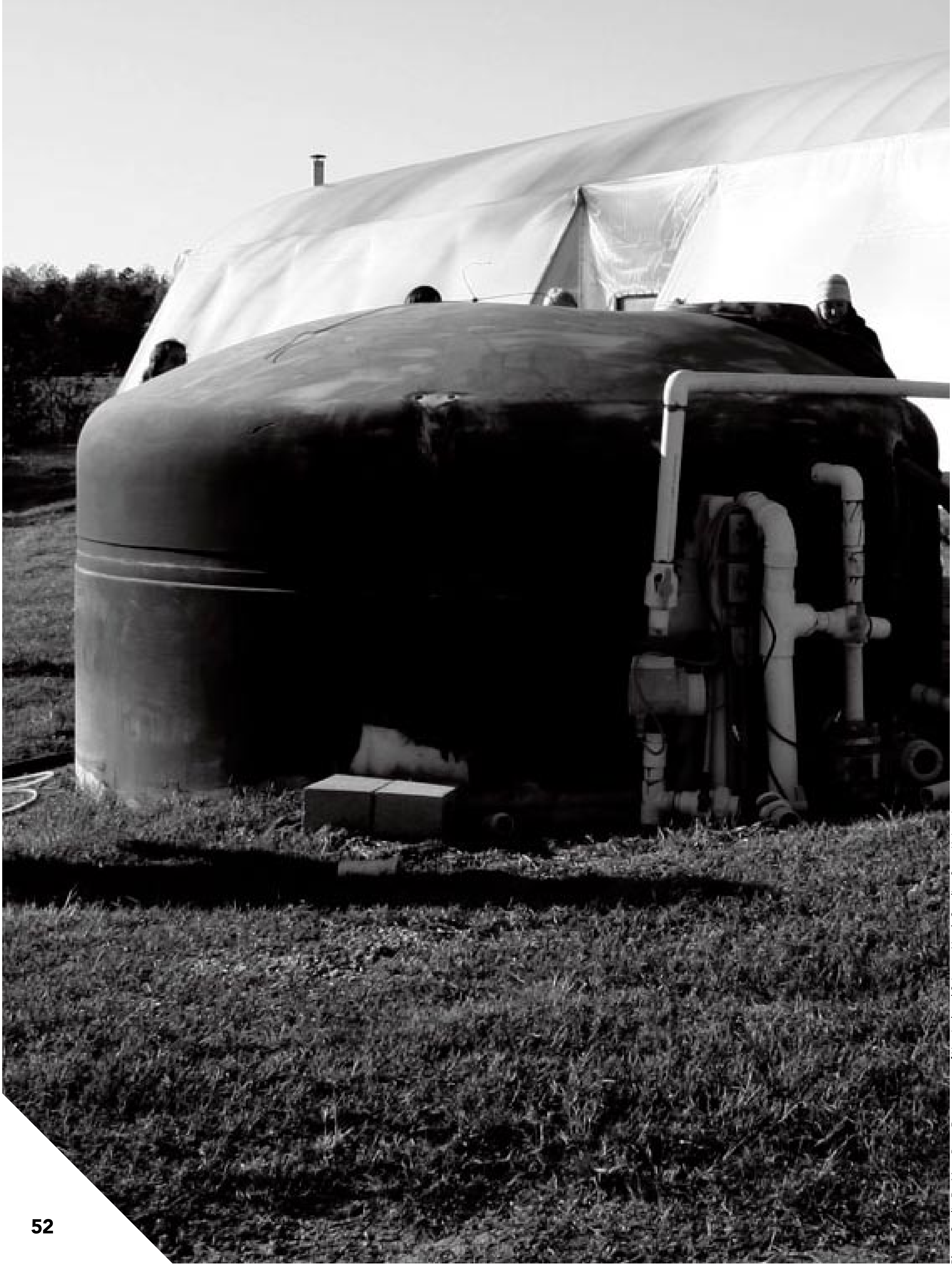


Photo Credit: Dr. Mary Peet, Department of Horticultural Science, North Carolina State University production either already has peaked or will shortly do so (Heinberg, 2004; Roberts, 2004).

Of course, there are alternatives to fossil fuel energy—wind, solar, and geothermal energy as well as biofuels—so it's possible that oil and natural gas could be replaced with alternative sources of energy to keep industrial animal agriculture viable. But the US industrial economy was created on a platform of *stored, concentrated energy* that produced a very favorable energy *profit ratio* (the amount of energy yield less the amount of energy expended to make it available). Alternative energies, on the other hand, are based on *current, dispersed* energy, which has a much lower energy profit ratio. Consequently, economies that depend on cheap energy are not likely to fare well in the future. This is why the depletion of fossil fuel resources will require that America transition not only to *alternative* fuels to produce food but to a new energy *system*.

The real energy transition will have to be from an energy *input* system to an energy *exchange* system, and this transition is likely to entail significant system changes in the US production of crops and livestock. For example, future agricultural production systems are less likely to be specialized monocultures and more likely to be based on biological diversity, organized so that each organism exchanges energy with other organisms, forming a web of synchronous relationships, instead of relying on energy-intensive inputs.

A second natural resource that has been essential to industrial agriculture is a relatively *stable climate*. We often mistakenly attribute the yield-producing success of the past century entirely to the development of new production technologies. But those robust yields were due at least as much to unusually favorable climate conditions as they were to technology.

A National Academy of Sciences (NAS) Panel on Climatic Variation reported in 1975 that "our present [stable] climate is in fact highly *abnormal*" and that "the earth's climate has always been changing, and the magnitude of … the changes can be catastrophic" (emphasis added). The report went on to suggest that climate change might be exacerbated by "our own activities" and concluded that "the global patterns of food production and population that have evolved are *implicitly dependent* on the climate of the present century" (emphasis added) (NAS, 1975). In other words, according to the NAS, it is this *combination* of "normal" climate variation *plus* the changes caused by industrial economies (greenhouse gas emissions) that could have a significant impact on future agricultural productivity.

While most climatologists acknowledge that it is impossible to predict exactly how climate change will affect agricultural production in the near term, they agree that greater climate fluctuations—"extremes of precipitation, both droughts and floods"—are likely. Such instability can be especially devastating for the highly specialized, genetically uniform, monoculture systems characteristic of current industrial crop and livestock production.

A third natural resource that may challenge our current agricultural production system is *water*. Lester Brown points out that although each human needs only four liters of water a day, the US industrial agriculture system consumes 2,000 liters per day to meet US daily food requirements (Brown, 2006). A significant amount of that water is consumed by production agriculture: over 70% of global fresh water resources is used for irrigation.

As discussed earlier in this report, the Ogallala Aquifer, which supplies water for one of every five irrigated acres in the United States, is now half depleted and is being overdrawn at the rate of 3.1 trillion gallons per year,[7] according to some reports (Soule and Piper, 1992). Furthermore, a recent *Des Moines Register* article reported that the production of biofuels is putting significant additional pressure on US water resources, and that climate change is likely to further stress these resources (Beeman, 2007). According to the *Wall Street Journal*, "Kansas is threatening to sue neighboring Nebraska for consuming more than its share of the Republican River" as farmers consume more water for irrigation[8] (that suit has since been filed); Kansas had previously sued Colorado over Arkansas River water diverted in Colorado, in part, for agriculture irrigation and use by the city of Denver.

Reduced snowpacks in mountainous regions due to climate change will decrease spring runoff, a primary source of irrigation water in many parts of the world, further intensifying water shortages.

These early indications of stress indicate that energy, water, and climate changes will intersect and affect each other in many ways and will make industrial production systems increasingly vulnerable.

But new soil management methods can make major contributions to the sustainability of future US farming systems. Research and on-farm experience have shown that the management of soils in accordance with closed recycling systems that build soil organic matter significantly enhances the soil's capacity to absorb and retain moisture, reducing the need for irrigation. On-farm experience (as well as nature's own elasticity) also indicates that: (1) diverse systems are more resilient than monocultures in the face of adverse climate conditions; (2) energy inputs can be dramatically reduced when recycling systems replace input/output systems; and (3) management of soil health based on recycling systems requires more mixed crop/livestock systems. Furthermore, new insights from studies in modern ecology and evolutionary biology applied to nutrient recycling and humus-based soil management could provide additional information that can help in the design of postindustrial farming systems.

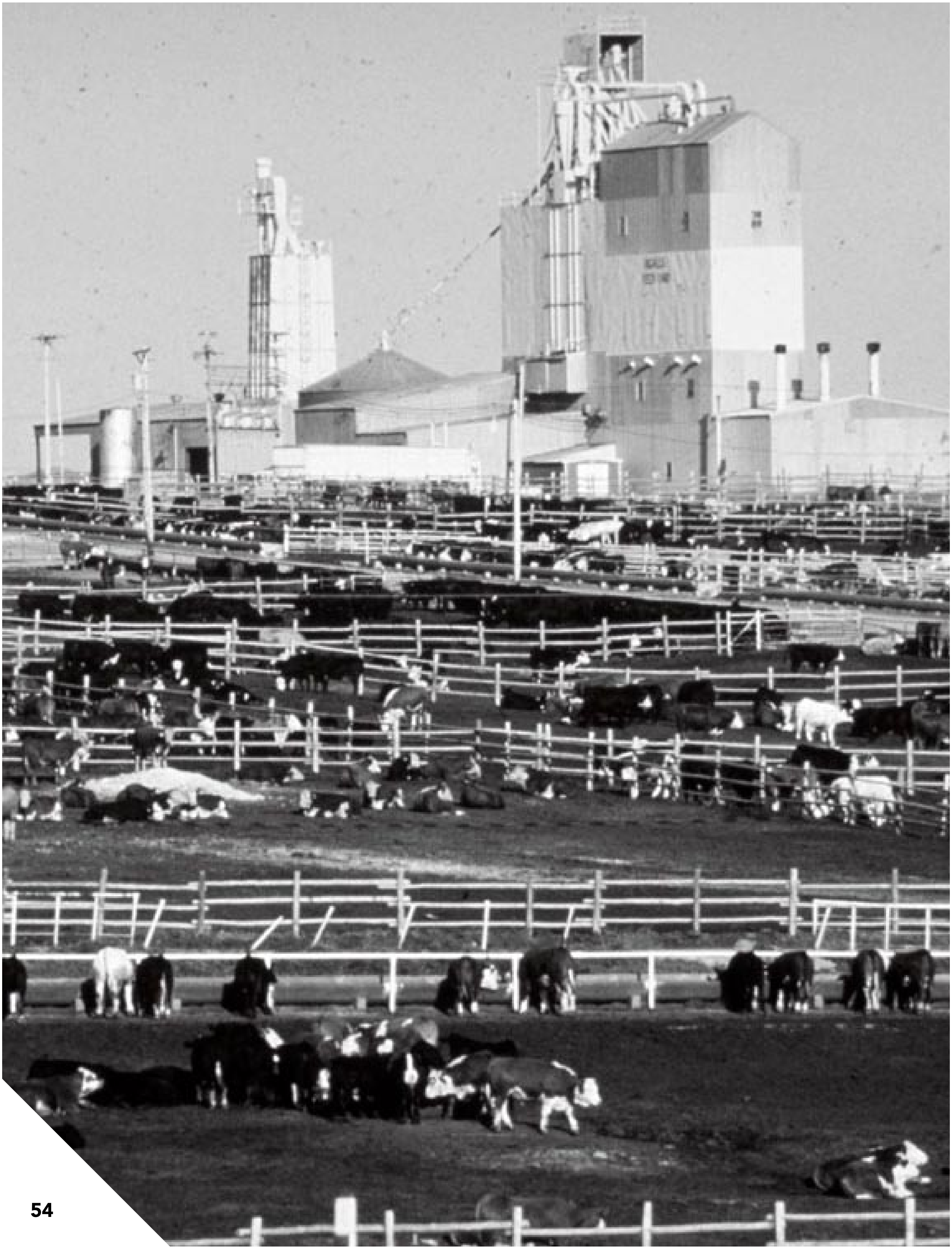
Scientists have recognized for some time that the single-tactic, specialized, energy-intensive approach of industrial agriculture which relies on technology to intervene in a system to solve a specific problem, such as eliminating a single pest species, is not sustainable. Joe Lewis and his colleagues, for example, wrote that, while it may seem that an optimal corrective action for an undesired entity is to use a pesticide to eliminate the pest, in fact "such interventionist actions never produce sustainable desired effects. Rather, the attempted solution becomes the problem." The alternative, they propose, is

Converting Methane to Energy

Methane digesters are a relatively new technology used on a few farms to process animal waste. The technology allows the farmer to capitalize on the natural process of organic waste decomposition by capturing the methane that is produced and put it to work as a fuel source. The digester is essentially a large, sealed manure container that captures the methane gas produced by the manure as it decomposes. The captured methane can power an on-farm electrical generator or heat the digester vessel itself, because the digestion process works more efficiently at warmer temperatures.

Untreated, methane is a potent greenhouse gas, but also, just as importantly, a good source of energy. Manure left in a lagoon or spread on a field emits methane into the atmosphere. Capturing the methane and using it for energy reduces the fossil fuel demand for a typical animal feeding operation, helps to reduce greenhouse gas emissions, and reduces both the odor from the manure and the total volume of manure that requires disposal.

Although the benefits of methane digesters have been widely promoted, serious challenges remain when it comes to the large volumes of IFAP waste and its components such as nitrogen, phosphorus, pathogens, arsenic, and other heavy metals.



"an understanding and shoring up of the full composite of inherent plant defenses, plant mixtures, soil, natural enemies, and other components of the system. These natural 'built in' regulators are linked in a web of feedback loops and are renewable and sustainable" (Lewis et al., 1997). Unfortunately, IFAP is built on the so-called single tactic model, which seeks to maximize production and simplify management needed to get there.

The management of pests, weeds, or animal diseases from such an ecological perspective involves a web of relationships that require more biologically diverse systems. "For example, problems with soil erosion have resulted in major thrusts in use of winter cover crops and conservation tillage. Preliminary studies indicate that cover crops also serve as bridge/refugia to stabilize natural enemy/pest balances and relay these balances into the crop season" (Lewis et al., 1997). In short, natural system management can revitalize soil health, reduce weed and other pest pressures, eliminate the need for pesticides, and support the transition from an energy-intensive industrial farming operation to a self-regulating, self-renewing one. A diversified crop/animal system enhances the possibilities for establishing a self-regulating system.

Other benefits, such as greater water conservation, follow from the improved soil health that results from closed recycling systems. As research conducted by John Reganold and his colleagues has demonstrated, soil managed by such recycling methods develops richer top soil, more than twice the organic matter, more biological activity, and far greater moisture absorption and holding capacity (Reganold et al., 1987; Reganold et al., 2001).

Such soil management methods illustrate the path to an energy system that operates on the basis of energy *exchange* instead of energy *input*. But more innovation is needed. Nature, for example, is a very efficient energy manager; all of its energy comes from sunlight, which is processed into carbon through photosynthesis and becomes available to various organisms that exchange energy through a web of relationships. Bison on the prairie obtain their energy from the grass, which gets its energy from the soil. Bison deposit their excrement on the grass and thus provide energy for insects and other organisms, which, in turn, convert it to energy that enriches the soil to produce more grass. These are the energy exchange systems that must be explored and adapted for use in postindustrial farming systems. But very little research is currently devoted to exploring such energy exchanges for farms.

Fortunately, a few farmers have already developed energy exchange systems and appear to be quite successful in managing their operations with very little fossil fuel input (Kirschenmann, 2007). But converting farms to this new energy model on a national scale will require a major transformation. The highly specialized, energy-intensive monocultures will need to convert to complex, highly diversified operations that function on energy exchange. Research has established the practicality and multiple benefits of such integrated crop-livestock operations, but further research is needed to explore how to adapt this new model of farming to various climates and ecosystems (Russelle et al., 2007).

In the meantime, current intensive confined animal feeding operations, can take steps to begin transitioning to a more sustainable future. In our visits to many such operations, we saw innovative adaptations of some of these principles. For example, a large feedlot we visited, which holds 90,000 head of cattle in confinement, composts all of its manure and sells it in a thriving compost market, thus improving its bottom line. As fertilizer costs go up due to increased energy costs, more farmers may turn to such sources of fertilizer to reduce their costs. The Commission visited an integrated producer of 90,000 dozen eggs a day, that composts its manure, mixing it with wood chips from ground-up wooden pallets, and sells the compost as garden and landscaping mulch, again generating additional income for the company. A 4,500-cow confinement dairy operation recycles its bedding sand and plastic baling wire. Both the dairy and the feedlot also cover their silage piles to reduce pollution.

Farmers in many parts of the world are adopting deep-bedded hoop barn technologies for raising their animals in confinement. As explained earlier in this report, hoop barns are much less expensive to construct, have demonstrated production efficiencies comparable to those of nonbedded confinement systems, and are more welfare-friendly for animals (Lay Jr. et al., 2000). The deep-bedded systems allow animals to exercise more of their natural functions, absorb urine and manure for composting and building soil quality on nearby land, and provide warmth for the animals in cold weather. Such hoop structures are used in hog, beef, dairy, and some poultry operations and have demonstrated reduced environmental impact and risk.[9]

Tweaking the current monoculture confinement operations with such methods will be very useful in the short term, but as energy, water, and climate resources undergo dramatic changes, it is the Commission's judgment that US agricultural production will need to transition to much more biologically diverse systems, organized into biological synergies that exchange energy, improve soil quality, and conserve water and other resources. As Herman Daly said, long-term sustainability will require a transformation from an industrial economy to an ecological economy.

The Recommendations of the Commission

The Pew Commission on Industrial Farm Animal Production was charged with examining the current US system of food animal production and its impact on public health, the environment, animal welfare, and rural communities. The Commission's recommendations are intended to ensure that the system is able to provide safe, affordable meat, dairy, and poultry products in a sustainable way. Commissioners recognize that the current system, like agriculture as a whole, has achieved a remarkable record of increasing productivity and lowering prices at the supermarket, with the result that Americans' expenditures for meat, poultry, dairy, and eggs as an inflation-adjusted share of their disposable income were lower in 2007 than in 1950.

But as industrial farm animal production (IFAP) systems have increased cost-efficient agricultural food production, they have also given rise to problems that are beginning to require attention by policymakers and the industry. Given the relatively rapid emergence of the technologies for industrial farm animal production, and the dependence on chemical inputs, energy, and water, many IFAP systems are not sustainable environmentally or economically.

Much of the basis for concentrated animal production originally derived from inexpensive corn and other plentiful feed grain crops, cheap energy, and free, abundant water. Inexpensive corn, for example, allowed the development of specially formulated feeds that increase growth rates and shorten the time required to get animals to market. But the emerging market for biofuels has changed that equation because the value of corn and other commodity crops is now tied to their energy value, often resulting in higher prices. Similarly, IFAP systems also depend on abundant freshwater resources and on inexpensive fossil fuels for energy. As supplies of both become scarce, their rising costs raise questions about the sustainability of the current production process. Sustainability will require new approaches that use less water and energy.

Industrial farm animal production systems are also highly dependent on intensive animal confinement, which commonly requires the use of antimicrobials to prevent disease, not just to treat it. Together with the use of antimicrobials to promote animal growth, these practices accelerate the emergence of resistant microbes, with obvious risks for both animals and humans.

In addition, intensive confinement systems increase negative stress levels in the animals, posing an ethical dilemma for producers and consumers. This dilemma can be summed up by asking ourselves if we owe the animals in our care a decent life. If the answer is yes, there are standards by which one can measure the quality of that life. By most measures, confined animal production systems in common use today fall short of current ethical and societal standards.

Furthermore, the concentrated animal waste and associated possible contaminants from IFAP systems pose a substantial environmental problem for air quality, surface and subsurface water quality, and the health of workers, neighboring residents, and the general public.

Finally, the costs to rural America have been significant. Although many rural communities embraced industrial farming as a source of much-needed economic development, the results have often been the reverse. Communities with greater concentrations of industrial farming operations have experienced higher levels of unemployment and increased poverty. Associated social concerns—from elevated crime and teen pregnancy rates to increased numbers of itinerant laborers—are problematic in many communities and place greater demands on public services. The economic multiplier of local revenue generated by a corporate-owned farming operation is substantially lower than that of a locally owned operation. Reduced civic participation rates, higher levels of stress, and other less tangible impacts have all been associated with high concentrations of industrial farm production.

The Commissioners have taken all these issues into account in developing the recommendations that follow.

The Recommendations of the Commission

Public Health

Numerous known infectious diseases can be transmitted between humans and animals; in fact, of the more than 1,400 documented human pathogens, about 64% are zoonotic.

Recommendation #1. Restrict the use of antimicrobials in food animal production to reduce the risk of antimicrobial resistance to medically important antibiotics.

a. Phase out and ban use of antimicrobials for nontherapeutic (i.e., growth promoting) use in food animals[10] (see PCIFAP definition of "nontherapeutic").
b. Immediately ban any new approvals of antimicrobials for nontherapeutic uses in food animals[10] and retroactively investigate antimicrobials previously approved.
c. Strengthen recommendations in FDA Guidance #152 to be enforceable by FDA, in particular the investigation of previously approved animal drugs.
d. To facilitate reduction in IFAP use of antibiotics and educate producers on how to raise food animals without using nontherapeutic antibiotics, USDA's extension service should be tasked to create and expand programs that teach producers the husbandry methods and best practices necessary to maintain the high level of efficiency and productivity they enjoy today.

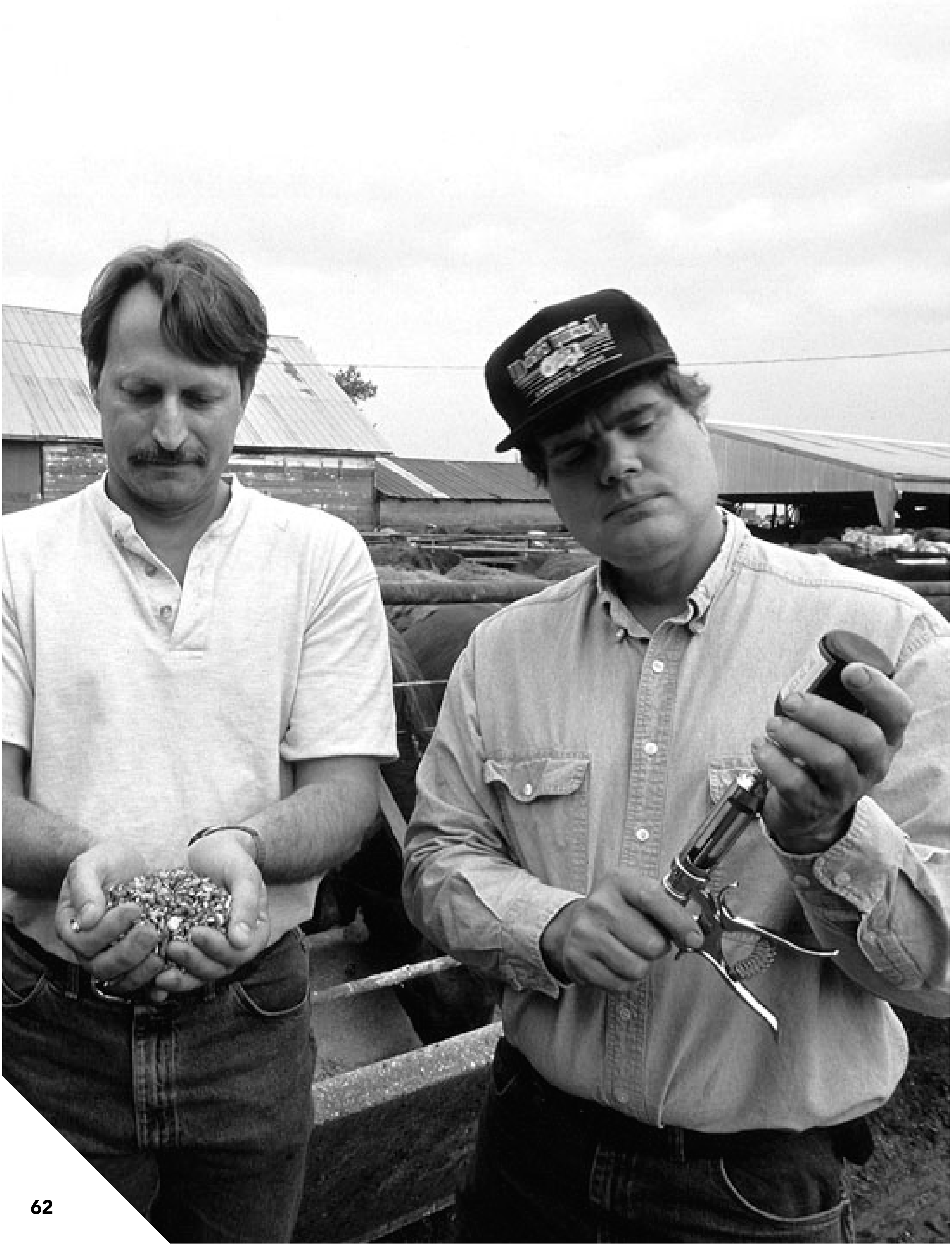
Background

In 1986, Sweden banned the use of antibiotics in food animal production except for therapeutic purposes and Denmark followed suit in 1998. A WHO (2002) report on the ban in Denmark found that "the termination of antimicrobial growth promoters in Denmark has dramatically reduced the food animal reservoir of enterococci resistant to these growth promoters, and therefore reduced a reservoir of genetic determinants (resistance genes) that encode antimicrobial resistance to several clinically important antimicrobial agents in humans." The report also determined that the overall health of the animals (mainly swine) was not affected and the cost to producers was not significant. Effective January 1, 2006, the European Union also banned the use of growth-promoting antibiotics (Meatnews.com, 2005).

In 1998, the National Academy of Sciences (NAS) Institute of Medicine (IOM) noted that antibiotic-resistant bacteria increase US health care costs by a minimum of $4 billion to $5 billion annually (IOM, 1998). A year later, the NAS estimated that eliminating the use of antimicrobials as feed additives would cost each American consumer less than $5 to $10 per year, significantly less than the additional health care costs attributable to antimicrobial resistance (NAS, 1999). In a 2007 analysis of the literature, another study found that a hospital stay was $6,000 to $10,000 more expensive for a person infected with a resistant bacterium as opposed to an antibiotic-susceptible infection (Cosgrove et al., 2005). The American Medical Association, American Public Health Association, National Association of County and City Health Officials, and National Campaign for Sustainable Agriculture are among the more than 300 organizations representing health, consumer, agricultural, environmental, humane, and other interests supporting enactment of legislation to phase out nontherapeutic use in farm animals of medically important antibiotics and calling for an immediate ban on antibiotics vital to human health.

The Preservation of Antibiotics for Medical Treatment Act of 2007 (PAMTA) amends the Federal Food, Drug, and Cosmetic Act to withdraw approvals for feed-additive use of seven specific classes of antibiotics[11]—penicillins, tetracyclines, macrolides, lincosamides, streptogramins, aminoglycosides, and sulfonamides—each of which contains antibiotics also used in human medicine (2007a). The PAMTA provides for the automatic and immediate restriction of any other antibiotic used only in animals if the drug becomes important in human medicine, unless FDA determines that such use will not contribute to the development of resistance in microbes that have the potential to affect humans. FDA Guidance #152 defines an antibiotic as potentially important in human medicine if FDA issues an Investigational New Drug determination or receives a New Drug Application for the compound.

Most antibiotics currently used in animal production systems for nontherapeutic purposes were approved before the Food and Drug Administration (FDA) began giving in-depth consideration to resistance during the drug approval process. FDA has not established a schedule for reviewing existing approvals, although Guidance #152 notes the importance of doing so. Specifically, Guidance #152 sets forth the responsibility of the FDA Center for Veterinary Medicine (CVM), which is charged with regulating antimicrobials approved for use in animals: "prior to approving an antimicrobial new animal drug application, FDA must determine that the drug is safe and effective for its intended use in the animal. The Agency must also determine that the antimicrobial new



The Infectious Disease Society of America (ISDA) recently called antibiotic-resistant infections an epidemic in the United States.

animal drug intended for use in food-producing animals is safe with regard to human health" (FDA-CVM, 2003). The Guidance also says that "FDA believes that human exposure through the ingestion of antimicrobial-resistant bacteria from animal-derived foods represents the most significant pathway for human exposure to bacteria that has emerged or been selected as a consequence of antimicrobial drug use in animals." However, it goes on to warn that the "FDA's guidance documents, including this guidance, do not establish legally enforceable responsibilities. Instead, the guidance describes the Agency's current thinking on the topic and should be viewed only as guidance, unless specific regulatory or statutory requirements are cited. The use of the word 'should' in Agency guidance means that something is suggested or recommended, but not required" (FDA-CVM, 2003).

The Commission believes that the "recommendations" in Guidance #152 should be made legally enforceable and applied retroactively to previously approved antimicrobials. Additional funding for FDA is required to achieve this recommendation.

Recommendation #2. Clarify antimicrobial definitions to provide clear estimates of use and facilitate clear policies on antimicrobial use.

a. The Commission defines as *nontherapeutic*[10] any use of antimicrobials in food animals in the absence of microbial disease or known (documented) microbial disease exposure; thus, any use of the drug as an additive for growth promotion, feed efficiency, weight gain, routine disease prevention in the absence of documented exposure, or other routine purpose is considered nontherapeutic.[12]
b. The Commission defines as *therapeutic* the use of antimicrobials in food animals with diagnosed microbial disease.
c. The Commission defines as *prophylactic* the use of antimicrobials in healthy animals in advance of an expected exposure to an infectious agent or after such an exposure but before onset of laboratory-confirmed clinical disease as determined by a licensed professional.

Background

In 2000, the WHO, United Nations Food and Agriculture Organization (FAO), and World Organization for Animal Health (OIE, *Fr.* Office International des Épizooties) agreed on definitions of antimicrobial use in animal agriculture based on a consensus (WHO, 2000). Government agencies in the United States, including USDA and FDA, govern aspects of antimicrobial use in food animals but have varying definitions of such use. Consistent definitions should be adopted for the use of all US oversight groups that estimate types of antimicrobial use and for the development of law and policy. Congress recently revived a bill to address the antimicrobial resistance problem: the Preservation of Antibiotics for Medical Treatment Act of 2007 (PAMTA) defines nontherapeutic use as "any use of the drug as a feed or water additive for an animal in the absence of any clinical sign of disease in the animal for growth promotion, feed efficiency, weight gain, routine disease prevention, or other routine purpose" (2007a). If the bill becomes law, this will be the legal definition of nontherapeutic use for all executive agencies and, therefore, legally enforceable.

Recommendation #3. Improve monitoring and reporting of antimicrobial use in food animal production in order to accurately assess the quantity and methods of antimicrobial use in animal agriculture.

a. Require pharmaceutical companies that sell antimicrobials for use in food animals to provide a calendar-year annual report of the quantity sold. Companies currently report antibiotic sales data on an annual basis from the date of the drug's approval, which makes data integration difficult. FDA is responsible for oversight of the use of antimicrobials in food animals and needs consistent data on which to report use.
b. Require reporting of antimicrobial use in food animal production, including antimicrobials added to food and water, and incorporate the reported data in USDA's National Animal Identification System (NAIS).[13] The FDA-CVM regulates feed additives but does not have the budget or personnel to oversee their disposition after purchase. In addition, CVM and USDA are responsible for monitoring the use of prescribed antimicrobials in livestock production but rely on producers and veterinarians to keep records of the antibiotics used and for what purpose.
c. Institute better integration, monitoring, and oversight by government agencies by developing a comprehensive plan to monitor antimicrobial use in food animals, as called for in a 1999 National Research Council (NRC) report (NAS, 1999). An integrated national database of antimicrobial resistance data and research would greatly improve the organization, amount, and types of data collected and would facilitate necessary policy changes by increasing data cohesion and accuracy. Further, priority should be given to linking data on both antimicrobial use and resistance in the National Antimicrobial Resistance Monitoring System (NARMS). This could be accomplished by full implementation of Priority Action 5 of *A Public Health Action Plan to Combat Antimicrobial Resistance*, which calls for the establishment of a monitoring system and the assessment of ways to collect and protect the confidentiality of usage data (CDC/FDA/NIH, 1999). Since USDA already provides antimicrobial use data in fruit and vegetable production, it seems logical that usage information can be obtained from either agricultural producers and/or the pharmaceutical industry without undue burden.

Background

There are no reliable data on antimicrobial use in US food animal production. Rather, various groups have reported estimates of use based on inconsistent standards. For example, in 2001, the Union of Concerned Scientists (UCS) estimated that 24.6 million pounds of antimicrobials were used per year for nontherapeutic purposes (Mellon et al., 2001) in animal agriculture (only cattle, swine, and poultry), whereas the Animal Health Institute (AHI) figure for the same year was only 21.8 million pounds for *all* animals and uses (therapeutic and nontherapeutic) (AHI, 2002). These disparities make it difficult to get a true picture of the state and extent of antimicrobial use and its relationship to antimicrobial resistance in industrial farm animal production.

The potential for pathogen transfer from animals to humans is increased in IFAP because so many animals are raised together in confined areas.

Recommendation #4. Improve monitoring and surveillance of antimicrobial resistance in the food supply, the environment, and animal and human populations in order to refine knowledge of antimicrobial resistance and its impacts on human health.

a. Integrate, expand, and increase the funding for current monitoring programs.

b. Establish a permanent interdisciplinary oversight group with protection from political pressure, as recommended in the 1999 NRC report *The Use of Drugs in Food Animals: Risks and Benefits*. The group members should represent agencies involved in food animal drug regulation (e.g., FDA, the CDC, USDA), similar to the Interagency Task Force (CDC/FDA/NIH, 1999). In order to gather useful national data on antimicrobial resistance in the United States, the group should review progress on data collection and reporting, and should coordinate both the organisms tested and the regions where testing is concentrated, in order to better integrate the data. Agency members should coordinate with each other and with the NAIS to produce an annual report that includes integrated data on human and animal antimicrobial use and resistance by region. Finally, the group should receive appropriate funding from Congress to ensure transparency in funding as well as scientific independence.

c. Revise existing programs and develop a comprehensive plan to incorporate monitoring of the farm environment (soils and plants) and nearby water supplies with the monitoring of organisms in farm animals.

d. Improve testing and tracking of antimicrobial-resistant infections in health care settings. Better tracking of AMR infections will give health professionals and policymakers a clearer picture of the role of antimicrobial-resistant organisms in animal and human health and will support more effective decisions about the use of antimicrobials.

Background

Monitoring and surveillance of antimicrobial resistance in the United States are covered by the National Antimicrobial Resistance Monitoring System (NARMS), a program run by FDA in collaboration with CDC and USDA. CDC is responsible for monitoring resistance in humans, but other federal agencies also conduct antimicrobial resistance research activities. For instance, USDA's National Animal Health Monitoring System (NAHMS) compiles food animal population statistics, animal health indicators, and antimicrobial resistance data. USDA's Collaboration in Animal Health and Food Safety Epidemiology (CAHFSE) is a joint effort of the department's Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS), and Food Safety and Inspection Service (FSIS) to monitor bacteria that pose a food safety risk, including AMR bacteria. The United States Geological Survey (USGS) studies the spread of antimicrobial-resistant organisms in the environment. To achieve a comprehensive plan for monitoring and responding to antimicrobial resistance in the food supply, the environment, and animal and human populations, these agencies should work together to create an integrated plan with independent oversight, and should upgrade from a passive form of monitoring to an active, comprehensive, uniform, mandatory approach.

The US and state geological surveys (Krapac et al., 2004; USGS, 2006) as well as several independent groups (Batt, Snow et al., 2006; Centner 2006; Peak, Knapp et al., 2007) have looked closely at the spread of antimicrobial-resistant organisms in the environment, specifically in waterways, presumably from runoff or flooding. A recent study by the University of Georgia suggested that even chickens raised without exposure to antibiotics were populated with resistant bacteria. The authors suggested that an incomplete cleaning of the farm environment could have allowed resistant bacteria to persist and reinfect naïve hosts (Idris, Lu et al., 2006; Smith, Drum et al., 2007). In Denmark, it took several years after the withdrawal of antimicrobials for antimicrobial resistance to diminish in farm animal populations. These experiences emphasize the importance of monitoring the environment for antimicrobial contamination and responding with careful and comprehensive planning.

Recommendation #5. Increase veterinary oversight of all antimicrobial use in food animal production to prevent overuse and misuse of antimicrobials.

a. Restrict public access to agricultural sources of antimicrobials.

b. Enforce restricted access to prescription drugs. By law, only a veterinarian may order the extralabel use of a prescribed drug in animals, but, in fact, prescription drugs are widely available for purchase online, directly from the distributors or pharmaceutical companies, or in feed supply stores without a prescription. Without stricter requirements on the purchase of antimicrobials, extralabel (i.e., nontherapeutic) use of these drugs is possible and even probable. For that reason, *no* antibiotics should be available for over-the-counter purchase.

c. Enforce veterinary oversight and authorization of all decisions to use antimicrobials in food animal production. The extralabel drug use (ELDU) rule under the Animal Medicinal Drug Use Clarification Act (AMDUCA) permits veterinarians to go beyond label directions in using animal drugs and to use legally obtained human drugs in animals. However, the rule does not permit ELDU in animal feed or to enhance production. ELDU is limited to cases in which the health of the animal is threatened or in which suffering or death may result from lack of treatment. Veterinarians should consider ELDU in food-producing animals only when no approved drug is available that has the same active ingredient in the required dosage form and concentration or that is clinically effective for the intended use (1994). North Carolina State University, the University of California-Davis, and the University of Florida run the Food Animal Residue Avoidance Databank (FARAD) (http://www.farad.org/), which includes useful information for food animal veterinarians, including vetGRAM, which lists label information for all food animal drugs. To be effective, AMDUCA and ELDU must be enforced. In addition, as technology allows, the FDA-CVM should compel veterinarians to submit prescription and treatment information on farm animals to a national database to allow better tracking of antibiotic use as well as better oversight by veterinarians. Veterinary education for food animal production should teach prescription laws and reporting requirements.

d. Encourage veterinary consultation in these decisions. AMDUCA requires the veterinarian to properly label drugs used in a manner inconsistent with the labeling (i.e., extralabel) and to give the livestock owner complete instructions about proper use of the drug. Further, ELDU must take place in the context of a valid, current veterinarian-client-patient relationship—the veterinarian must have sufficient knowledge of the animal to make a preliminary diagnosis that will determine the intended use of the drugs. The producer should be encouraged to work with the veterinarian both to ensure the health of the animal(s) and to conform to antibiotic requirements. For example, the National Pork Board Pork Quality Assurance program encourages consultation with veterinarians to maintain a comprehensive herd health program (NPB, 2005).

Background

Presenters at a 2003 NRC workshop concluded that unlike human use of antibiotics, nontherapeutic uses in animals typically do not require a prescription (certain antimicrobials are sold over the counter and widely used for purposes or administered in ways not described on the label) (Anderson et al., 2003). Before AMDUCA, veterinarians were not legally permitted to use an animal drug in any way except as indicated on the label. After the passage of AMDUCA, veterinarians gained the right to prescribe/dispense drugs for "extralabel" use, but FDA limits such use to protect public health (1994). ELDU occurs when the drug's actual or intended use is not in accordance with the approved labeling. For instance, ELDU refers to administration of a drug for a species not listed on the label; for an indication, disease, or other condition not on the label; at a dosage level or frequency not on the label; or by a route of administration not on the label. Over-the-counter sale of antimicrobials opens the door to the nontherapeutic, unregulated use of antibiotics in farm animals.

If the full cost of externalized environmental and health costs were taken into account, those same products would be far more expensive.

Recommendation #6. Implement a disease-monitoring program and a fully integrated and robust national database for food animals to allow 48-hour trace-back through phases of their production.

a. Implement a tracking system for animals as individuals or units from birth until consumption, including movement, illnesses, breeding, feeding practices, slaughter condition and location, and point of sale. Use the same numbering system as for USDA's NAIS (see above), but expand it to provide more information to appropriate users (NAIS tracks animals based only on their movement).
b. Require federal oversight of all aspects of this tracking system, with stringent protections for producers against lawsuits. The tracking arm of the NAIS, which has not yet been implemented, is designed to be administered by private industry in collaboration with state governments. NAIS has garnered support from both, but the program should be expanded significantly and monitored by a separate federal agency to enhance confidentiality for producers. The British Cattle Movement Service (www.bcms.gov.uk) could serve as a model for this system.
c. Require registration of premises and animals by 2009 and implement animal tracking by 2010. USDA's APHIS has created a voluntary animal ID system in collaboration with the farm animal industry, so implementation of a mandatory federal system should be feasible within a relatively short time frame.
d. Allocate special funding to small farms to facilitate their participation in the national tracking system, which would have a much greater financial impact on them, particularly the costs of the identification method (e.g., ear tag, microchip, retinal scan). Such funding should be made available concurrent with the announcement of mandatory registration.

Background

In May 2005, APHIS began implementing an animal tracking system, the NAIS (USDA, APHIS 2006), which will track premises and 27 species of animals (including cattle, goats, sheep, swine, poultry, deer, and elk). Data are linked to several databases run by private technology companies, while USDA shops for a technology company with data warehousing expertise to run the full national database in the future. The United Kingdom uses a similar database for its Cattle Tracing System (DOE and FRA, 2001).

NAIS registration is voluntary at the time of this writing, and the Bush administration announced on November 22, 2006, that it would not require it of producers. The major industry concerns are about trust and confidentiality, says John Clifford, deputy administrator for APHIS veterinary services. However, proposals to make registration mandatory by 2009 have been floated by USDA; the department has officially stated that, "If the marketplace, along with State and Federal identification programs, does not provide adequate incentives for achieving complete participation, USDA may be required to implement regulations" (USDA, 2006).

The goal of the NAIS is a 48-hour trace-back to identify exposures since the 48-hour time frame is vital to containing the spread of infection (USDA, 2005). USDA advertises the NAIS as a "valuable tool for other 'non-NAIS' purposes—such as animal management, genetic improvement, and marketing opportunities," and notes that producers could improve the quality of their product and thus increase sales using the tracking. Many industry groups support the NAIS for these reasons, but small producers worry about the costs, oversight of data collection, and maintenance (Western Organization of Resource Councils, May 2006).

The first two phases of the NAIS call for the registration of premises and of individual animals using a US Animal Identification Number (USAIN). According to USDA, "[t]he US Animal Identification Number (USAIN) will evolve into the sole national numbering system for the official identification of individual animals in the United States. The USAIN follows the International Organization for Standardization (ISO) Standard for Radio Frequency [tracking] of Animals and can thus be encoded in an ISO transponder or printed on a visual tag" (USDA, APHIS 2006). The Wisconsin Livestock ID Consortium developed this US Animal ID Number, which has 15 digits, the first three of which are the country code (840 for the United States). The final phase will be the animal tracking phase.

A national animal identification system was first proposed in response to bovine spongiform encephalopathy (mad cow disease, or BSE) scares and deadly *E. Coli* outbreaks in the 1990s. The desire to identify contaminated meat quickly and quell an outbreak was the main reason for proposing Animal ID (AID), followed by the desire to market American meat abroad, where AID was becoming more and more common. Threats from European markets, in particular, to ban US meat unless it was more stringently monitored led to the proposal of an animal identification system, and USDA lobbied to be in charge of a voluntary program between private industry and the federal government.

The ability to market "safe" meat at home and abroad remains a good reason to institute a mandatory federal animal identification system. Safety of the food supply in terms of public health is the most important reason that the system should be mandatory and controlled by the federal government. The government should be able to track disease outbreaks via this system, which would also have information on feeding/rearing practices and antimicrobial use. In short, an animal identification system would protect the American public and allow for better data on animal protein production in general.

Recommendation #7. Fully enforce current federal and state environmental exposure regulations and legislation, and increase monitoring of the possible public health effects of IFAP on people who live and work in or near these operations.

a. Because IFAP workers—farmers, caretakers, processing plant workers, veterinarians, federal, state, and private emergency response personnel, and animal diagnostic laboratory personnel—are exposed to and may be infected by zoonotic, novel, or other infectious agents, they should be a priority target population for heightened monitoring, annual influenza vaccines, and training in the use of personal protective equipment. IFAP workers who have the highest risk of exposure to a novel virus or other infectious agent should be priority targets for health information and education, pandemic vaccines, and antiviral drugs.
b. IFAP employers and responsible health departments need to coordinate the monitoring and tracking of all IFAP facility employees to document disease outbreaks and prevent the spread of a novel zoonotic disease.
c. Occupational health and safety programs, including information about risks to health and about resources, should be more widely available to IFAP workers. Occupational safety and health information must also be disseminated in ways that allow people with little or no education or English proficiency to understand their risks and why precautions must be taken. Because of the well-documented health and safety risks among IFAP workers, the Occupational Health and Safety Administration should develop health and safety standards for IFAP facilities as allowable by law.
d. Current legislation and regulations concerning surveillance and health and safety programs should be implemented and should prioritize IFAP workers.

Background

In most jurisdictions, few, if any, restrictions on IFAP facilities address the health of IFAP workers or the public. Localities are therefore often unprepared to properly deal with IFAP impacts on local services and the health of people in the community.

Because of the large numbers of animals in a typical IFAP facility, pathogens can infect hundreds or thousands of animals even though the infection rate may be fairly low.

Recommendation #8.
Increase research on the public health effects of IFAP on people living and working on or near these operations, and incorporate the findings into a new system for siting and regulating IFAP.

a. Support research to characterize IFAP air emissions and exposures from the handling and distribution of manure on fields—including irritant gases (ammonia and hydrogen sulfide, at a minimum), bioaerosols (endotoxin, at a minimum), and respirable particulates—for epidemiological studies of exposed communities near IFAP facilities. Such research should include characterization of mixed exposures, studies of particulates in rural areas, and standardization and harmonization of exposure assessment methods and instrumentation to the degree possible.
b. Support research to identify and validate the most applicable dispersion models for IFAP facilities and their manure emissions. Such modeling research must take into account multiple IFAP facilities and their manure management plans in a given area, meteorological conditions, and chemical transformation of pollutants, and should be evaluated with prediction error determined through comparison of predicted values with actual monitoring data. Such models would be useful to state and federal regulatory agencies to determine the results of best management practices, to assess health impacts on exposed populations, and to model setback distances before the construction of new facilities. There is a further need for models that enable evaluation of concentration/exposure scenarios after an event that triggers asthma episodes or nuisance complaints.
c. Support research on the respiratory health and function of populations that live near IFAP facilities, including children and sensitive individuals. Such studies are powerful epidemiological approaches to assess the impact of air pollutants on respiratory health and must include appropriate exposure assessments, exposure modeling, and use of time-activity patterns with personal exposure monitoring to better calibrate modeling of exposures. Exposure assessment data need to be linked with measures of respiratory health outcome and function data, including standardized assessment of respiratory symptoms and lung function, assessment of allergic/immunological markers of response, and measurement of markers of inflammation, including the use of noninvasive approaches such as tear fluid, nasal lavage, and exhaled breath condensate.
d. Support systematic and sustained studies of ecosystem health near IFAP facilities, including toxicologic, infectious, and chemical assessments, to better assess the fate and transport of toxicologic, infectious, and chemical agents that may adversely affect human health. Systematic monitoring programs should be instituted to assess private well water quality in high-risk areas, supplemented by biomonitoring programs to assess actual exposure doses from water sources.

Background

While there is an increasing amount of research already taking place on IFAP's impacts on the people that work and live on or near these facilities, there is a need to more fully define the extent to which IFAP poses a threat to those populations. There is clear epidemiological evidence that IFAP facilities are associated with increased asthma outcome risk among those living nearby, but there is a need to develop and understand exposure and health outcome relationships. These topics should be addressed by scientific research.

Recommendation #9.
Strengthen the relationships between physicians, veterinarians, and public health professionals to deal with possible IFAP risks to public health.

a. To better understand the cross-species spread of disease, expand and increase funding for dual veterinary/public health degree programs.
b. Fund and implement federal and state training programs to increase the number of practicing food animal veterinarians (2007b).
c. Initiate and expand federal coordination between Health and Human Services (HHS), FDA, CDC, and USDA to better anticipate, detect, and deal with zoonotic disease. NARMS is not extensive enough to be effective for outbreak detection; it serves a general monitoring function. Include all the data from the various federal agencies in the IFAP clearinghouse (outlined among the environment recommendations) for use by a newly created Food Safety Administration (Recommendation #10) and the states.
d. Promote international coordination on zoonotic diseases and food safety. As an increasing amount of US food is imported, it is vital to hold this food to the same standards as domestically produced food.
e. Provide more training through land-grant universities and schools of public health to producers, community health workers, health professionals, and other appropriate personnel to promote detection of disease as a first line of defense against emerging zoonotic diseases and other IFAP-related occupational health and safety outcomes.

Background

These three groups of health professionals (physicians, veterinarians, and public health professionals) have already begun to collaborate, and such collaboration should be promoted and extended as quickly as possible to protect the public's health as well as that of the food animal population. The American Medical Association's and American Veterinary Medical Association's One Health Initiative is a very good beginning, and the Commission recommends the following to further extend this collaboration.

Recommendation #10.
Create a Food Safety Administration that combines the food inspection and safety responsibilities of the federal government, USDA, FDA, EPA, and other federal agencies into one agency to improve the safety of the US food supply.

Background

The current system to ensure the safety of US food is disjointed and dysfunctional; for example, FDA regulates meatless frozen pizza whereas USDA has jurisdiction over frozen pizza with meat. This fractured system has failed to ensure food safety, and a solution requires a thorough national debate about how the most effective and efficient food safety agency would be constructed.

Recommendation #11.
Develop a flexible risk-based system for food safety from farm to fork to improve the safety of animal protein produced by IFAP facilities.

a. Any risk-based, farm-to-fork food safety system must allow for size differences among production systems—a "one-size-fits-all" system will not be appropriate for all operations. The system must be flexible enough for small and local producers to get their products to the marketplace.
b. Attack food safety issues at their source, instead of trying to fix a problem after it has occurred, by instituting better sanitary and health practices at the farm level. Ranch operating plans may provide one approach to on-farm food safety; FDA's 2004 proposed rule for the prevention of *Salmonella enteritidis* in shell eggs is another example (http://www.cfsan.fda.gov/~lrd/fr04922b.html).
c. Ensure that diagnostic tools are sensitive and specific and are continuously evaluated to detect newly emerging variants of microbial agents of food origin.
d. Make resources available through competitive grants to encourage the development of practical but rigorous monitoring systems and rapid diagnostic tools. Provide resources for the application of newly identified or developed technologies and processes and for the training of inspectors and quality control staff of facilities.
e. Introduce greater transparency in feed ingredients. Often producers do not even know what additives they are feeding the animals since the feed arrives premixed from the integrator. One option would be to extend certain provisions of the Food, Drug, and Cosmetic Act to the farm.
f. Encourage the food animal production industry (contractors, producers, and integrators) to commit to finding ways to minimize the risk of outbreaks of zoonotic disease and other IFAP-related public health threats to vulnerable communities, such as those where IFAP facilities are the most concentrated and where local citizens are least able to protect their rights (e.g., lower-income and/or minority areas).
g. Include both imported and domestically produced foods of animal origin in the enhanced monitoring systems.

Background
Recent food-borne illness outbreaks and meat recalls have called into question the reliability of our system for ensuring the safety of domestic and imported meat. IFAP facilities can have a variety of effects on public health if precautions are not taken to protect the health of their food animals. Livestock production systems must be assessed for vulnerabilities beyond the naturally occurring disease agents. The US production of food has been a model for the world, but a number of countries have now instituted better practices. The food production system is one of our most vulnerable critical infrastructure systems and requires preparation and protection from possible domestic or foreign bioterrorism. Confidence in the safety of our food supply must be maintained and, in some cases, restored.

The ongoing addition of antimicrobial agents to IFAP livestock foodstuffs to promote growth also promotes the emergence of resistant strains of pathogens, presenting a significant risk to human health.

Recommendation #12. Improve the safety of our food supply and reduce use of antimicrobials by more aggressively mitigating production diseases (disorders associated with IFAP management and breeding).

a. More attention should be given to antimicrobial-resistant and other diseases on the farm. Too often attempts are made to address the effects of production diseases after they arise (at processing), rather than preventing them from occurring in the first place.
b. Research into systems that minimize production diseases should be expanded, implemented, and advocated by the state and the federal governments.

Background

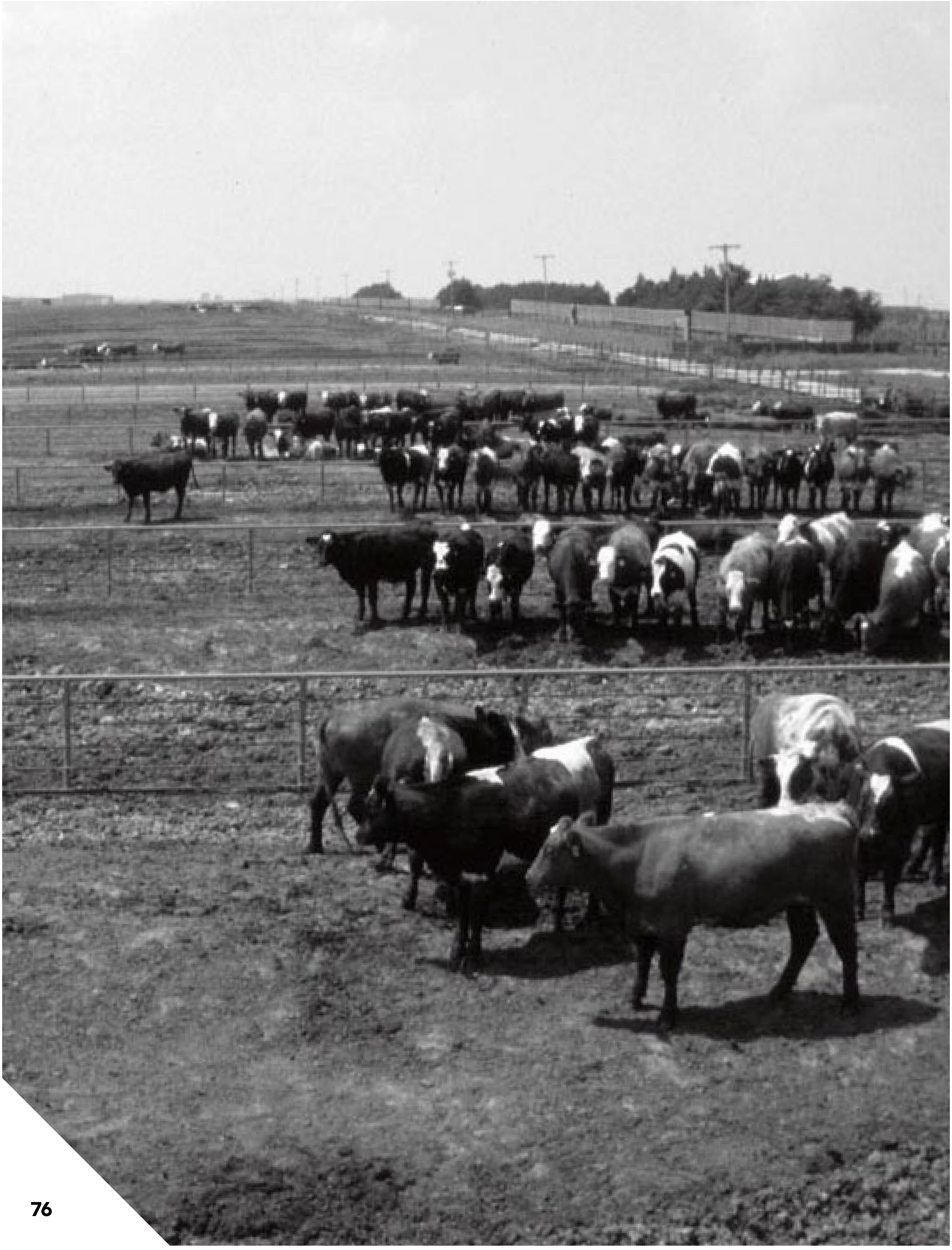
Production diseases are diseases that, although present in nature, become more prevalent as a result of certain production practices. As production systems increase the number of animals in the same spaces, preventive health care strategies must be developed in parallel in order to minimize the risks of production-related diseases.

The Recommendations of the Commission

Environment

Recommendation #1. Improve enforcement of existing federal, state, and local IFAP facility regulations to improve the siting of IFAP facilities and protect the health of those who live near and downstream from them.

a. Enforce all provisions of the Clean Water Act[14] and the Clean Air Act[15] that pertain to IFAP.
b. Provide adequate mandatory federal funding to states to enable them to hire more trained inspectors, collect data, monitor farms more closely, educate producers on proper manure handling techniques, write Comprehensive Nutrient Management Plans (CNMPs), and enforce IFAP regulations (e.g., NRCS, EPA Section 106 grants, SBA loans).
c. States should enforce federal and state permits quickly, equitably, and robustly. A lack of funding and political will often inhibits the ability of states to adequately enforce existing federal and state IFAP (currently Concentrated Animal Feeding Operation, or CAFO) regulations. Often states must rely on general fund appropriations to fund IFAP (CAFO) monitoring and rule enforcement. Dedicated mandatory funding would improve this situation, and additional funding for monitoring and enforcement could be realized if permitting fee funds were dedicated to monitoring and enforcement.
d. States should implement robust inspection regimes that are designed to deter IFAP facility operators from ignoring pollution rules. Often, no state-sanctioned official visits an IFAP facility unless there is a complaint, and then it may be too late to document or fix the problem. Each state should set a minimum inspection schedule (at least once a year), with special attention to repeat violators (Kelly, March 20, 2007).
e. State environmental protection agencies, rather than state agricultural agencies, should be charged with regulating IFAP waste. This would prevent the conflict of interest that arises when a state agency charged with promoting agriculture is also regulating it (Washington State Department of Ecology, 2006). While environmental protection agencies may not have expertise with food animals, they are generally better equipped than state agriculture agencies to deal with waste disposal since they regulate many other types of waste disposal. Unfortunately, several states are transferring the regulation of IFAP facilities from the department of environment to their department of agriculture.
f. The EPA should develop a standardized approach for regulating air pollution from IFAP facilities. IFAP air emissions—including pollutants such as particulate matter, hydrogen sulfide, ammonia, methane, and volatile gases—are unregulated at the federal level.
g. Clarify the definition of the types of waste handling systems and number of animals that constitute a regulated IFAP facility (CAFO) in order to bring a greater proportion of the waste from IFAP facilities under regulation. Under currently proposed EPA rules, only 49 to 60% of IFAP waste qualifies for federal regulation (EPA, 2003).
h. The federal government should develop criteria for allowable levels of animal density and appropriate waste management methods that are compatible with protecting watershed, airshed, soil, and aquifers by adjusting for relevant hydrologic and geologic factors. States should use these criteria to permit and site IFAP operations.
i. Once criteria are established and implemented, EPA should monitor IFAP's effects on entire watersheds, not just on a per farm basis, since IFAP can have a cumulative effect on the health of a watershed.
j. Grant permits only to new IFAP facilities that comply with local, state, and federal regulations.
k. Require existing IFAP facilities to comply and shut down those that cannot or do not.
l. The federal and state governments should increase the number of IFAP operations (currently restricted to EPA-defined CAFOs) to be regulated under federal and state law (NMPs, effluent restrictions, National Pollutant Discharge Elimination System (NPDES) permits) and provide robust financial and technical support to smaller producers included in the expanded IFAP (CAFO) definition to help them comply with these regulations. Under the current definition of a concentrated animal feeding operation (CAFO), only 5% of animal feeding operations (AFOs) are CAFOs, yet they raise 40% of US livestock. And only about 30% (4,000) of the 5% have federal permits (Copeland 2006). If the current final rule (1,000 animal units, or AU) were lowered to the original rule proposed in 2000, which would regulate CAFOs between 300 and



Animals and their waste are concentrated and may well exceed the capacity of the land to produce feed or absorb the waste.

999 AU or a 500-animal threshold (EPA, 2003), 64% to 72% more waste would be covered under the federal permitting process.

m. Require operations that do not obtain a permit to prove they are not discharging waste into the environment. Test wells for groundwater monitoring, and require surface water monitoring for those who wish to opt out of obtaining a permit. This would expand the number of AFOs subject to regulation. Currently, many operations that meet IFAP facility (CAFO) size thresholds do not obtain permits or fall outside state and federal regulation because they claim they do not discharge. Claiming no discharge exempts IFAP facilities from federal regulation, although they are often still subject to state laws, which vary greatly from state to state (as noted in the National Conference of State Legislatures study [NCSL, 2008]).

Background

Too few IFAP operations are monitored, regulated, or even inspected on a regular basis. It is imperative that all levels of government thoroughly enforce existing IFAP laws for all IFAP facilities. Funding should be increased to enable federal and state authorities to enforce IFAP regulations in order to reduce the number of large operations negatively impacting the soil, air, and water.

Recommendation #2. Develop and implement a new system to deal with farm waste (that will replace the inflexible and broken system that exists today) to protect Americans from the adverse environmental and human health hazards of improperly handled IFAP waste.

a. Congress and the federal government should work together to formulate laws and regulations outlining baseline waste handling standards for IFAP facilities. These standards would address the minimum level of mandatory IFAP facility regulation as well as which regulations states must enforce to prevent IFAP facilities from polluting the land, air, and water; states could choose to implement more stringent regulations if they considered them necessary. Our diminishing land capacity for producing food animals, combined with dwindling freshwater supplies, escalating energy costs, nutrient overloading of soil, and increased antibiotic resistance, will result in a crisis unless new laws and regulations go into effect in a timely fashion. This process must begin immediately and be fully implemented within 10 years.
b. Address site-specific permits for the operation of all IFAP facilities and include the monitoring of air, water, and soil, total maximum daily loads (TMDLs),[16] site-specific NMPs,[17] comprehensive nutrient management plans (CNMPs),[18] inspections, data collection, and self-reporting to the clearinghouse (see Recommendation #3e in this section).
c. Require the use of environmentally sound treatment technologies for waste management (without specifying a particular technology that might not be appropriate for all conditions).
d. Mandate shared responsibility and liability for the disposal of IFAP waste between integrators and producers proportional to their control over the operation (instead of this burden being solely the responsibility of the producer; [Arteaga, 2001]).
e. Include baseline federal zoning guidelines that set out a framework for states. Require a pre-permit/construction environmental impact study. Such a requirement would not prevent states and counties from enacting their own, more comprehensive, zoning

laws if necessary (see Recommendation #1 under Competition and Community Impacts).

f. Establish mechanisms for community involvement to provide neighbors of IFAP facilities opportunities to review and comment on proposed facilities, and allow them to take action in cases where federal or state regulations have been violated in the absence of enforcement of those laws by the appropriate authority. Individuals who have had their private property contaminated through no fault of their own must have access to the courts to obtain redress.
g. Ensure that all types of IFAP waste (e.g., dry litter, wet waste) are covered by regulations (EPA, 2003).
h. Establish standards that protect people, animals, and the environment from the effects of IFAP waste on and off the operation's property (Arteaga, 2001; EPA, 2003; Schiffman, Studwell et al., 2005; Sigurdarson and Kline 2006; Stolz, Perera et al., 2007).
i. Phase out the use of lagoon and spray systems in areas that cannot sustain their use (e.g., fragile watersheds, floodplains, certain geologic formations, areas prone to disruptive weather patterns).
j. Require new and expanding IFAP facilities in vulnerable areas to use primary, secondary, and tertiary treatment of animal waste (similar to the treatment associated with human waste) until lagoon and spray systems can be replaced by safe and effective alternative technologies.
k. Require minimal water use in alternative systems to protect the nation's dwindling freshwater resources, balanced with the system's effect on air and soil quality. Liquid manure handling systems should be used only if another system is not feasible or would have greater environmental impact than a liquid system. The sustainability of alternative systems in relation to water resources and carbon use should be a major focus during their development.
l. Prohibit the installation of new liquid manure handling systems and phase out their use on existing operations as technology allows.
m. Require states to implement a robust inspection regime that combines adequate funding for annual inspections with additional risk-based inspections where necessary. It is important that all IFAP facilities be inspected on a regular basis to ensure compliance with state and federal waste management regulations. Additionally, some IFAP facilities may need special attention because of the type of manure handling system in use, the facility's age, its size, or its location. These high-risk operations should be inspected more often than lower-risk operations.

Background

Most animal production facilities in the United States and increasingly in the world have become highly specialized manufacturing endeavors and should be viewed as such. The regulatory system for oversight of IFAP facilities is flawed and inadequate to deal with the level and concentration of waste produced by current food animal production systems, which were not well understood or even foreseen when the laws were written. A new system of laws and regulations that applies specifically to modern IFAP methods is needed.

IFAP facilities have become more concentrated in certain geographic areas. New regulations must address the zoning and siting of IFAP facilities, particularly with regard to the topography, demographics, and climate of the suggested region. They must also take into account an individual's right to property free from pollution caused by neighboring IFAP facilities. IFAP facility owners and integrators do not have a right to pollute their neighbors' land. Property owners or tenants must have the right to take legal action or petition the government to do so on their behalf if their property is polluted by a neighboring IFAP facility.

Waste from IFAP facilities contains both desirable and undesirable byproducts. Desirable byproducts include nutrients that, when applied in appropriate amounts, can enhance production of food crops and biomass to produce energy. Undesirable components include excess pathogenic bacteria, antibiotic-resistant bacteria, viruses, industrial chemicals, heavy metals, and other potentially problematic organic and inorganic compounds. New IFAP laws and regulations must mandate development of sustainable waste handling and treatment systems that can use the beneficial components and render the less desirable components benign. These new laws should not mandate specific systems for producers; rather they should set discharge standards that can be met using a variety of systems that accommodate the local climate and geography.

Congress should work with the EPA, USDA, and FDA to establish a clear and consistent definition of which IFAP facilities should be regulated and to develop

As in large human settlements, improper management of the highly concentrated feces produced by IFAP facilities can and does overwhelm natural cleansing processes.

a risk-based assessment method for all types of IFAP systems, considering variables such as topography, climate, and hydrology. New and clearly defined regulations will prevent an operation from slipping through the cracks and will make it clear to states, communities, and citizens how to proceed regarding the impacts of IFAP.

Recommendation #3. Increase and improve monitoring and research of farm waste to hasten the development of new and innovative systems to deal with IFAP waste and to better our understanding of what is happening with IFAP today.

a. All IFAP facilities should have, at a minimum, a Nutrient Management Plan (NMP) for the disposal of manure.[19] An NMP describes appropriate methods for the handling and disposal of manure and for its application to fields. The plan should also include records of the method and timing of manure disposal.
    i. State and federal governments should provide funds through state regulatory agencies and the National Resources Conservation Service (NRCS) to help producers write and implement NMPs.[20]
    ii. The EPA should set federal minimum standards for the extent of NMPs and specify what monitoring data should be kept.
    iii. Allow the Environmental Quality Incentives Program (EQIP) to (1) fund the writing of NMPs to expedite their implementation and (2) provide business plans for alternative systems to equalize access to government funds for non-IFAP and IFAP (CAFO)-style production.[21]

b. The federal, state, and local governments should begin collecting data on air emissions, ground and surface water emissions, soil emissions, and health outcomes (e.g., cardiovascular disease, heart disease, injuries, allergies) for people who live near IFAP facilities and for IFAP workers. These data should be tabulated and combined with existing data in a *national IFAP data clearinghouse* that will enable the EPA and other agencies to keep track of air, water, and land emissions from IFAP facilities and evaluate the public health implications of these emissions. The EPA and other state and federal agencies should use these comprehensive data both to support independent research and to better regulate IFAP facilities. Currently, FDA, EPA, and other federal agencies each keep extensive records for different industries as a way to track changes and regulate each industry. The clearinghouse would consolidate data from around the country, thereby giving producers the chance to improve their operation by providing access to information about better technologies and improved waste systems. It would also allow researchers, regulators, and policymakers to evaluate changing environmental and public health impacts of agriculture and adjust regulations accordingly. The EPA, FDA, and USDA should take the following actions:

i. Add data collected on farm waste handling systems to the clearinghouse for use assessing and evaluating the sustainability of animal production models and farm waste handling systems by region.
ii. Link data to their collection location to facilitate regional comparisons, given different environmental and geological conditions.
iii. Implement data protection procedures to ensure that personal information (e.g., information that could be used by identity thieves) can be accessed only by authorized agencies and personnel for official purposes.
iv. Include comprehensive USDA Agriculture Census data in the national clearinghouse to provide a context for the data and thus improve their utility.
v. Include data on individual violations of state and federal IFAP facility (CAFO) regulations in the public portion of the national clearinghouse. Currently, it is difficult to determine compliance with IFAP (CAFO) laws because states may or may not keep good records of violations and may make them extremely difficult for the public to access (NASDA, 2001).

c. Expand our understanding of how to deal with concentrated IFAP waste, as well as the health and environmental effects of this waste through more diversely funded and well-coordinated research to address methods for dealing with IFAP waste and its environmental and health effects, as well as to move the United States towards more sustainable systems for dealing with farm waste. National standards for alternative waste systems are needed to guide development of improvements to existing waste handling systems as well as the development of alternative/new waste handling systems.

i. Require states to report basic data (general location, number of animals, NMP, etc.) on all IFAP facilities in the public portion of the national clearinghouse.
ii. Federal and state governments should fund research into alternative systems to replace existing, insufficient waste handling systems, similar to the recent research done at North Carolina State University. They should also increase funding for research on the effects of IFAP waste on public health, the environment, and animal welfare.
iii. Establish a national clearinghouse for data on alternative systems. The clearinghouse would be the repository of regionally and topographically significant data on economic performance, environmental performance (air, water, and soil), and overall sustainability for potentially useful alternative waste handling systems.
iv. Improve and standardize research methods for data collection and analysis for the clearinghouse. Standardized methods would allow states and the federal government to compare regionally relevant data in the clearinghouse and facilitate evaluation of new waste handling systems.
v. Increase funding for research to effectively assess and improve the economic performance, energy balance, risk assessment, and environmental sustainability of alternative waste handling systems.
vi. Increase funding for research focused on comprehensive systems to deal with waste, rather than those focused on one process to deal with one aspect of waste (such as using a digester to reduce volume, which does little to reduce the levels of certain toxic components). Dealing with only one component of waste may have the unintended consequence of causing greater harm to the environment.

Studies have demonstrated strong and consistent associations between IFAP air pollution and asthma.

vii. Expand the type and number of entities researching farm waste handling by expanding the public funding of research at both land-grant and non-land-grant institutions, and other research entities. In addition, transparency of funding source in agricultural research should be standard.

Background

A robust monitoring system should be instituted to improve knowledge about IFAP facilities' current waste management practices as the basis for development of cleaner and safer methods of food animal production.

Recommendation #4.
Increase funding for research into improving waste handling systems and standardize measurements to allow better comparisons between systems.

a. Develop a central repository for information on how to best facilitate rapid adoption of new air and water pollution reduction technologies that currently exist or are under development across the country. Research to develop effective means of assistance to pay for them, (EQIP should be part of this) should be a component of this repository. (Examples of technologies include: biofilters, buffer strips, dehydration, injection, digesters, reduced feed wastage, etc.)
b. Increase funding for the creation and expansion of programs for implementing improved husbandry and technology practices on currently existing facilities including funding conversions to alternative farming practices.[22] (Examples of such programs include, but are not limited to: EQIP, cooperative extension, NRCS, cost share, loans, grants, and accelerated capital depreciation.) Sign-up and application information for these types of programs should be included in the clearinghouse so that producers only have to go to one place to get information and sign up for a program. A dollar amount cap should be placed on the cost-share program to prevent large-scale operators from using the program to externalize their costs. These funds should not be used for the physical construction of new facilities.
c. Target increased assistance and information to small producers who are least able to afford implementation of new practices and deal with increased regulation, but still have the potential to pollute. Air emission technologies, such as biofilters, that are used in other parts of the world should be considered for use in IFAPs in the United States.

Background

Data from research into alternative systems should be linked to the IFAP information clearinghouse to facilitate and expedite access and use. Greater financial and technical assistance must be provided to those who wish to implement alternative systems.

The Recommendations of the Commission

Animal Welfare

Recommendation #1.
The animal agriculture industry should implement federal performance-based standards to improve animal health and well-being.

a. The federal government should develop performance-based (not resource-based) animal welfare standards. Animal welfare has improved in recent years based on industry research and consumer demand; the latter has led, for example, to the creation of the United Egg Producers' certification program and the McDonald's animal welfare council. However, in order to fulfill our ethical responsibility to treat farm animals humanely, federally monitored standards that ensure at least the following minimum standards for animal treatment:
   - *Good feeding:* Animals should not suffer prolonged hunger or thirst;
   - *Good housing:* Animals should be comfortable especially in their lying areas, should not suffer thermal extremes, and should have enough space to move around freely;
   - *Good health:* Animals should not be physically injured and should be free of preventable disease related to production; in the event that surgical procedures are performed on animals for the purposes of health or management, modalities should be used to minimize pain; and
   - *Appropriate behavior:* Animals should be allowed to perform normal nonharmful social behaviors and to express species-specific natural behaviors as much as reasonably possible; animals should be handled well in all situations (handlers should promote good human–animal relationships); negative emotions such as fear, distress, extreme frustration, or boredom should be avoided.

b. Implement a government oversight system similar in structure to that used for laboratory animal welfare: Each IFAP facility would be certified by an industry-funded, government-chartered, not-for-profit entity accredited by the federal government to monitor IFAP. Federal entities would audit IFAP facilities for compliance. Consumers could look for the third-party certification as proof that the production process meets federal farm animal welfare standards.

c. Change the system for monitoring and regulating animal welfare, recommend improvements in animal welfare as science, and encourage consumers to continue to push animal welfare policy. Improved animal husbandry practices and an ethically based view of animal welfare will solve or ameliorate many IFAP animal welfare problems.

d. Federal standards for farm animal welfare should be developed immediately based on a fair, ethical, and evidence-based understanding of normal animal behavior.

Background
There is increasing, broad-based interest in commonsense, husbandry-based agriculture that is humane, sustainable, ethical, and a source of pride to its practitioners. Proper animal husbandry[23] practices (e.g., breeding for traits besides productivity, growth, and carcass condition) and animal management are critical to the welfare of farm animals, as well as to the environment and public health. Evaluating animal welfare without taking into account animal health, husbandry practices, and normal behaviors for each species is inadequate and inappropriate.

Consumer concern for humane treatment of food-producing animals is growing and has prompted change in the industry.

Recommendation #2.
Implement better animal husbandry practices to improve public health and animal well-being.

a. Change breeding practices to include attributes and genetics besides productivity, growth, and carcass condition (Appleby and Lawrence, 1987); for example, hogs might be bred for docile behavior, fowl for bone strength and organ capacity, and sows, dairy and beef cattle for "good" mothering. In recent decades, farm animals have been selectively bred for specific physical traits (e.g., fast growth, increased lean muscle mass, increased milk production) that have led to greater incidence of and susceptibility to transmissible disease, new genetic diseases, a larger number and scope of mental or behavioral abnormalities[24], and lameness.
b. Improve and expand the teaching of animal husbandry practices at land-grant universities.
c. Federal and state governments should fund (through tax incentives and directed education funding, including for technical colleges) the training of farm workers and food industry personnel in sustainable, ethical animal husbandry.
d. Diversify the type of farm animal production systems taught at land-grant schools beyond the status quo IFAP system.
    i. Increase funding for the teaching of good husbandry and alternative production techniques through local extension offices.
    ii. Work to reduce and eliminate "production diseases," defined as diseases caused by production management or nutritional practices; liver abscesses in feedlot cattle are an example of a production disease.

Background
The use of better husbandry practices in IFAP can eliminate or alleviate many of the animal welfare and public health issues that have arisen because of IFAP confinement practices.

Recommendation #3.
Phase out the most intensive and inhumane production practices within a decade to reduce IFAP risks to public health and improve animal well-being; these practices include the following:

a. Gestation crates where sows are kept for their entire 124-day gestation period. The crates do not allow the animals to turn around or express natural behaviors, and they restrict the sow's ability to lie down comfortably. Alternatives such as open feeding stalls and pens can be used to manage sows.
b. Restrictive farrowing crates, in which sows are not able to turn around or exhibit natural behavior. As an alternative, farrowing systems (e.g., the Freedom Farrowing System, Natural Farrowing Systems) provide protection to the piglets while allowing more freedom of movement for the sow.
c. Any cages that house multiple egg-laying chickens (commonly referred to as "battery cages") without allowing the hens to exhibit normal behavior (e.g., pecking, scratching, roosting).
d. The tethering and/or individual housing of calves for the production of white veal. This practice is already rare in the United States, so its phaseout can be done quickly.
e. Forced feeding of fowl to produce foie gras.
f. Tail docking of dairy cattle.
g. Forced molting by feed removal for laying hens to extend the laying period (for the most part, this has been phased out by UEP standards implemented in 2002).[25]

Background
Certain IFAP practices cause animal suffering and should be phased out in favor of more humane animal treatment. While all the practices listed above should be eliminated as soon as possible (i.e., within 10 years), current technology and best practices may limit their short-term phase-out. The phase-out plan should include tax incentives, such as accelerated depreciation for new and remodeled structures, targeted to regional and family operations.

Recommendation #4.
Improve animal welfare practices and conditions that pose a threat to public health and animal well-being; such practices and conditions include the following:

a. Flooring and housing conditions in feedlots and dairies: cattle kept on concrete, left in excessive amounts of feces, and/or not provided shade and/or misting in hot climates.
b. Flooring and other housing conditions at swine facilities: hogs that spend their entire lifetime on concrete are prone to higher rates of leg injury (Andersen and Boe, 1999; Brennan and Aherne, 1987).
c. The method of disposal of unwanted male chicks and of adult fowl in catastrophic situations that require the destruction of large numbers of birds.
d. Hand-catching methods for fowl that result in the animals' broken limbs, bruising, and stress.
e. Body-altering procedures that cause pain to the animals, either during or afterward.
f. Air quality in IFAP buildings: gas buildup can cause respiratory harm to animal health and to IFAP workers through exposure to gas buildup, toxic dust, and other irritants.
g. Ammonia burns on the feet and hocks of fowl due to contact with litter.
h. Some weaning practices for piglets, beef cattle, and veal calves: the shortening of the weaning period or abrupt weaning to move the animal to market faster can stress the animals and make them more vulnerable to disease.

The federal government should act on the following recommendations to improve animal welfare:

a. Strengthen and enforce laws dealing with the transport of livestock by truck.[26] Transport laws should also address the overpacking of livestock during transportation, long-distance transport of farm animals without adequate care, and transport of very young animals.
b. The federal government must include fowl under the Humane Methods of Slaughter Act.[27]

Background

Certain IFAP practices need to be improved to provide a more humane experience for the animal. Those listed above should be carefully examined for humaneness and remedied as appropriate, taking into account available technology and current best practices.

Food animals that are treated well and provided with at least minimum accommodation of their natural behaviors and physical needs are healthier and safer for human consumption.

Recommendation #5. Improve animal welfare research in support of cost-effective and reliable ways to raise food animals while providing humane animal care.

a. There is a significant amount of animal welfare research being done, but the funding often comes from special interest groups. Some of this research is published and distributed to the agriculture industry, but without acknowledgment of the funding sources. Such lack of disclosure taints mainstream animal welfare research. To improve the transparency of animal research, there needs to be disclosure of funding sources for peer-reviewed published research. Much of today's agriculture and livestock research, for example, comes from land-grant colleges with animal science and agriculture departments that are heavily endowed by special interests or industry. However, a lot of very good research on humane methods of stunning and slaughter has been funded by the industry.

b. More diversity in the funding sources for animal welfare research is also needed. Most animal welfare research takes place at land-grant institutions, but other institutions should not be barred from engaging in animal welfare research due to lack of research funds. The federal government is in the best position to provide unbiased animal welfare research; therefore federal funding for animal welfare research should be revived and increased.

c. Focus research on animal-based outcomes relating to natural behavior and stress, and away from physical factors (e.g., growth, weight gain) that do not accurately characterize an animal's welfare status except in the grossest sense.

d. Include ethics as a key component of research into the humaneness of a particular practice. Scientific outcomes are critical, but whether a practice is ethical must be taken into account.

Background

While there is a large amount of peer-reviewed research on animal welfare issues being done today, there is room to improve the quality and focus of that research. More diversity in the funding sources for animal welfare research is also needed. While land-grant institutions are where most animal welfare research takes place, other institutions should not be barred from engaging in animal welfare research due to lack of research funds. Federal funding for animal welfare research should be revived and increased. The Federal government is in the best position to provide unbiased animal welfare research.

The Recommendations of the Commission

Community Impacts

"large-scale industrialized farms create a variety of social problems for communities"

Recommendation #1. States, counties, and local governments should implement zoning and siting guidance governing new IFAP operations that fairly and effectively evaluate the suitability of a site for these types of facilities.

Regulatory agencies should consider the following factors for inclusion in their IFAP plans, and should adopt such guidelines regardless of whether an IFAP facility currently exists in their jurisdiction (Please note that each of the following components should take climate, soil type, prevailing winds, topography, air emissions, operation size, noise levels, traffic, designated lands, and other criteria deemed relevant into account.):

a. *Setback Distances:* IFAP facilities pose environmental and public health risks to the areas in which they are sited. Determining an exact distance from the production facility at which risks begin and end is very difficult, but is important to consider. Distances from schools, residences, surface and groundwater sources, churches, parks, and areas designated to protect wildlife should all be factored into the proposed location of a food animal production facility. Waterways are particularly crucial as any waste that seeps into water sources may travel great distances. Proximity, size, available environmental monitoring data, and state regulations for setbacks for other industries must also be taken into account. Setback distances should be significant enough to alleviate public health and environmental concerns. Determination of appropriate distances should be made by local officials since state regulators cannot take into account every particular factor—they typically set a minimum base standard, which localities should follow, and make more stringent where necessary.

b. *Method of Production:* Every type of livestock and poultry production has positive and negative aspects. Zoning officials should consider the economic, environmental, and health effects of, for example, cage-free versus caged facilities, hoop barn versus crate facilities, operations with outdoor/pasture access versus permanent indoor confinement, or any other systems.

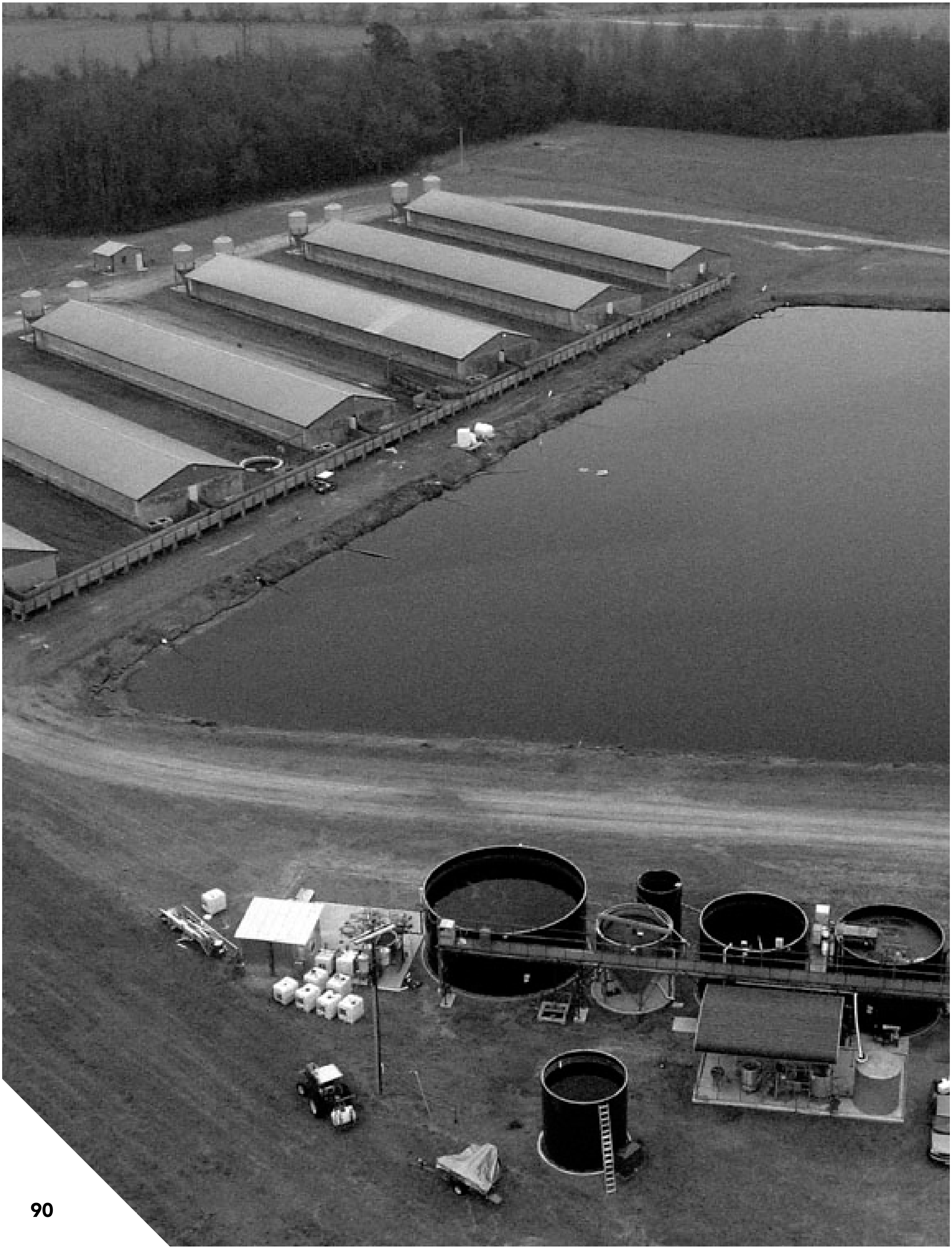
c. *Concentration:* Each locality should take into account the number of IFAP facilities already in existence, particularly per watershed. A surge in the number of IFAP facilities in North Carolina led to devastating environmental effects, including serious environmental justice issues. Growth there and in other places has been so rapid that potential concerns were not fully recognized until they had already created problems. Too many IFAP facilities in one area can destroy land and waterways and devastate entire communities. No facility should be sited that cannot coexist with the land, water, environment, or community in a sustainable manner.

d. *Waste Disposal:* One of the most important issues concerning IFAP facilities is the method of waste handling. If manure is properly applied to land or injected using an approved manure management plan, there should be enough land available to avoid runoff into surface or groundwater or seepage into groundwater. Many states have already become aware of the potentially hazardous nature of lagoons and have, therefore, made the decision to prohibit them for new facilities. The aforementioned criteria are very important in ensuring waste can be handled properly. Consideration should be given to the fact that animal waste can be as dangerous, if not more so, than untreated human waste and some industrial wastes. Further, localities should operate under the premise that every IFAP facility has the potential for runoff and should, therefore, prepare accordingly. Plans to prevent and deal with this situation are part of the Nutrient Management Plan (NMP), referenced below.

e. *Agency Capabilities:* Local officials should fully fund the costs associated with the review of zoning applications.

f. *Public Input:* Because IFAP facilities affect the entire community, advance public input should factor into the decision of whether or not to site a facility. This should not be only in cases where there is controversy. Public input is important to a community's well-being as it allows all citizens, regardless of economic or social status, to participate in the decision-making process. Neighbors and other citizens should also have access to redress when IFAP facilities fail to comply with standards.

g. *Local Control:* Again, localities will have to deal with IFAP impacts and should therefore be the authority on facilities sited within community boundaries. Local



The food animal industry's shift to a system of captive supply transactions controlled by production contracts has shifted economic power from farmers to livestock processors.

officials and citizens tend to have the best knowledge about potential impacts, positive or negative, whereas state officials are more likely to make decisions based on generalizations. Further, local officials are more directly accountable for decisions than state officials.

h. *Inspections:* The relationship between inspections and zoning is twofold. First, zoning officials should conduct an on-site inspection before siting an operation in order to adequately evaluate the criteria mentioned in criteria *a* through *d* above. Second, operators should be aware that inspections will take place as determined by the state in order to ensure all operations follow established regulations as well as their Nutrient Management Plans (NMPS; more on these below).
i. *Proof of Financial Responsibility:* All operations should be bonded for performance and remediation.
j. *Permit Fees:* Fees are suggested in order to help the state and/or locality fund inspections, enforcement, and the day-to-day function of the local agency. Such fees can range from around $100 up to any amount the agency deems appropriate, and should reflect a sliding scale based on the size of the operation.

Two specific components the Commission believes should be mandatory in zoning permits are:

k. *Environmental Impact Statement:* The IFAP facility owner and the animal grower must establish the potential impact of the facility on the land, water, and general environment. The statement should include best practice information for maintaining soil, water, and air quality, as well as descriptions of chemical management (e.g., use of fertilizers), manure management, carcass management, storm water response, and an emergency response plan, at a minimum.
l. *Nutrient Management Plan (NMP):* All IFAP facilities must comply with USDA-NRCS Standard 590, which requires a Nutrient Management Plan. NMPS outline appropriate methods for handling and disposing of manure, including land application issues. Producers should be able to clearly indicate in their NMP that the facility will implement all possible best practices to minimize the potential for runoff, and that they will minimize runoff during catastrophic events (e.g., floods).[28]

Background

Regulations governing the siting and zoning of IFAP facilities vary tremendously across the country. In fact, many states, counties, and local governments have little or no regulations on the books for dealing with new IFAP facilities. Questions often arise on how to establish zoning and siting regulations, how to enforce them, and how to reconcile the needs of the producers and integrators with the lifestyle and health of their neighbors and environmental maintenance of the land. Without well-developed and thought-out regulations, governments are often unable to regulate the siting of IFAP facilities in a way that protects the rights of both the community and the producers. Compliance with all criteria of a zoning permit ensures protection of communities, producers, and the environment.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Recommendation #2.
Implement policies to allow for a competitive marketplace in animal agriculture to reduce the environmental and public health impacts of IFAP.

a. The Commission recommends the vigorous enforcement of current federal antitrust laws to restore competition in the farm animal market. If enforcing existing antitrust laws are not effective in restoring competition, further legislative remedies should be considered, such as more transparency in price reporting and limiting the ability of integrators to control the supply of animals for slaughter.

Background

The current food animal production system is highly concentrated and exhibits conditions that suggest monopsony, in which there are very few buyers for a large number of suppliers. Under monopsonistic conditions, fewer goods are sold, prices are higher in output markets and lower for sellers of inputs, and wealth is transferred from the party without market power to the party with market power. For example, the top four pork-producing companies in the United States control 60% of the pork market, and the top four beef packers control over 80% of the beef market. Farmers have little choice but to contract with those few producers if they are to sell the food animals they grow.

Vigorous market competition is of vital importance to consumers: they benefit most from an open, competitive, and fair market where the values of democracy, freedom, transparency, and efficiency are in balance. Rural communities and consumers suffer from a loss of competitive markets as wealth is transferred from the party without market power to the party with market power. These situations require robust remedy.

The consolidation in the food animal industry, as well as the continued growth of completely integrated operations (where the processor owns the farm, the animals, and the processing plant), has led to a situation where independent producers, whether contracting or selling on the open market, are beholden to big corporations. Growers often take out large loans to pay for land and equipment in anticipation of a contract from a big corporate integrator. Because the contracts are often presented in "take-it-or-leave-it" terms, the producer may end up with a large loan and no way to pay it off if the integrator revokes the contract.

The Recommendations of the Commission

Additional Research Needs

Recommendation:
Increase funding for, expand, and reform animal agriculture research.

Background

As the Commission traveled across the country and talked to experts in animal agriculture, we heard many recurring themes, but some of the loudest came from the research community. In particular, Commission members heard three things:

- there are not enough research dollars from public funding;
- the percentage of research funded by industry is growing; and
- if enough money is put into research, science can solve many of the problems of IFAP.

Industry representatives and academics agreed: more public funding is needed to generate unbiased research into IFAP issues.

Our understanding of how IFAP affects humans, animals, and society must be expanded. The Commission has concluded that a more diversely funded, well-coordinated and transparent national research program is needed to address the many problems and challenges facing IFAP.

(1965). Command Paper 2836. Report of the Technical Committee to Enquire into the Welfare of Animal Kept under Intensive Livestock Husbandry Systems. Her Majesty's Stationary Office: London.

(1977). The Family Farm in California: Report of the Small Farm Viability Project. Agriculture DoFa, Development DoHaC (eds). Sacramento, California: Employment Development Department, Governor's Office of Planning and Research, pp 229-30.

(1994). Animal Medicinal Drug Use Clarification Act. In: *Code of Federal Regulations*.

(2007a). Preservation of Antibiotics for Medical Treatment Act.

(2007b). Veterinary Public Health Workforce Expansion Act of 2007.

Abeles-Allison M, Connor L (1990). An Analysis of Local Benefits and Costs of Michigan Hog Operations Experiencing Environmental Conflicts. Department of Agricultural Economics, Michigan State University, East Lansing.

AHI (2002). Survey Shows Decline in Antibiotics Use in Animals. Animal Health Institute.

Andersen IL, Boe KE (1999). Straw bedding or concrete floor for loose-housed pregnant sows: Consequences for aggression, production and physical health. *Acta Agriculturae Scandinavica Section A—Animal Science* 49: 190-195.

Anderson AD, McClellan J, Rossiter S, Angulo FJ (2003). Public Health Consequences of Use of Antimicrobial Agents in Agriculture. In: *The Resistance Phenomenon in Microbes and Infectious Disease Vectors: Implications for Human Health and Strategies for Containment Workshop*. Knobler SL, Lemon SM, Najafi M, Burroughs T (eds). The National Academies Press: Washington, DC, pp 231-243.

Appleby MC, Lawrence AB (1987). Food restriction as a cause of stereotypic behavior in tethered gilts. *Animal Production* 45: 103-110.

Arbuckle KE, Downing JA (2001). The influence of watershed land use on lake N:P in a predominantly agricultural landscape. *lo* 46: 970-975.

Arbuckle TE, Sherman GJ, Corey PN, Walters D, Lo B (1988). Water nitrates and CNS birth defects: a population-based case-control study. *Arch Environ Health* 43: 162-7.

Arteaga ST (2001). National Pollutant Discharge Elimination System Compliance Challenges. In: *American Society of Agricultural Engineers Annual Meeting:* St. Joseph, Michigan.

Bakr WM, Fawzi M, Hashish MH (2004). Detection of coagulase positive *staphylococci* in meat products sold in Alexandria using two different media. *J Egypt Public Health Assoc* 79: 31-42.

Batt AL, Snow DD, Aga DS (2006). Occurrence of sulfonamide antimicrobials in private water wells in Washington County, Idaho, USA. *Chemosphere* 64: 1963-71.

Beeman P (2007). Speakers Say Biofuel Boom Puts Pressure on Water. In: *The Des Moines Register:* Des Moines, Iowa.

Brennan JJ, Aherne FX (1987). Effect of Floor Type on the Severity of Foot Lesions and Osteochondrosis in Swine. *Canadian Journal of Animal Science* 67: 517-523.

Brown LR (2006). *Plan B 2.0.* W.W. Norton and Company: New York.

Burkholder J, Libra B, Weyer P, Heathcote S, Kolpin D, Thorne PS, Wichman M (2007). Impacts of waste from concentrated animal feeding operations on water quality. *Environ Health Perspect* 115: 308-12.

CDC (2006). Update on Multi-State Outbreak of *E. coli* O157:H7 Infections from Fresh Spinach, October 6, 2006.

CDC/FDA/NIH (1999). A Public Health Action Plan to Combat Antimicrobial Resistance. Interagency Task Force on Antimicrobial Resistance.

Centner TJ (2006). Governmental oversight of discharges from concentrated animal feeding operations. *Environ Manage* 37: 745-52.

Cole D, Todd L, Wing S (2000). Concentrated swine feeding operations and public health: a review of occupational and community health effects. *Environ Health Perspect* 108: 685-99.

Cook M (1998). Reducing Water Pollution from Animal Feeding Operations. In: *Testimony before the Subcommittee on Forestry, Resource Conservation, and Research of the Committee on Agriculture.* Representatives USHO (ed). EPA: http://www.epa.gov/ocirpage/hearings/testimony/105_1997_1998/051398.htm.

Copeland C (2006). Animal Waste and Water Quality: EPA Regulation of Concentrated Animal Feeding Operations (CAFOs). Service CR (ed). United States Congress: Washington, DC, pp CRS-1-CRS-23.

Cosgrove SE, Qi Y, Kaye KS, Harbarth S, Karchmer AW, Carmeli Y (2005). The impact of methicillin resistance in *Staphylococcus aureus* bacteremia on patient outcomes: mortality, length of stay, and hospital charges. *Infect Control Hosp Epidemiol* 26: 166-74.

Daly HE (1999). *Ecological Economics and the Ecology of Economics*. Edward Elgar: Northampton, Massachusetts.

Delgado CL (2003). Rising consumption of meat and milk in developing countries has created a new food revolution. *Journal of Nutrition* 133: 3907S-3910S.

Delgado CL, Rosegrant MW, Steinfeld H, Ehui S, Courbois C (1999). The Growing Place of Livestock Products in World Food in the Twenty-First Century. In: MTID *discussion papers*. (IFPRI) (ed).

DeLind L, Durrenberger PE, Flora CB, Flora J, Heffernan WD, Padgitt S (1995). Social Consequences of Intensive Swine Production: Some Effects of Community Conflict. In: *Understanding the Impacts of Large-Scale Swine Production: An Interdisciplinary Scientific Workshop*: Des Moines, Iowa.

Diamond J (1999). *Guns, Germs, and Steel*. W.W. Norton and Company: New York.

Diamond J (2005). *Collapse: How Societies Choose to Fail or Succeed*. Viking Press: New York.

Do Pico G (1986). Workgroup report on diseases. *Am J Ind Med* 10: 261-266.

DOE, FRA (2001). British Cattle Movement Service.

Donham K, Carsons T, Adrian B (1982a). Carboxyhemoglobin values in swine relative to carbon monoxide exposure: Guidelines to monitor for animal and human health hazards in swine buildings. *Am J Vet Res* 5: 813-816.

Donham K, Cumro D, Reynolds S, Merchant J (2000). Dose-response relationships between occupational aerosol exposures and cross-shift declines of lung function in poultry workers: Recommendations for exposure limits. *J Occup Environ Med* 42: 260-269.

Donham K, Gustafson K (1982). Human occupational hazards from swine confinement. *Annals of the American Conference of Governmental Industrial Hygienists* 2: 137-142.

Donham K, Haglind P, Peterson Y, Rylander R, Belin L (1989). Environmental and health studies of workers in Swedish swine buildings. *Br J Ind Med* 46: 31-37.

Donham K, Knapp L, Monson R, Gustafson K (1982b). Acute toxic exposure to gases from liquid manure. *J Occup Med* 24: 142-145.

Donham K, Merchant J, Lassise D, Popendorf W, Burmeister L (1990). Preventing respiratory disease in swine confinement workers: Intervention through applied epidemiology, education, and consultation. *Am J Ind Med* 18: 241-262.

Donham K, Popendorf W (1985). Ambient levels of selected gases inside swine confinement buildings. *American Industrial Hygienic Association Journal* 46: 658-661.

Donham K, Reynolds S, Whitten P, Merchant J, Burmeister L, Popendorf W (1995). Respiratory dysfunction in swine production facility workers: Dose-response relationships of environmental exposures and pulmonary function. *Am J Ind Med* 27: 405-418.

Donham K, Yeggy J, Dague R (1988). Health implications for workers and animals in swine buildings. *Biological Wastes*: 161-173.

Donham KJ, Wing S, Osterberg D, Flora JL, Hodne C, Thu KM, Thorne PS (2007). Community health and socioeconomic issues surrounding concentrated animal feeding operations. *Environ Health Perspect* 115: 317-20.

Dozier III WA, Lacy MP, Vest LR (2001). Broiler Production and Management. University of Georgia, College of Agricultural and Environmental Sciences, Department of Poultry Science, Cooperative Extension Service: Athens, Georgia, pp 8.

Durrenberger PE, Thu KM (1996). The Expansion of Large Scale Hog Farming in Iowa: The Applicability of Goldschmidt's Findings Fifty Years Later. *Human Organization* 55: 411-15.

EPA (2006). Consumer Factsheet on: Nitrates/Nitrites.

EPA (2007a). Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2005. National Center for Environmental Publications, pp 393.

EPA (2007b). US EPA 2008 Compliance and Enforcement: Clean Water Act. pp 1-3.

EPA (2003). NPDES Permit Regulation and Effluent Limitations Guidelines for Concentrated Animal Feeding Operations. Office of Water.

FAWC (2007). Five Freedoms. FAWC (ed).

FDA-CVM (2003). Guidance for Industry #152.

Frazão E, Meade B, Regmi A (2008). Converging Patterns in Global Food Consumption and Food Delivery Systems. *Amber Waves: The Economics of Food, Farming, Natural Resources, and Rural America* 6: 22-29.

Frenzen PD, Drake A, Angulo FJ (2005). Economic cost of illness due to *Escherichia coli* O157 infections in the United States. *Journal of Food Protection* 68: 2623-2630.

Gibbs SG, Green CF, Tarwater PM, Scarpino PV (2004). Airborne antibiotic resistant and nonresistant bacteria and fungi recovered from two swine herd confined animal feeding operations. *J Occup Environ Hyg* 1: 699-706.

Gilchrist MJ, Greko C, Wallinga DB, Beran GW, Riley DG, Thorne PS (2007). The potential role of concentrated animal feeding operations in infectious disease epidemics and antibiotic resistance. *Environ Health Perspect* 115: 313-6.

Gilles JL, Dalecki M (1988). Rural Well-Being and Agricultural Change in Two Farming Regions. *Rural Sociology* 53: 40-55.

Goldschmidt W (1946). Small Business and the Community: A Study in Central Valley of California on Effects of Scale of Farm Operations. In: *Report of the Special Committee to Study Problems of American Small Business*. 79th Congress, 2nd Session: Washington, DC.

Goldschmidt W (1978). *As You Sow: Three Studies in the Social Consequences of Agribusiness*. Allanheld, Osmun and Company: Montclair, New Jersey.

Gollehon NR, Caswell M., Ribaudo M., Kellogg R., Lander C., Letson D (2001). Confined Animal Production and Manure Nutrients. Service UER (ed).

Graham JP, Boland JJ, Silbergeld E (2007). Growth Promoting Antibiotics in Food Animal Production: An Economic Analysis. *Public Health Rep* 122: 79-87.

Gray GC, Trampel DW, Roth JA (2007). Pandemic influenza planning: shouldn't swine and poultry workers be included? *Vaccine* 25: 4376-81.

Harris CK, Gilbert J (1982). Large-Scale Farming, Rural Income, and Goldschmidt's Agrarian Thesis. *Rural Sociology* 47: 449-58.

Harrison PF, Lederberg J (ed) (1998). *Antimicrobial Resistance: Issues and Options.* National Academy Press: Washington, DC.

Heinberg R (2004). *Power Down*. New Society Publishers: Gabriola Island, BC, Canada.

Holm B, Bakken M, Klemetsdal G, Vangen O (2004). Genetic correlations between reproduction and production traits in swine. *Journal of Animal Science* 82: 3458-3464.

Horrigan L, Lawrence RS, Walker P (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environ Health Perspect* 110: 445-56.

HSUS (2006a). The Welfare of Animals in the Broiler Chicken Industry. In: An HSUS Report. HSUS (ed). HSUS: Washington, DC pp 1-7.

HSUS (2006b). USDA Reverses Decades-Old Policy on Farm Animal Transport. In: Press Release. HSUS: Washington, DC.

Huijsdens XW, van Dijke BJ, Spalburg E, van Santen-Verheuvel MG, Heck ME, Pluister GN, Voss A, Wannet WJ, de Neeling AJ (2006). Community-acquired MRSA and pig-farming. *Ann Clin Microbiol Antimicrob* 5: 26.

Idris U, Lu J, Maier M, Sanchez S, Hofacre CL, Harmon BG, Maurer JJ, Lee MD (2006). Dissemination of fluoroquinolone-resistant *Campylobacter spp*. within an integrated commercial poultry production system. *Appl Environ Microbiol* 72: 3441-7.

IOM (1998). Antimicrobial Resistance: Issues and Options. National Academy Press: Washington.

Jensen J (2006). Carbon Credits: New Opportunities for US Livestock Industry. In: *AgSTAR Conference*. US EPA: Madison, Wisconsin.

Kelly N (March 20, 2007). Senate panel cool to feed-farm curbs. In: *The Journal Gazette*: Ft. Wayne.

Khanna T, Friendship R, Dewey C, Weese JS (2007). Methicillin resistant *Staphylococcus aureus* colonization in pigs and pig farmers. *Vet Microbiol:* Article In Press.

Kilburn KH (1997). Exposure to reduced sulfur gases impairs neurobehavioral function. *South Med J* 90: 997-1006.

Kirschenmann F (2007). Potential for a New Generation of Biodiversity in Agroecosystems of the Future. *Agronomy Journal* 99: 375.

Kitai S, Shimizu A, Kawano J, Sato E, Nakano C, Kitagawa H, Fujio K, Matsumura K, Yasuda R, Inamoto T (2005). Prevalence and characterization of *Staphylococcus aureus* and enterotoxigenic *Staphylococcus aureus* in retail raw chicken meat throughout Japan. *J Vet Med Sci* 67: 269-74.

Kleiner AM, Rikoon JS, Seipel M (2000). Pigs, participation, and the democratic process: The impacts of proximity to large-scale swine operations on elements of social capital in Northern Missouri communities. In: *Meeting of the Rural Sociological Society*: Washington, DC.

Klevens RM, Morrison MA, Nadle J, Petit S, Gershman K, Ray S, Harrison LH, Lynfield R, Dumyati G, Townes JM, Craig AS, Zell ER, Fosheim GE, McDougal LK, Carey RB, Fridkin SK (2007). Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *Jama* 298: 1763-71.

Knol EF, Bergsma R, van Arendunk JAM, van der Lende T (2001). Genetic correlations between piglet survival, birth weight and performance traits. In: *Genetic aspects of pig survival*. Knol EF (ed). PhD Thesis, Wageningen University: Wageningen, pp 57-74.

Kostraba JN, Gay EC, Rewers M, Hamman RF (1992). Nitrate levels in community drinking waters and risk of IDDM. An ecological analysis. *Diabetes Care* 15: 1505-8.

Krapac IG, Koike S., Meyer MT, Snow DD, Chou SFJ, Mackie RI, Roy WR, and Chee-Sanford, JC (2004). Long term monitoring of the occurrence of antibiotics residues and antibiotic resistance genes in groundwater near swing confinement facilities. In: *4th International Conference on Pharmaceuticals and Endocrine Distrupting Chemicals in Water*. National Ground Water Association: Minneapolis, Minnesota, pp 158-174.

Lay Jr. DC, Haussmann MF, Daniels MJ (2000). Hoop Housing for Feeder Pigs Offers a Welfare-Friendly Environment Compared to Nonbedded Confinement System. *Journal of Applied Animal Welfare Science* 3: 33-48.

Leopold A (1999). The Outlook for Farm Wildlife. In: *Aldo Leopold: For the Health of the Land*. Callicott JB, Freyfogle ET (eds). Island Press: Washington, DC pp 218.

Lewis WJ, van Lenteren JC, Phatak SC, Tumlinson JH, 3rd (1997). A total system approach to sustainable pest management. *Proc Natl Acad Sci* USA 94: 12243-8.

Lund MS, Puonti M, Rydhmer L, Jensen J (2002). Relationship between litter size and perinatal and pre-weaning survival in pigs. *Animal Science* 74: 217-222.

MacCannell D (1988). Industrial Agriculture and Rural Community Degradation. In: *Agriculture and Community Change in the US: The Congressional Research Reports*. Swanson LE (ed). Westview Press: Boulder, Colorado.

Markowitz L, Hynes N, de la Cruz P, Campos E, Barbaree J, Plikaytis B, Mosier D, Kaufmann A (1985). Tick-borne Tularemia: An outbreak of Lymphadenopathy in children. JAMA Nov 22/29: 2922-2925.

Marmion B, Ormsbee R, Kyrkow M, Wright J, Worswick D, Izzo A, Esterman A, Feery B, Shapiro R (1990). Vaccine prophylaxis of abattoir-associated Q fever: Eight years' experience in Australian abattoirs. *Epidemiol Infect*: 275-287.

Martin A (2004). US venture hints at Brazil's hog farm potential. In: *Chicago Tribune*: Chicago.

McMichael AJ (1993). *Planetary Overload: Global Environmental Changes and the Health of the Human Species*. Cambridge University Press: Cambridge, England.

McMillan M, Schulman MD (2003). *Hogs and Citizens: A Report from the North Carolina Front*. Ohio University Press: Athens, Ohio.

Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS, Shapiro C, Griffin PM, Tauxe RV (1999). Food-related illness and death in the United States. *Emerging Infectious Diseases* 5: 607-625.

Meatnews.com (2005). Europe Bans Antibiotic Growth Promoters.

Mellon MG, Benbrook C, Benbrook KL, Union of Concerned Scientists. (2001). *Hogging it: estimates of antimicrobial abuse in livestock*. Union of Concerned Scientists: Cambridge, Massachusetts.

Mench JA, James H, Pajor EA, Thompson PB (2008). The Welfare of Animals in Concentrated Animal Feeding Operations. In: *Report to the Pew Commission on Industrial Farm Animal Production*. Pew Commission on Industrial Farm Animal Production: Washington, DC.

Merchant JA, Naleway AL, Svendsen ER, Kelly KM, Burmeister LF, Stromquist AM, Taylor CD, Thorne PS, Reynolds SJ, Sanderson WT, Chrischilles EA (2005). Asthma and farm exposures in a cohort of rural Iowa children. *Environ Health Perspect* 113: 350-6.

Mirabelli MC, Wing S, Marshall SW, Wilcosky TC (2006a). Race, poverty, and potential exposure of middle-school students to air emissions from confined swine feeding operations. *Environ Health Perspect* 114: 591-6.

Mirabelli MC, Wing S, Marshall SW, Wilcosky TC (2006b). Asthma symptoms among adolescents who attend public schools that are located near confined swine feeding operations. *Pediatrics* 118: e66-75.

Mississippi State University Extension Service (1997). Broiler Production in Mississippi.

Moran GJ, Krishnadasan A, Gorwitz RJ, Fosheim GE, McDougal LK, Carey RB, Talan DA (2006). Methicillin-resistant *S. aureus* infections among patients in the emergency department. *N Engl J Med* 355: 666-74.

Myers KP, Olsen CW, Setterquist SF, Capuano AW, Donham KJ, Thacker EL, Merchant JA, Gray GC (2006). Are swine workers in the United States at increased risk of infection with zoonotic influenza virus? *Clin Infect Dis* 42: 14-20.

Myers KP, Setterquist SF, Capuano AW, Gray GC (2007). Infection due to 3 avian influenza subtypes in United States veterinarians. *Clin Infect Dis* 45: 4-9.

NAS (1975). Understanding Climate Change: Report of the Panel on Climate Variations. National Academy of Sciences: Washington, DC.

NAS (1999). *The Use of Drugs in Food Animals: Benefits and Risks*. National Academies Press: Washington, DC.

NASDA (2001). Comments on Pollutant Discharge Regulation/Guidelines & Standards for Animal Feeding Operations. Graves L (ed). National Association of State Departments of Agriculture.

NCSL (2008). Concentrated Animal Feeding Operations: A Survey of State Policies. In: *A Report to the Pew Commission on Industrial Farm Animal Production*. PCIFAP (ed). National Conference of State Legislatures: Washington, DC.

Neirenberg D (2003). Factory farming in the developing world: in some critical respects, this is not progress at all. In: *World Watch* 16: pp 10-19.

Nolan BT, Hitt KJ (2006). Vulnerability of shallow groundwater and drinking-water wells to nitrate in the United States. *Environ Sci Technol* 40: 7834-40.

NPB (2005). Take Care: A Producer's Guide to Using Antibiotics Responsibly. Des Moines, Iowa.

Osbern L, Crapo R (1981). Dung Lung: A report of toxic exposure to liquid manure. *Ann Intern Med* 95: 312-314.

Peak N, Knapp CW, Yang RK, Hanfelt MM, Smith MS, Aga DS, Graham DW (2007). Abundance of six tetracycline resistance genes in wastewater lagoons at cattle feedlots with different antibiotic use strategies. *Environ Microbiol* 9: 143-51.

Peters JA, Blackwood TR (1977). Source Assessment: Beef Cattle Feedlots. EPA-600/2-77-107. US Environmental Protection Agency, Research Triangle Park, North Carolina.

Pimentel D, Houser J, Preiss E, White O, Fang H, Mesnick L, Barsky T, Tariche S, Schreck J, Alpert S (1997). Water Resources: Agriculture, the Environment, and Society. *BioScience* 47: 97-106.

Rabalais NN, Wiseman WJ, Turner RE, Sen Gupta BK, Dortch Q (1996). Nutrient changes in the Mississippi River and system responses on the adjacent continental shelf. *Estuaries* 19: 386-407.

Radon K, Schulze A, Ehrenstein V, van Strien RT, Praml G, Nowak D (2007). Environmental exposure to confined animal feeding operations and respiratory health of neighboring residents. *Epidemiology* 18: 300-8.

Rao PV, Bhattacharya R, Pant SC, Bhaskar AS (1995). Toxicity evaluation of in vitro cultures of freshwater cyanobacterium *Microcystis aeruginosa*: I. Hepatic and histopathological effects in rats. *Biomed Environ Sci* 8: 254-64.

Reganold JP, Elliott LF, Unger YL (1987). Long-term Effects of Organic and Conventional Farming on Soil Erosion. *Nature* 330: 370-2.

Reganold JP, Glover JD, Andrews PK, Hinman HR (2001). Sustainability of three apple production systems. *Nature* 410: 926-30.

Reynolds S, Donham K, Whitten P, Merchant J, Burmeister L, Popendorf W (1996). Longitudinal evaluation of dose-response relationships for environmental exposures and pulmonary function in swine production workers. *Am J Ind Med* 29.

Roberts P (2004). *The End of Oil*. Houghton Mifflin Company: Boston.

Russelle MP, Morey RV, Baker JM, Porter PM, Jung HJ (2007). Comment on "Carbon-negative biofuels from low-input high-diversity grassland biomass." *Science* 316: 1567; author reply: 1567.

Rylander R (1987). Role of endotoxins in the pathogenesis of respiratory disorders. *Eur J Respir Dis Suppl* 154: 136-144.

Saenz RA, Hethcote HW, Gray GC (2006). Confined animal feeding operations as amplifiers of influenza. *Vector Borne Zoonotic Dis* 6: 338-46.

Schiffman SS, Miller EA, Suggs MS, Graham BG (1995). The effect of environmental odors emanating from commercial swine operations on the mood of nearby residents. *Brain Res Bull* 37: 369-75.

Schiffman SS, Studwell CE, Landerman LR, Berman K, Sundy JS (2005). Symptomatic effects of exposure to diluted air sampled from a swine confinement atmosphere on healthy human subjects. *Environ Health Perspect* 113: 567-76.

Schraft H, Kleinlein N, Untermann F (1992). Contamination of pig hindquarters with *Staphylococcus aureus*. *Int J Food Microbiol* 15: 191-4.

Schroeder CM, Naugle AL, Schlosser WD, Hogue AT, Angulo FJ, Rose JS, Ebel ED, Disney WT, Holt KG, Goldman DP (2005). Estimate of illnesses from *Salmonella enteritidis* in eggs, United States, 2000. *Emerg Infect Dis* 11: 113-5.

Seffner W (1995). Natural water contents and endemic goiter—a review. *Zentralbl Hyg Umweltmed* 196: 381-98.

Shi Q, Cui J, Zhang J, Kong FX, Hua ZC, Shen PP (2004). Expression modulation of multiple cytokines in vivo by cyanobacteria blooms extract from Taihu Lake, China. *Toxicon* 44: 871-9.

Sigurdarson ST, Kline JN (2006). School proximity to concentrated animal feeding operations and prevalence of asthma in students. *Chest* 129: 1486-91.

Smith DL, Harris AD, Johnson JA, Silbergeld EK, Morris JG, Jr. (2002). Animal antibiotic use has an early but important impact on the emergence of antibiotic resistance in human commensal bacteria. *Proc Natl Acad Sci USA* 99: 6434-9.

Smith JL, Drum DJ, Dai Y, Kim JM, Sanchez S, Maurer JJ, Hofacre CL, Lee MD (2007). Impact of Antimicrobial Usage on Antimicrobial Resistance in Commensal *Escherichia coli* Strains Colonizing Broiler Chickens. *Appl Environ Microbiol* 73: 1404-14.

Song WL, Huang M, Rumbeiha W, Li H (2007). Determination of amprolium, carbadox, monensin, and tylosin in surface water by liquid chromatography/tandem mass spectrometry. *Rapid Communications in Mass Spectrometry* 21: 1944-1950.

Soule JD, Piper D (1992). *Farming in Nature's Image*: An Ecological Approach to Agriculture. Island Press: Washington, DC.

Spellberg B, Guidos R, Gilbert D, Bradley J, Boucher HW, Scheld WM, Bartlett JG, Edwards Jr. J, America IDSo (2008). The Epidemic of Antibiotic-Resistant Infections: A Call to Action for the Medical Community from the Infectious Disease Society of America. *Clin Infect Dis* 46.

Starmer E, Wise TA (2007a). Feeding at the Trough: Industrial Livestock Firms Saved $35 billion from Low Feed Prices. In: *Policy Brief* 07-03. Institute GDAE, (ed). Tufts University: Medford, Massachusetts, pp 4.

Starmer E, Wise TA (2007b). Living High on the Hog: Factory Farms, Federal Policy, and the Structural Transformation of Swine Production. In: *Working Paper 07-04*. Institute GDAE (ed). Tufts University: Medford, Massachusetts, pp 30.

Steinfeld H, Gerber P, Wassenaar T, Castel V, Rosales M, de Haan C (2006). *Livestock's Long Shadow—Environmental Issues and Options*. Food and Agriculture Organization of the United Nations: Rome, Italy.

Stock R, Mader T (1985). Feed additives for beef cattle. In: *NebGuide*. University of Nebraska: Lincoln, Nebraska.

Stokstad ELR, Jukes TH (1958-1959). Studies of the growth-promoting effect of antibiotics in chicks on a purified diet. *Antibiotics Annual*: 998-1002.

Stolz JF, Perera E, Kilonzo B, Kail B, Crable B, Fisher E, Ranganathan M, Wormer L, Basu P (2007). Biotransformation of 3-nitro-4-hydroxybenzene arsonic acid (roxarsone) and release of inorganic arsenic by *Clostridium* species. *Environ Sci Technol* 41: 818-23.

Summer W (1971). Odor pollution of air—cause and control. The Chemical Rubber Company Press: Cleveland, Ohio, pp 310.

Suzuki S (1994). Pathogenicity of *Salmonella enteritidis* in poultry. *Int J Food Microbiol* 21: 89-105.

Tajtakova M, Semanova Z, Tomkova Z, Szokeova E, Majoros J, Radikova Z, Sebokova E, Klimes I, Langer P (2006). Increased thyroid volume and frequency of thyroid disorders signs in schoolchildren from nitrate polluted area. *Chemosphere* 62: 559-64.

Tao B (2003). A stitch in time: Addressing the environmental, health, and animal welfare effects of China's expanding meat industry. In: *Georgetown International Law Review*.

Tetreau ED (1940). Social Organization in Arizona's Irrigated Areas. *Rural Sociology* 5: 192-205.

Teuber M (2001). Veterinary use and antibiotic resistance. *Curr Opin Microbiol* 4: 493-9.

Thu KM (2002). Public Health Concerns for Neighbors of Large-Scale Swine Production Operations. *Journal of Agricultural Safety and Health* 8: 175-84.

Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S (2002). Agricultural sustainability and intensive production practices. *Nature* 418: 671-677.

Trewavas A (2002). Malthus foiled again and again. *Nature* 418: 668-670.

USDA (2005). National Animal Identification System: Draft Strategic Plan. USDA (ed).

USDA (2006). National Animal Identification System (NAIS): Strategies for the Implementation of NAIS. USDA (ed).

USDA, APHIS (2006). National Animal Identification System (NAIS).

USDA-ERS (2001). Agricultural and Resource Management Survey.

USDA-ERS (2008). Data Sets: 2005 County-Level Poverty Rates. Gibbs R (ed). USDA Economic Research Service.

USGS (2006). Pharmaceuticals and Other Emerging Contaminants in the Environment—Transport, Fate, and Effects.

van Loo H, Diederen BMW, Savelkoul PHM, et al., (2007). Methicillin-Resistant *Staphylococcus aureus* in Meat Products, the Netherlands. *Emerg Infect Dis* 13: 1753-1755.

Voss A, Loeffen F, Bakker J, Klaassen C, Wulf M (2005). Methicillin-resistant *Staphylococcus aureus* in pig farming. *Emerg Infect Dis* 11: 1965-6.

Walker P, Rhubart-Berg P, McKenzie S, Kelling K, Lawrence RS (2005). Public health implications of meat production and consumption. *Public Health Nutr* 8: 348-56.

Washington State Department of Ecology (2006). Agency-Wide Notices, Orders & Penalties 1985–2005. Drop in inspections when authority given to Department of Agriculture in 2003, as compared with previous years when Department of Ecology had dairy inspection authority.

Webb J, Archer JR (1994). Pollution of soils and watercourses by wastes from livestock production systems. In: *Pollution in Livestock Production Systems*. Dewi IA, Axford RFE, Marai IFM, Omed HM (eds). CABI Publishing: Oxfordshire, England, pp 189-204.

Western Organization of Resource Councils (May 2006). National Animal Identification System: The Unanswered Questions.

WHO (1992). Basic documents. 39th ed. WHO: Geneva.

WHO (2000). Report on Infectious Diseases.

WHO (2002). Impacts of antimicrobial growth promoter termination in Denmark. In: *International Invitational Symposium: Beyond Antimicrobial Growth Promoters in Food Animal Production*. Panel WIR (ed). WHO Department of Communicable Diseases, Prevention and Eradication: Foulum, Denmark.

Wing S, Wolf S (2000). Intensive livestock operations, health, and quality of life among eastern North Carolina residents. *Environ Health Perspect* 108: 233-8.

Witte W, Strommenger B, Stanek C, Cuny C (2007). Methicillin-resistant *Staphylococcus aureus* ST398 in humans and animals, Central Europe. *Emerg Infect Dis* 13: 255-8.

Woolhouse ME, Gowtage-Sequeria S (2005). Host range and emerging and reemerging pathogens. *Emerg Infect Dis* 11: 1842-7.

Woolhouse ME, Taylor LH, Haydon DT (2001). Population biology of multihost pathogens. *Science* 292: 1109-12.

Wright W, Flora CB, Kremer KS, Goudy W, Hinrichs C, Lasley P, Maney A, Kroma M, Brown H, Pigg K, Durgan B, Coleman J, Elias Morse D (2001). Technical work paper on social and community impacts. Generic Environmental Impact Statement on Animal Agriculture: Minnesota Environmental Quality Board.

Zetola N, Francis JS, Nuermberger EL, Bishai WR (2005). Community-acquired meticillin-resistant *Staphylococcus aureus*: an emerging threat. *Lancet Infect Dis* 5: 275-86.

Endnotes

1 Vertical integration describes a style of management that seeks to control many components of the production chain. Usually each component of the hierarchy produces a different product or service, and the products combine to satisfy a common need. One of the earliest, largest and most famous examples of vertical integration was the Carnegie Steel company. The company controlled not only the mills where the steel was manufactured but also the mines where the iron ore was extracted, the coal mines that supplied the coal, the ships that transported the iron ore, the railroads that transported the coal to the factory, and the coke ovens where the coal was coked.

2 From: EPA Administered Permit Programs: The National Pollutant Discharge Elimination System, 40 CFR § 122.23 (2001).

3 Animal pharmaceutical industry trade association.

4 Group representing packing and food processing companies.

5 Animal Welfare Act. 7 USC § 2131. (1966).

6 Daly, Robert Costanza, and others have formed a professional Ecological Economics movement.

7 http://news.bbc.co.uk/hi/english/static/in_depth/world/2000/world_water_crisis/default.stm

8 Review and Outlook, 2007. "Ethanol's Water Shortage." *Wall Street Journal*. Oct 17. A18.

9 For extensive peer-reviewed research on hoop barn performance go to www.leopold.iastate.edu, click on Ecology Initiative, and type "hoop barns" in the search box.

10 The PCIFAP defines *nontherapeutic* as any use of antimicrobials in food animals in the absence of clinical disease or known (documented) disease exposure; i.e., any use of the drug as a food or water additive for growth promotion, feed efficiency, weight gain, disease prevention in the absence of documented exposure or any other "routine" use as nontherapeutic.

11 Fluoroquinolones are approved in animals only for therapeutic use (not for nontherapeutic use) and thus are not covered under PAMTA.

12 This definition is adapted from PAMTA.

13 The USDA APHIS has begun implementing an animal tracking system, the National Animal Identification System (NAIS; http://animalid.aphis.usda.gov/nais/index.shtml). Announced in May 2005, the NAIS tracks both premises and 27 species of food animals (including cattle, goats, sheep, swine, poultry, deer, and elk). The data are linked to several databases run by private technology companies, while USDA shops for a technology company with data warehousing expertise to run the full national database. The United Kingdom uses a similar database system for its Cattle Tracing System (CTS; http://www.bcms.gov.uk/), which facilitates tracking and is accessible online to users and administrators. See PCIFAP Recommendation #6 in this section for more information.

14 Clean Water Act. Vol 33 USC § 1251 et seq. 33 ed.; 1977.

15 USEPA. Animal Feeding Operations Air Quality Compliance Agreement Fact Sheet; 2006.

16 Total maximum daily load: The total amount of a specific compound that can be emitted in a day.

17 Nutrient management plan: Specifies how waste should be handled on a specific farm taking into account local conditions and conforming to USDA-NRCS Standard 590. ftp://ftp-fc.sc.egov.usda.gov/IA/technical/N590(12-2006).pdf

18 Comprehensive nutrient management plan: A CNMP incorporates practices to utilize animal manure and organic byproducts as a beneficial resource. A CNMP addresses natural resource concerns dealing with soil erosion, manure, and organic byproducts and their potential impacts on water quality, which may derive from an AFO.

19 USDA-NRCS Standard 590: ftp://ftp-fc.sc.egov.usda.gov/IA/technical/N590(12-2006).pdf.

20 NRCS, EQIP, cooperative extension, and private cost share are examples of existing programs that might be used to implement nutrient management plans.

21 Working Land Conservation: Conservation Security Program and Environmental Quality Incentives Program. Senate Committee on Agriculture, Nutrition and Forestry. Washington, DC; 2007.

22 Hoop-barns, free-range, pasture based systems, etc.

23 Animal husbandry is defined as the branch of agriculture concerned with the care and breeding of domestic animals such as cattle, hogs, sheep, and horses (*American Heritage Dictionary*, 4th ed).

[24] Sows have been bred to reproduce more quickly and therefore produce more piglets per year, but a side effect has been a decrease in maternal behavior/increased piglet mortality (Lund et al., 2002; Holm et al., 2004; Knol et al., 2001).

[25] United Egg Producers Certified program literature, available online at www.uepcertified.com.

[26] The 28-hour law was passed when trains were the predominant method of animal transport.

[27] The Humane Methods of Slaughter Act of 1958, 1978, 2002; Pub.L. 87-765, Aug. 27, 1958, 72 Stat. 862.

[28] ftp://ftp-fc.sc.egov.usda.gov/IA/technical/N590(12-2006).pdf

Final Report
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