Farm Animals and Their Welfare in 2000

5
CHAPTER

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Introduction

Humans use far more animals for agricultural production than for any other purpose. Worldwide 1.9 billion cattle, sheep, and swine, and 39.7 billion chickens and turkeys, were slaughtered in 1998 (UN Food and Agricultural Organization [FAO] 2000). Many other species are farmed for food or fiber in smaller numbers, including agouti and capybara, alligators, alpaca and llamas, bison, deer, emus and ostriches, goats, iguanas, pheasants, pigeons, quail, rabbits, and waterfowl. The most rapidly growing segments of the agricultural industry are probably aquaculture and mariculture (the farming of fish, shellfish, and other aquatic animals), which now produce more than 20,000 metric tons of food annually, according to the FAO. Animal agriculture also generates many important byproducts, including gelatin, hides, horn, inedible fats used for industrial purposes, meat and bone meals, manure, and medicinal products. In developing countries buffalo, camels, and cattle are widely used for draft power as well as for food.

From an animal welfare viewpoint, farm animals present unique challenges. The primary purpose of farming, whether of plants or animals, is to produce abundant, high-quality, and competitively priced products for human consumption. Consumer preferences and economics therefore play a central role in determining how farm animals are treated. As a consequence of real or perceived economic constraints, people have developed many animal-production practices that would not be considered acceptable if used with other types of animals. For example, confining animals for many weeks at a time in such a way that they cannot walk or turn around would not be tolerated for zoo or companion animals but is a common practice with pregnant sows.

Farm animals have been a traditional concern of the modern animal protection movement. In the early 1800s, when the movement emerged as a significant sociopolitical force in the United Kingdom, its first priority was protection of farm animals, with particular emphasis on cattle and horses. Subsequently priorities changed, and throughout most of the 1900s, animal protectionism in Europe and the English-speaking world focused more strongly on the use of animals for scientific research and on the rescue of abandoned or ill-treated companion animals. Today, however, with vigorous public debate over animal agriculture and its effects, farm animals are re-emerging as a major subject of humane concern.

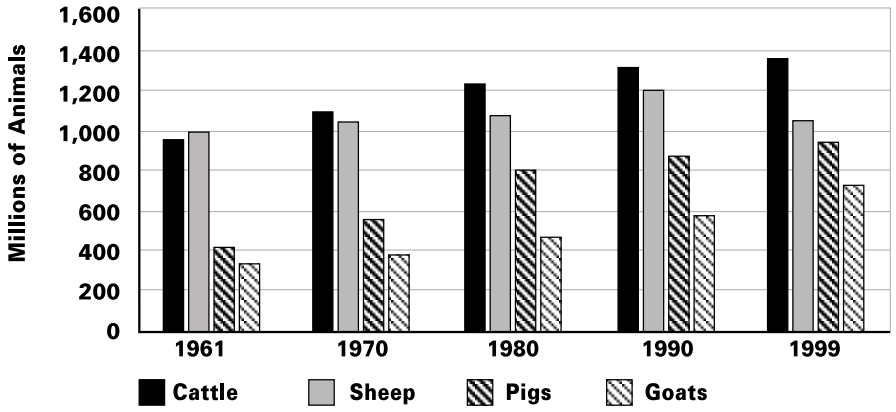
Such attention is timely. Animal agriculture is undergoing significant restructuring worldwide, with major and complex implications for animals, human society, and the environment. At the same time, the public is bombarded with polarized, simplistic depictions of animal agriculture both by its opponents and by its defenders. The result is a public misinformed about the issues despite their great importance. In this chapter we review the major changes that have occurred in animal agriculture since 1950, mainly in the industrialized countries; the resulting implications for animal welfare; and the factors that have contributed to these changes.

The Revolution in Animal Production

Animal Numbers and Distribution

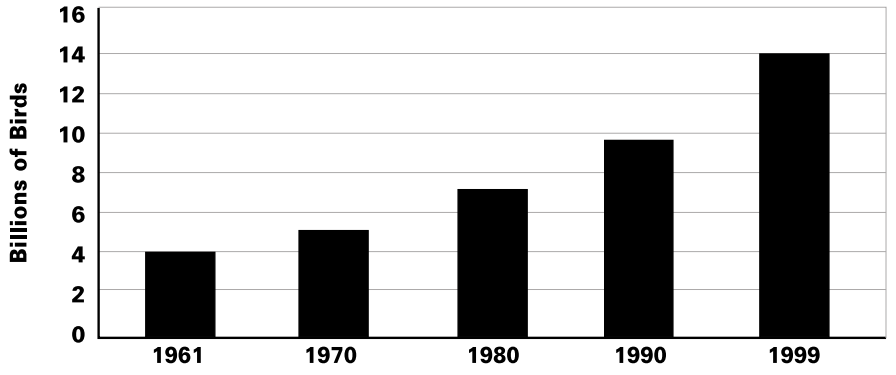
The world's human population has increased by about 2 percent per year for the last forty years, with most of that increase occurring in the developing countries. As the population has increased, so too have the consumption of animal products and the numbers of animals raised for agricultural production (Figure 1a,b). Poultry production has shown the largest increase and, in the United States at least, consumption of poultry has consistently increased as consumption of

Figure 1a
Changes in Worldwide Inventory of Common Farm Animals Kept for All Purposes, 1961–1999



Source: UN Food and Agricultural Organization 2000

Figure 1b
Changes in Worldwide Inventory of Chickens Kept for All Purposes, 1961–1999



Source: UN Food and Agricultural Organization 2000

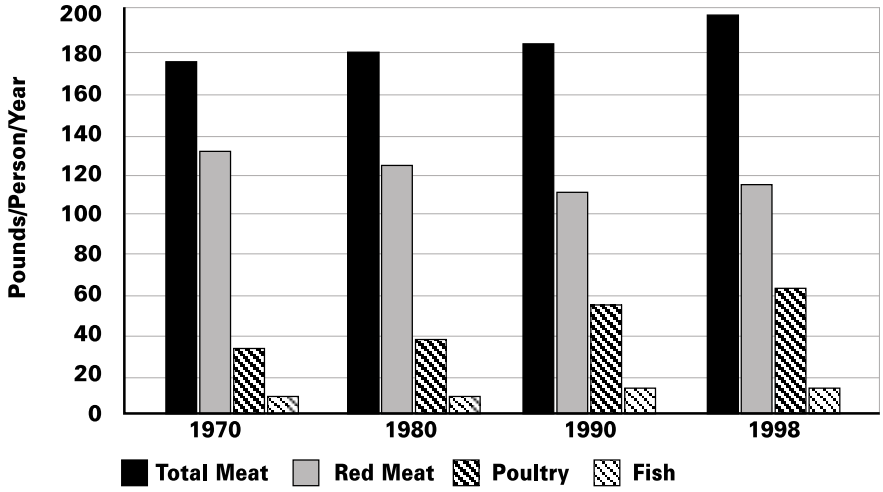
red meat has tended to decline (Figure 2). Animal products currently contribute 10 percent of the calories eaten by people in developing countries and nearly 30 percent of the calories eaten in industrialized countries (FAO 1994). By 2020 global demand for meat is projected to increase more than 60 percent over current consumption, with 88 percent of this increase resulting from higher total meat consumption in developing countries (Council for Agricultural Science and Technology 1999).

Specific types of animal agriculture tend to be concentrated in specific countries or regions of the world. The United States produces about one-fourth of the world's beef and veal; China is by far the world's largest pork producer (Figure 3). The United States produces more than 30 percent of the world's poultry meat, and China and the United States are the world's leading producers of eggs. The United States and India together produce about 30 percent of the total world production of milk, although the dairy cow populations in the United States are actually low when compared with those of many other countries; high U.S. production is due to high production per cow. Overall, China produces one-third of the world's meat supply, followed by the United States and the European Union, producing approximately 15 to 20 percent each (USDA National Agricultural Statistics Service [NASS] 2000). Animal products play a major role in the economy of many countries. In the United States for example, the value of farm animal products was more than $95 billion in 1999, with about $11.2 billion of that total due to exports (USDA Economic Research Service [ERS] 2000a).

Housing and Handling Methods

Until about 1950 farm animals in industrialized countries were raised using traditional methods that relied on labor to accomplish routine tasks such as feeding and manure removal, and that generally involved keeping animals in outdoor or semi-outdoor environments. (Beef cattle and sheep are still kept in this way, at least during most of their production cycle.) After World War II, however, there emerged a new generation of technology typically called "confinement" or "intensive" animal production. Intensive production systems use hardware and automation instead of human labor for many routine tasks, and the animals are generally kept in specialized indoor environments. In industrialized countries, confinement rearing is now the norm for poultry and swine, while dairy cattle are generally kept in semi-intensive systems where the animals have access to a paddock, cement yard, or pasture for at least part of the year. Worldwide, intensive animal-production systems accounted for 79 percent of the poultry, 39 percent of the pork, and 68 percent of the eggs produced during 1996 (Sere and Steinfeld 1996).

Figure 2
Per Capita Consumption of Red Meat, Poultry, and Fish (Boneless, Trimmed Equivalent) in the United States, 1970–1998

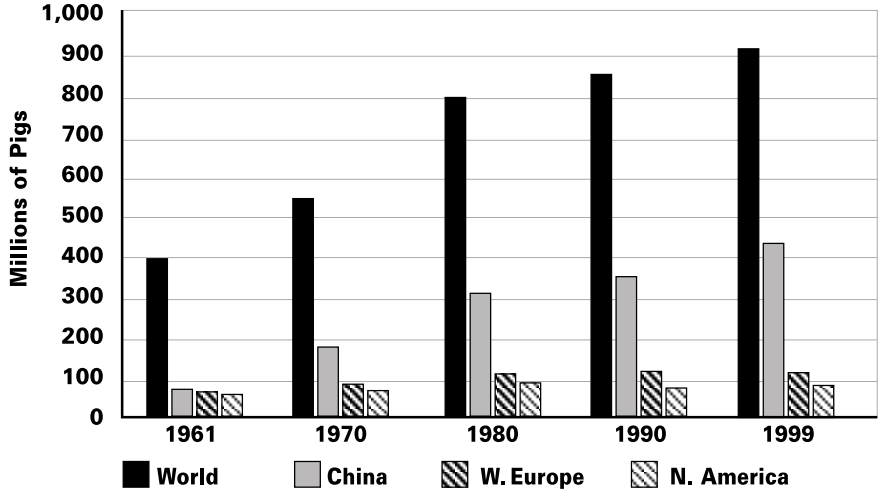


Source: UN Food and Agricultural Organization 2000

Poultry

Poultry production is the most highly intensified of all the agricultural industries. In the 1950s hens were kept in small flocks outdoors on range. The death rate could be high because of soil-borne diseases, extreme temperatures, and predators. Egg production was largely seasonal, and poultry meat was available mainly when the hens were "retired" from egg-laying and sent to the processing plant. A major, and highly successful, push to use genetic selection (initiated in the United States by a nationwide "Chicken of Tomorrow" contest) produced strains of chickens suited to either egg-laying (layers) or meat production (broilers). Cage housing systems were developed for layers that allowed better environmental control, including control of the amount of light necessary to stimulate higher levels of egg production.

Figure 3
Changes in Hog Inventory in Selected Countries, 1961–1999



Note: "North America" includes the United States, Canada, and Mexico.

Source: UN Food and Agricultural Organization 2000

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Figure 4.
Laying hens in a battery-cage system

Most laying hens in North America are now housed in cages (Figure 4), although in response to animal welfare concerns, some countries have moved toward providing more extensive housing, either on range or in housing systems similar to those used for broilers. Wire "battery cages" are arranged in rows and tiers (or batteries), with sloping floors that allow eggs to roll to the front for collection. There are many different designs, but a typical cage houses three to ten hens, and a typical house contains thousands to tens of thousands of cages. Feeding, watering, and egg and manure collection are all automated. Hens are housed in these cages from the start of lay at sixteen to eighteen weeks of age through one or more laying cycles.

Egg production begins to decline as hens age, so if the hens are to be kept after the end of their first laying cycle (at around seventy weeks of age), they are stimulated to resume higher egg production by "forced molting," which induces them to replace their feathers. Forced molting is accomplished by depriving the hens of feed, usually for eight to twelve days or until they lose 30–35 percent of their body weight. Egg production ceases for a period of one to several weeks during


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Figure 5.
Commercial broilers are usually housed in floor systems, sometimes in groups of 10,000 or more birds.

the molt, then the hens resume higher rates of egg production for a second, or even a third, laying cycle.

Hens generally have the distal third or half of their beaks removed (called "beak trimming") to prevent injuries due to pecking, and they may also have part of their toes removed so that they do not scratch one another. Beak and toe trimming are usually performed when chicks are one to two weeks of age, using a hot blade to cauterize the tissues. Male chicks have no commercial value and are considered a by-product of the egg industry. In 1998 219 million chicks were killed in the commercial laying industry in the United States (USDA NASS 1999c), usually in a high-speed macerator or by gas within twenty-four hours after hatching.

Broiler chickens are housed in large groups (usually tens of thousands) in either completely or partially enclosed buildings on a floor covered with bedding (Figure 5). Feeding and watering are automated. Broilers grow rapidly and are marketed at from three to twelve weeks of age. Broiler chickens are usually not beak trimmed, although "broiler breeders" (the parent birds that produce broilers) are both beak- and toe-trimmed.

Broiler breeders are reared to sexual maturity in houses similar to those used in broiler production. However, to prevent fertility problems associated with obesity, broiler breeders are severely feed-restricted. This can lead to excessive drinking; hence, to prevent problems with wet litter, water is often restricted during the rearing period to four to six hours per day. At twenty-two weeks of age, males and females are housed together, often in flocks of ten thousand birds, and hatching eggs are produced. As with table-egg production, hens may be force-molted for a second or third laying cycle. Turkeys are produced similarly except that artificial insemination is necessary because the males are so large, due to genetic selection for growth, that they cannot mate normally.


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Figure 6.
A sow in a farrowing crate with her piglets.

Swine

Swine production in North America has seen a strong trend away from pasture production on small farms toward large-scale confinement systems. Pigs may be kept in one facility from farrowing (birth), through the "growing" phase (to a weight of about ninety lbs.), to "finishing" (market weight), or different facilities may be used for different phases.

During farrowing each sow is usually confined to a "farrowing crate" large enough to permit her to stand, lie, and nurse the piglets, but not large enough for her to turn around (Figure 6); the piglets, attracted to warmth, are induced to rest in a protected, heated area to the side or front of the crate in order to reduce the risk of their being crushed by the sow. Newborn piglets have their "needle teeth" (deciduous canines and corner incisors) clipped short to prevent injuries to other piglets; they may be ear-notched or tattooed for individual identification; and their tails may be clipped short ("docked") to prevent later damage from tail biting by other pigs. Male piglets are surgically castrated, without anesthesia, to prevent "boar taint," an unpleasant odor in the meat. Piglets are usually weaned at three to four weeks of age. Recently, however, there has been a trend toward "segregated early weaning," removing the piglets earlier to an environment some distance from the sow. This isolates piglets from many disease pathogens while they are still protected by maternally derived immunity, thus reducing the risk of disease and the associated slowing of growth later in life.


T. HARTSOCK

Figure 7.
Pregnant sows are commonly housed in "gestation crates"; this technology has now been banned in the United Kingdom.

After the piglets have been weaned, the sows are bred by either natural mating or artificial insemination. During pregnancy, sows are fed a limited amount of food to prevent obesity. Formerly this was often achieved by keeping sows in groups and moving them each day into individual feeding stalls where dominant animals could not monopolize the food. Today individual feeding is usually achieved by housing sows in individual stalls or "gestation crates" for most of their


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Figure 8.
Growing and finishing pigs are usually housed in groups until they reach market weight at about six months of age.

pregnancy. To conserve space in the facility, crates provide only enough room for the sow to take about one step forward and back and not enough to walk or turn around (Figure 7). Boars are generally housed in individual pens or stalls to prevent aggression.

Market pigs are housed in groups during the growing and finishing phases (Figure 8), typically in totally or partially enclosed buildings, although they may sometimes be finished on pasture. The buildings typically have flooring constructed of concrete with slats (sections of solid floor alternating with slots that allow manure to fall into a pit below) covering some or all of the floor area. Manure is usually moved as a liquid to outdoor lagoons or sealed tanks and held for several months before being sprayed on the land. Bedding materials, such as straw, are not generally used in these liquid-manure systems.

Dairy cattle

Dairy cattle are usually housed in semi-intensive systems involving some combination of indoor and outdoor environments. According to a USDA survey, 58 percent of dairy operations pastured their lactating cows for at least three months during 1995 (USDA Animal and Plant Health Inspection Service [APHIS] 1996). About a quarter of U.S. dairy operations house cows in free-stall barns (USDA APHIS 1996); these are loose-housing systems with bedded stalls that the cows can enter and leave freely. Roughly 60 percent of U.S. dairy operations use tie-stall barns in which each cow is confined to an individual stall and held by a neck chain, strap, or stanchion such that she can lie down but cannot turn around. The stalls are usually bedded or covered with a rubber mat. The cows may be released from the stalls for milking, or they may remain in their stalls and be milked by a mobile milker. In some regions of the United States, dairy cattle are managed in "dry lot" systems (Figure 9), where several thousand cows are housed in outdoor padocks with a central parlor for milking.

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Figure 9.
In some states, such as California, milk is sometimes produced on large "dry lot dairies" housing several thousand cows.

Dairy cows are usually bred by artificial insemination. Since the cow's milk production is intended for human consumption, most calves are weaned within twenty-four hours of birth (USDA APHIS 1996). Heifers (female calves) are often raised on the dairy farm as replacement animals for the milking herd. However, about one-fifth of large operations (those with more than two hundred cows) contract the rearing of heifers to other farms (USDA APHIS 1996). When young, calves may be kept in group pens, in individual stalls that restrict movement and contact with neighboring calves, or in individual hutches or cubicles that may be associated with a small outdoor area. Male calves are generally considered a byproduct of the dairy industry. Depending on economics and local circumstances, these calves will either be killed shortly after birth or raised for meat. In the latter case, calves may be raised to an age of four months or older on a grain-based diet and marketed as "pink veal" or "baby beef," or they may be fed a low-iron, milk-based or milk-like diet, and marketed as "white" or "special-fed" veal. These calves may be kept in small groups, but white-veal calves are more commonly kept in individual stalls that limit their movement and prevent them from turning around.

To prevent injuries, dairy cattle are dehorned at an early age, usually by the use of a hot iron to cauterize the developing horn buds. Local anesthetic is used for this procedure by some growers (for example, those in the United Kingdom) but not by others. Tail docking of dairy cattle is increasingly common in Australia, New Zealand, and North America; it is usually performed by placing a tight rubber ring around the tail several inches below the base, whereupon the constricted portion of the tail dies and falls off after several days. The ostensible reason for tail-docking is to improve hygiene and udder health, but there is little evidence that docking has these effects. Docking does, however, make milking easier in milking parlors in which cows are milked from the rear.

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Figure 10.
In the United States and Canada, most beef animals are born and raised on pasture or rangeland systems and are "finished" on a grain-based diet in large feedlots.

Beef cattle, sheep, and goats

Beef cattle, sheep, and goats are usually kept on pasture throughout much of their lives. Beef cows are bred either by natural mating or by artificial insemination; embryos from preferred animals may be implanted into others considered of lower quality. Beef calves stay with their mothers until weaning at roughly seven months of age; they may then be shipped to a feedlot (Figure 10) where they are fed grain for four to six months until they reach market weight. Early weaning of beef calves (at three to four months of age), followed by feedlot finishing, is becoming increasingly common. To decrease problems with aggression and to produce more tender meat, male calves not to be used for breeding are castrated. Both surgical and nonsur-

gical castration methods are used, and all are performed without anesthesia. Beef cattle are also dehorned using several different methods and are usually individually marked by hot-iron or freeze branding. Confinement systems are uncommon for sheep and goats, although lambs are sometimes finished in feedlots or raised in cages. Sheep and goats are castrated and dehorned using methods similar to those used for beef cattle. To prevent fecal contamination of the hindquarters and subsequent infestation with flies, sheep are usually tail-docked through the use of tight rubber rings, a crushing device, or a hot knife.

Other Methods of Enhancing Productivity

While changes were occurring in animal housing and handling methods, other performance-enhancing technologies, including developments in nutrition, veterinary care, and genetic selection, came into widespread use. Vaccines, disease-eradication programs, and disease-prevention measures virtually eliminated some previously common animal diseases. Several hormone products came into use to enhance productivity. In the United States, more than 90 percent of beef cattle now are implanted with hormones or given hormones in their feed to improve their rate of gain and feed efficiency (USDA APHIS 1995a). The United States has also approved the use of recombinant bovine growth hormone (rBST) for injection into dairy cattle as a means of increasing their metabolic efficiency and boosting milk yield. In the United States in 1996, rBST was administered to approximately 10 percent of dairy cows overall and to more than 30 percent of cows on farms with more than two hundred cows (USDA APHIS 1996). An older and more widespread intervention has been the use of low dosages of antibiotics as feed additives to enhance growth; this practice has raised human health concerns about the development of antibiotic-resistant pathogens (National Research Council [NRC] 1999). In the United States during 1994, 55 percent of beef cattle and 59 percent of market hogs were given antibiotics in their feed (USDA APHIS 1995a,b). Low levels of antibiotics are included in most U.S. broiler and turkey feed rations to improve growth and feed conversion (North and Bell 1990).

Farm animals have also undergone significant changes through genetic selection for desirable production traits such as rapid growth, leanness, high milk yield, high egg production, and low feed requirements. In some sectors the use of artificial insemination has allowed males of high genetic merit for production traits to sire huge numbers of offspring on many different farms. The industrial infrastructure of animal breeding has also been evolving. For poultry and egg production, much of the primary breeding is done by a small number of companies. Instead of producing their own breeding sows, many swine producers now buy replacement breeding animals from specialized breeding companies.

These and other changes have resulted in a dramatic increase in the productivity of animal agriculture during the last fifty years. Annual milk yield per cow has doubled or tripled in most developed countries since 1950 (Putnam 1991). Broiler chickens now reach a market weight of 4 lbs. in roughly six weeks—down from twelve weeks in 1950—and they require less than 2 lbs. of feed per pound of live weight—down from 3.25 lbs. in 1950 (Gyles 1989).

By and large, these increases in productivity have not been reflected in the prices paid to farmers for their products. According to the Consumer Price Index, retail costs to consumers for meat and dairy products in the United States have increased approximately 45 percent since 1982–1984, but payments to farmers have not increased at all (USDA NASS 1999a). In some cases they have decreased; for example, farmers in the United States received an average of $74.60 for 100 lbs. of cattle marketed in 1990 but only $58.70 in 1996. Farmers have little control over the margins charged by retailers for their products, and a combination of retail price increases and low farm profit margins no doubt contributes to the pressure on producers to increase production efficiency.

Broader Social Effects

As animal production in industrialized countries has become more mechanized and more concentrated in larger units, farm structure and the sociology of rural communities has changed as well. Fewer and fewer people are directly involved in animal production. In some regions, notably the United States and some of the former Soviet countries, large corporately or collectively owned units have replaced many traditional family-owned units. These changes have been most dramatic in the U.S. poultry industry, where five companies now control 53 percent of the broiler market, and one company, Tyson Foods, alone controls 24 percent of the market (Thornton 2000). Much broiler production has become vertically integrated: birds go from hatch to slaughter under the control of one company, which uses contract labor to raise the birds to market age. For example, Tyson Foods currently produces 98 percent of its broilers under contract, in approximately 20,000 houses on over 6,000 farms, with 45.9 million chicks started per week. The egg-laying industry is less integrated, but similar trends are apparent. In the 1950s the average hen flock contained fewer than a thousand birds; now flocks of tens of thousands to millions of hens are common. Recently the average U.S. flock size for laying hens was reported to be 63,000 birds, and 17 percent of farm sites housed more than 200,000 birds (USDA APHIS 1999). Such units account for a large fraction of the market: by 1998 34 percent of the U.S. egg industry was owned by only seven companies (Smith 1998).

Other U.S. industries are following

the model adopted by the poultry industry. In the 1970s approximately one million U.S. farms raised swine (Gillespie 1998), but by 1998 that number had dropped to 114,380 (USDA NASS 1999b). This decline in the number of pig farms is expected to continue, even though the number of pigs being produced in the United States is staying relatively constant (Figure 3). Consequently there has been an increase in unit size; 77.5 percent of the 1998 U.S. hog inventory was raised in units with at least a thousand pigs (Figure 11). Approximately 40 percent of pigs are now grown by contract in the United States, compared with only 3 percent in 1980 (Martinez 1999). In contrast, much beef cow-calf production is still comparatively small-scale. Although beef cattle in the United States tend to be finished to market weight in large feedlots with more than a thousand animals, approximately half of the beef cows are on farms with fewer than a hundred cows (USDA NASS 1999b).

We have concentrated on trends in the United States and other industrialized countries, but developing nations are also seeing rapid changes in animal agriculture. China provides a particularly important example. From the early 1980s to the early 1990s, China's per capita consumption of meat increased by 8.3 percent per year, and animal production in China began to grow rapidly. Most of China's huge production of pork comes from backyard feeding operations, with 92 percent of farmers raising fewer than five pigs per year (USDA ERS 2000b). However, multinational companies are expanding into developing nations, with animal health companies like the Pharmacia and Upjohn Company building complexes and Tyson Foods investing in giant poultry facilities in China. Developing nations are likely to face difficult adjustments if and as animal agriculture shifts from small-scale labor-based systems to more concentrated, intensive systems that place heavy demands on water and electrical supplies and require reliable transportation and marketing systems. As noted by Hursey (1997), the intensification of animal production in the developing countries will result in "a plethora of interlinked problems and challenges of far-ranging significance" (ii–iii).

Animal Welfare Issues

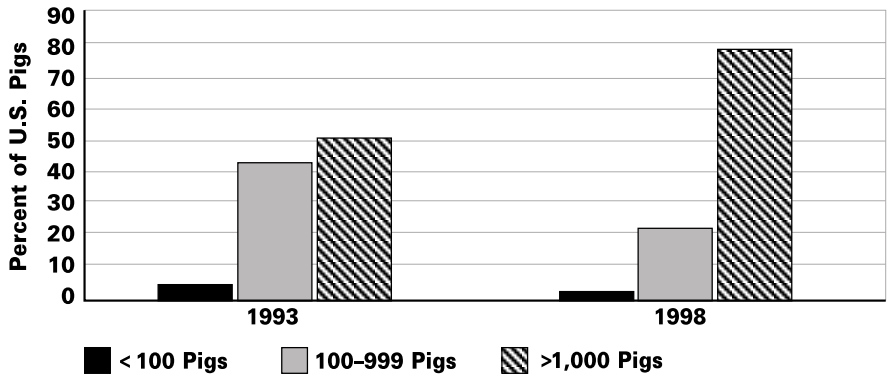
Some changes in animal agriculture have had positive effects on animal welfare. The use of indoor housing has eliminated some problems related to predation and harsh weather. Confinement sometimes has been used to prevent disease by excluding common pathogens from flocks or herds. Newer feeding technology, combined with advances in nutritional knowledge, have made it more feasible to meet animals' nutritional needs. Veterinary knowledge and technology allow vaccination, medication, and other disease prevention measures that would not have been possible a half century ago.

However, the various changes in animal agriculture have also created animal welfare problems. Some pertain specifically to the confinement of animals indoors. When large numbers of animals are confined in an enclosed space, inadequate ventilation is common. Harmful levels of respirable dust, heat stress (if the ventilation system cannot generate adequate air flow in hot weather), and irritating or dangerous gases (arising from manure in bedding or stored in pits below the floor) can result. In many confinement units, interruption of the electrical supply can cause complete failure of ventilation systems. Then heat and air-quality problems can rise to deadly levels in a matter of hours.

Agricultural buildings often use concrete as a durable, low-cost flooring material, but concrete surfaces have many possible drawbacks. Slippery concrete can cause accidents; irregular concrete seems to predispose hoofed animals to lameness; and concrete's overall hardness may stress hooves and joints. Under cool conditions unbedded concrete appears to be an uncomfortable lying surface and may disturb normal resting. Metal flooring is sometimes used as an alternative, but many of the same comfort problems remain. Poorly designed flooring in laying hens cages contributes to discomfort and foot and leg problems and can even cause the hens to become trapped.

Space in indoor units tends to be minimal. The recommended space allowance for laying hens in some countries is 60–80 square inches per hen, barely enough for the hen to turn around and not enough for her to perform normal comfort behaviors; how-

Figure 11
Changes in Farm Size in the U.S. Hog Industry, 1993–1998



Source: USDA National Agricultural Statistics Service 1999b

ever, many hens are allowed less than even that meager amount. Industry codes recommend about 8–10 square feet per market-weight pig—not much more than enough space for all animals in the pen to lie down at the same time. Commercial practice may crowd animals above this level. Amenities such as bedding to improve floor comfort or features of the natural environment such as perches and dust-baths (for hens) or nest-building material (for hens or sows) are usually omitted. Consequently, there is little opportunity for animals to engage in some of their natural behavior, and this may in time affect their health. Restricted space and barren environments may also lead to harmful behavioral abnormalities. Pigs in a restricted, barren space sometimes direct their foraging activities (rooting and chewing) to the bodies of pen-mates to the extent that they damage tails or other body parts, especially if tails have not been docked. Chickens that are not beak-trimmed may peck flockmates to the point of damaging or killing them.

Another set of problems has arisen through genetic selection for production efficiency. Typically, breeders of farm animals have exercised intense genetic selection for a small number of commercially important traits. However, if genetic selection is based on unduly narrow criteria, it can lead to significant animal health and welfare problems. Genetic selection of laying hens for high egg production and low maintenance requirements can create birds that are prone to osteoporosis because bone calcium is mobilized for egg shell formation. Selection for rapid growth in broiler chickens has led to birds that appear to gain weight too quickly relative to their leg strength, resulting in leg abnormalities and lameness. Broiler breeders, which live for much longer than do their offspring killed for meat, show the same very high levels of appetite. These birds have to be kept on restricted diets in order to prevent obesity, and aggression and abnormal behaviors are common problems, perhaps due to hunger. Among pigs some genetic lines selected strongly for rapid growth and muscle deposition show correlated increases in excitability. Such animals may develop severe, even fatal, physiological stress responses during handling and transportation.

Various other disease conditions can arise from pushing animals' body processes beyond their normal range. Dairy cattle with very high milk yields appear particularly prone to mastitis, lameness, and other health problems. Pigs fed finely ground grains, which help promote efficient feed use, are also predisposed to gastric ulcers. Fast growth in broiler chickens is associated with health problems such as ascites (pulmonary hypertension).

A number of animal management practices also raise animal welfare concerns. Some, such as hot-iron branding, castration without anesthesia, and early removal of dairy calves from their mothers, are traditional but have become controversial because of public concern about causing pain or distress to animals. Others practices, such as the tail docking of pigs and the beak trimming of hens, are controversial because they are seen as stop-gap measures masking basic inadequacies in environment or management. Transportation and management of animals after they leave the farm raise major animal welfare concerns that are covered elsewhere in this volume.

Understanding the Revolution in Animal Agriculture

Why are farm animals kept the way they are? A mix of cultural factors and technology is no doubt involved. Twentieth-century cultural values saw automation and mass production as forms of progress. Perhaps in response to rising standards of living, farmers sought to avoid the arduous and repetitive manual labor typical of more-traditional animal production systems. Retaining a reliable farm labor force became difficult as more lucrative employment opportunities arose in more mechanized sectors of the economy. The availability of antibiotics and other measures allowed large numbers of animals to be kept close together without major disease outbreaks. Moreover, for several decades agricultural research and development focused on greater productivity, efficiency, and return on investment, while paying little explicit attention to their impact on the environment, worker health, rural communities, or animal welfare.

While all these factors have likely contributed, changes in marketing and economic pressures played—and continue to play—a dominant role in reshaping animal agriculture. In earlier centuries food products made from animals, being highly perishable, tended to be produced and consumed locally. The twentieth century saw the advent of effective refrigeration, fast freezing, and other innovations in product preservation, combined with explosive growth in publicly subsidized road transportation. Meat, milk, and eggs now could be sold into ever larger markets—regional, national, even international. Producers were in effect competing against thousands of other producers, often in various regions of the world.

The resulting price competition and associated need to reduce production costs have had at least three effects. First, price competition has clearly contributed to the increase in farm size. Larger farms often enjoy economies of scale such as greater bargaining power in purchasing feed, and they can generally sell animal products at lower prices. Once larger units began to appear, other producers had to expand their operations in order to compete, even though expansion often involved greater debt and workload. In extreme cases, such as broiler production in the United States, the size of unit typically operated by a farm family ceased to be economically viable at all. Second,

production systems that avoided major costs or losses have replaced systems that failed to do so. Many sectors have changed almost universally to confinement systems where labor requirements are reduced and certain common causes of death or illness are avoided. Third, it has become difficult for producers to provide animals with certain traditional amenities. If profit per animal is sufficiently large, producers are free to provide space, veterinary care, bedding, and other amenities beyond what is strictly in the interests of profit; with very low profit margins, the time and resources that can be devoted to each animal are severely constrained.

In fact, many of the animal welfare problems commonly attributed to confinement technology may actually be problems of extreme price competition in a large market. By itself, the practice of penning sows individually during pregnancy may be a defensible way of promoting health and preventing aggression; but restricting the space allowance to a narrow, unbedded stall is a matter of economics. By itself, the use of caging to keep hens in small stable groups, separated from their excreta, may be a defensible means of improving hygiene and preventing social stress; however crowding many hens into a small, barren cage is a decision based on economics. Because confinement methods became the dominant technology during a time of increasing market competition, these methods often minimize the space and amenities provided per animal, but these negative aspects are more a reflection of market-driven economic constraints than of confinement methods themselves. This may help explain why the debate over confinement agriculture tends to run at cross-purposes. Producers defend confinement by citing the health and other benefits it was designed to deliver, while critics attack confinement by citing disadvantages to the animal caused partly by cost cutting.

Measures to Protect Farm Animals

Production Methods and Genetic Selection

One approach producers have used to address public concerns over farm animal welfare has involved returning to more traditional production methods. For example, "free-range" egg systems give laying hens access to outdoor runs as well as to indoor shelters with perches and nest-boxes; pasture systems for dairy cattle allow animals to graze at pasture during the summer months and walk to a parlor for milking twice a day; outdoor farrowing systems house sows in a field with individual huts that provide a protected area for them to give birth and raise their litters. A common public perception is that these older systems of animal production necessarily result in improved standards of animal welfare and food quality. In reality, some of these systems generate significant welfare problems of their own. For example, in the United States, where sheep are typically raised on pasture or range, predation and weather-related losses together account for about 85 percent of lamb deaths (USDA APHIS 1995c). Moreover, some traditional systems languished without research or development during a half century in which they went largely unused. If these systems come back into use, they will need to be developed and evaluated, and appropriate standards will need to be set in order to ensure that the systems meet the needs of the animals and consumers' expectations.

A second approach is to retain the advantages of confinement systems but mitigate the negative effects, partly by restoring a more traditional level of space and amenities. Some indoor farrowing pens allow a degree of freedom and comfort for the sow while providing a warm, draft-free, and protected environment for the newborn piglets. Enriched cages for laying hens keep the birds in small, stable groups (thus avoiding the social stress of large flocks) while providing amenities such as litter, a perch, and a nest-box. The European Community has announced that it intends to require all new cages for laying hens to be enriched in these ways by the year 2013.

A third alternative, still in its infancy, is to use electronics rather than physical restraint to solve certain animal management problems. For example, gestation crates for pregnant sows arose as a low-cost means of feeding sows individually to prevent bullying and over-eating by dominant animals; now, however, with computerized equipment, group-housed sows can enter an individual feeding station where they are recognized electronically and receive an assigned amount of food which they can eat without harassment. Similarly, new robotic milking systems allow cows to be kept in open pens and enter the milking station at will to be milked.

Virtually all of these approaches require research, testing, and development if they are to meet the health and welfare needs of the animals and the producer's needs for convenient, safe, and reliable production methods. Unfortunately, neither industry nor government invests significantly in such research in North America, and even in Europe the amount of research is inadequate to keep pace with the public's desire to reform animal production methods. Thus, for example, when Sweden announced its intention to ban battery cages for hens, there was substantial concern that available alternative systems were not well enough studied and developed to ensure that the ban would necessarily improve the welfare of the birds.

Partly because narrow genetic selection has contributed to many animal welfare problems, more-appropriate animal breeding can partially improve animal welfare. Broiler chickens can be selected for both skeletal soundness and production traits; this

can decrease leg problems with only a small negative effect on growth rate. Appropriate genetic selection can produce pigs that grow efficiently without deleterious reactions to stress and hens that are less predisposed to cannibalistic behavior in confinement. Use of "polled" (genetically hornless) cattle can obviate the need for dehorning. For these changes to occur, animal breeders, large breeding companies in particular, will need to be convinced to include animal welfare considerations in their criteria for genetic selection.

Economic Incentives and Policies

Many alternatives to standard confinement methods involve higher production costs, which must be offset through economic incentives to producers. Additional costs can be substantial if an alternative system involves more labor, less efficient use of feed, or greater losses through disease and death. If these problems are avoided, however, the cost of enhanced housing can be relatively small. Generally, housing is a small fraction of the total cost of animal production—compared with feed, labor, and utilities—so just a small increase in the retail price, if passed on to the producer, could support substantial housing improvements.

One way to compensate producers for using alternative systems is through labeling that identifies products produced according to specified standards or methods. The European Community has established standard definitions for alternative production methods, such as free-range eggs, which normally sell at a premium price. A more comprehensive scheme is the Freedom Foods program in the United Kingdom, originated by the Royal Society for the Prevention of Cruelty to Animals. The program requires certain standards and methods of animal production and inspects subscribing farms for compliance. The products are then eligible to carry the Freedom Foods label, which generally commands a premium price for the producer. Austria has taken a slightly different approach. There a producer-initiated program uses a numerical scoring system to assess standards of hygiene, disease prevention, animal handling skill, and appropriate housing. Producers achieving a certain overall score can use a distinctive label to identify the product. The program is credited with retaining consumer loyalty for small-scale Austrian producers in the face of lower-priced imports from countries where animal production is more intensive. As these programs grow, there may be a need for international standards and definitions in order to avoid confusion.

Some economic policies appear to mitigate farm animal welfare problems. In some countries, subsidization or price controls have kept the profit per animal at a reasonably traditional level, with the result that producers can afford to raise animals in flocks and herds of traditional size and to provide traditional levels of space, amenities, and care. In Norway, for example, price subsidies and the decision to reject free trade with other European countries have allowed small farms with high levels of care and reasonably spacious animal accommodation to remain economically viable.

The supply management system for egg production in Canada provides another example. Under free-market conditions, when egg prices are high, the greatest profit can generally be achieved by crowding extra birds into a cage system to the point of reducing their individual health and rate of lay, yet still increasing the total number of eggs produced. However, the Canadian supply management system limits the number of birds that a producer can house but does not limit the number of eggs that can be sold. The system tends to favor space allowances that maximize the productivity per bird, thus largely eliminating the incentive for extreme crowding, and the price stability created by the system has allowed smaller farms to remain viable (Figure 12).

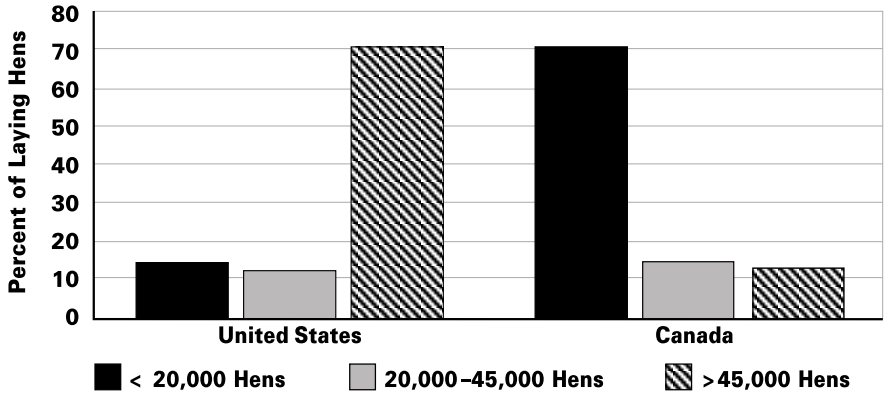
Economic incentives can also function on a smaller scale. For many years, pig producers in Alberta, Canada, have operated a system for insuring producers against the death of pigs during trucking. The premiums escalate markedly for producers who have a history of substantial claims; this incentive is credited with improving the standards of trucking and greatly reducing losses due to deaths during transportation. Incentives to improve animal welfare can also be given to workers. In several countries catching crews that load and transport chickens are given bonuses if the birds arrive at the processing facility in good condition, with few bruises or injuries, or alternatively are penalized if bruising, injury, and death exceed certain levels.

Legal Measures

At the beginning of the twenty-first century, legal protection of farm animals is in flux. Historically most animal protection laws were intended to prevent animal suffering caused by unusual and socially unacceptable behavior such as deliberate cruelty or gross neglect. Typically these provisions do not apply to suffering caused by common agricultural practices. Many Canadian provinces and U.S. states, for example, forbid the infliction of unnecessary suffering on animals but exempt "generally accepted" or "normal" farm animal management practices from this prohibition. The United Kingdom requires that captive birds in cages have enough space to stretch their wings freely, but commercial poultry are specifically exempted from this requirement.

In the late 1900s, however, a number of European countries introduced legal measures to restrict the use of controversial agricultural practices. In some cases, practices were specifically banned or regulated. Several countries now prohibit the use of battery cages for laying hens; Sweden requires that dairy cows be given access to pasture in the summer; and the United Kingdom does not allow veal calves to be kept in narrow crates. In

Figure 12
Percentage of Laying Hens on Farms of Different Sizes in the United States during 1987, and in Canada during 1986



Note: According to the U.S. Bureau of the Census and the Statistics Canada.
Source: Fraser and Leonard 1993

other cases, new animal housing systems must be approved for conformity to animal welfare standards before they can be marketed or used; Sweden, Norway, and Switzerland have such provisions. In yet other cases, codes of practice have been created that have some recognition under the law. In the United Kingdom, it is an offense to cause unnecessary pain or distress to farm animals in one's care; failure to follow established codes of practice, while not itself an offense, can be used as evidence against a defendant accused of causing unnecessary pain or distress. In other countries, such as the United States and Canada, industry codes of practice have been written, but compliance is strictly voluntary.

The United States, Canada, and many other countries outside Europe have regulations designed to protect the welfare of animals during transportation and pre-slaughter management, but not while they are being raised on farms. However, surveys in the United States suggest that public support for regulation is growing. For example, 67 percent of consumers polled said they would vote for additional government regulation of production practices (Animal Industry Foundation 1989). Seventy-one percent of U.S. citizens polled said they would vote "yes" on a measure legally requiring that farm animals be provided with living spaces large enough for animals to turn around and stretch their limbs (Decision Research 1997). In 1998 Coloradons voted 2 to 1 in favor of a statutory amendment to increase regulation of large-scale hog confinement facilities. Thus, the trend toward regulating farming practices may well spread to North America and elsewhere.

Where trade agreements require countries to accept each others' agricultural products, one country's producers can be penalized if they must follow restrictions that do not apply elsewhere. Swiss egg producers are not allowed to use battery cages, but eggs from caged hens are imported into Switzerland from countries where cages are allowed. Similarly since the ban on veal calf crates took effect in the United Kingdom, many calves from British farms have been shipped to continental Europe to be raised in crates. Nothing prevents their meat from then being sold in the United Kingdom. The need for international harmonization is clear, but international trade authorities have so far shown little inclination to provide the necessary leadership.

In fact, great uncertainty surrounds the future effects of international trade agreements on farm animal welfare. When the European Community created directives on farm animal welfare standards, it was its stated intention to exclude imports from countries that do not require equivalent standards. If this intention can be realized, then international trade might provide an incentive for raising and harmonizing standards. On the other hand, some critics fear that trade panels will disallow trade restrictions based on animal welfare considerations. In that case increased international trade will likely expand further the size of the competitive market, making price competition even more severe and imposing further constraints on the level of animal care that producers can afford to provide.

The Debate about Animal Agriculture

No contemporary account of farm animal production would be complete without mention of the acrimonious clash of views to which it has given rise. On one side are highly negative portrayals of animal agriculture, often originating from vegetarian or animal rights sources, including familiar works such as Peter Singer's *Animal Liberation* and John Robbins's *Diet for a New America*. These materials generally make six interrelated claims about animal agriculture: (1) farm animals live miserable lives, partly because of confinement production methods; (2) greed for profit has replaced traditional animal husbandry ethics in determining how animals are treated; (3) animal agriculture is now controlled by large corporations, not by individuals or farm families; (4) animal agriculture damages the environment through pollution, use of natural resources, and destruction of natural habitats; (5) animal production causes increased world hunger by consuming grain and other resources that could better be used to feed hungry people; and (6) animal products are un-

healthy for human consumers.

On the other side of the conflict are highly positive portrayals of animal agriculture, largely originating from animal producers and their organizations. These paint an entirely different picture of modern farming: (1) it is beneficial to animal welfare, partly because of the advantages of indoor environments; (2) it respects traditional animal husbandry values; (3) it is largely owned and operated by traditional farm families; (4) it benefits the environment by recycling nutrients back to the land; (5) it helps to reduce world hunger by creating food from materials not used in human nutrition; and (6) it produces safe, nutritious food.

With an activity as diverse as animal agriculture, proponents of each of these highly simplified views can cite facts and examples to support their claims, yet neither one provides an adequate or accurate description of animal agriculture. Even within a single region, animal production methods can vary from intensive systems such as layer barns to traditional ones such as cow-calf ranching. Corporate control is well established in certain sectors and regions, while families and individuals remain the dominant owners in others. Environmental impacts can be generally positive if animal numbers are commensurate with the land base and if manure is well managed; but environmental impacts can be negative if animal production is highly concentrated and environmental controls are lax.

The debate over animal agriculture, despite the polemical and often misleading way it has been represented to the public, has raised issues of immense importance. The revolution in animal agriculture during the twentieth century had, and continues to have, profound effects on farm animals, on human nutrition, on rural communities, and indeed on the global ecosystem; moreover, the changes have taken place with remarkably little informed public debate or comprehensive policy development. There is an urgent need for careful analysis to understand the effects of the revolution in animal agriculture, to identify better and worse options, and to allow informed consensus building to guide future developments.

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