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The Welfare of Animals in the Pig Industry

An HSUS Report: The Welfare of Animals in the Pig Industry

Abstract

The discordance between the behavioral needs of pigs and the life afforded to those raised commercially for the meat industry has created many animal welfare problems. Methods of pig production have changed substantially over the last several decades, and industrialized confinement operations have largely overtaken small, diversified farms. Overcrowded in indoor, barren environments, pigs in commercial production facilities are offered little opportunity to display their full range of complex social, foraging, and exploratory behavior. Behavioral abnormalities, such as tail-biting and aggression, arise due to environmental and social deficiencies. Poor air quality and intensive confinement may lead to health problems, and the lack of individualized attention to each animal compromises their care. Handling and transport for slaughter are highly stressful procedures, and some pigs become so fatigued, injured, or sick that they become nonambulatory, unable to stand and walk on their own accord. Each one of these issues is a significant animal welfare problem in need of immediate redress.

Introduction

Pigs first became used in agriculture when wild boar were domesticated, approximately 9,000 B.C.E.[1] They were introduced to what is now the continental United States beginning in the 16th century by colonists to the New World,[2] and wild and feral pigs now roam the southern and southeastern regions, California, and Hawaii, inhabiting forest, scrub brush, and grassland in areas often close to watering holes. Studies of pigs in natural, unrestricted environments have revealed that they display a rich behavioral repertoire, and have a well-defined social structure. They commonly segregate into small groups, but some pigs, particularly adult and sub-adult males, may be solitary.[3] Pigs build nests in which to rest by selecting a secluded area and collecting grass and small branches.[4,5] Because they have few sweat glands, pigs wallow in mud, using its cooling properties to help them regulate their body temperature.[6] Pigs are omnivores and choose to consume a varied diet of grass, roots, mast (forest nuts, such as acorns), and sometimes earthworms, crustaceans, and insects.[7] Wild boar can live to be 21 years old.[8]

Until the 1960s, in the United States, farmed pigs were typically raised in extensive systems, on diverse, small- and medium-sized operations,[9] where they were kept on pasture, in dry lots, or with portable housing.[10] When given access to pasture, the animals were provided with small, movable shelters or a centralized barn.[11] Approximately 4,000 m^2 (1 acre) of pasture was provided for every 20 pigs,[12] allowing ample space for the display of most of their natural behavior. Piglets were born twice a year, usually in the fall and in the spring.[13] Straw was used for bedding, providing comfort and warmth.

In contrast, changes in animal agriculture over the last half of the 20th century have drastically altered farming practices and management, and, subsequently, the welfare of domesticated pigs. On the large, commercial operations that are now the norm in the U.S. industry, pigs are primarily confined indoors in industrialized facilities. Pigs raised in these systems are no longer able to exhibit important natural behavior, such as rooting, wallowing, nest-building, and foraging, and are unable to segregate into natural social groups. Scientists have noted that pigs, like other domesticated animals,[14] retain the basic behavioral repertoire of their wild counterparts, despite being domesticated and confined on industrialized facilities.[15]

Industrial Production

Since the mid-20th century, small, extensive farms have given way to massive, commercial pig production facilities.[16,17] Large, more specialized indoor operations benefit from economies of scale.[18] In the 1990s, "megafarms"—those with more than 10,000 breeding sows (female pigs) in one location—became the dominant production type, confining 30% of all sows in the United States and 40% of all pigs raised to slaughter weight.[19] Smithfield Foods, the largest pig producer in the United States[20] and globally,[21] keeps more than 1.2 million breeding sows, and the next six top companies have more than 100,000 sows each.[22] In 2009, 113.6 million pigs were raised and slaughtered in the United States.[23] Most of these animals are now born and reared intensively in total confinement operations.[24]

The U.S. Census of Agriculture has tracked the number of animals in pig production by the size of the farming operation since 1978. The number of pigs on medium and large operations (those with 2,000 or more animals) has increased steadily, while those raised on small farms (with less than 100 animals) has decreased over the same time period. As of 2007, there were 20 times as many animals on large operations as there were in 1978.

Year	Number of pigs on farms by size of operation[25]		
	1-99 animals	2,000-4,999 animals	5,000 or more animals
1978	7,947,891	3,992,352	1,990,334
1982	5,083,390	5,432,777	2,733,808
1987	3,741,412	6,733,228	4,241,035
1992[26]	2,608,659	8,761,931	9,764,054
1997[27]	1,170,630	12,752,495	24,577,941
2002[28]	775,157	13,798,995	31,715,604
2007[29]	622,032	16,532,918	40,793,750

Customarily, the pig production cycle begins with the breeding of the sow, either naturally or by artificial insemination. After a 114-day gestation (pregnancy) period, mother sows farrow and nurse their piglets for 2-4 weeks before the litters are prematurely weaned.[30] Following the nursery phase, during which the young animals reach 18.1-27.2 kg (40-60 lb) by approximately 8-10 weeks of age, the young pigs are moved to different facilities for "growing" and "finishing."[31,32] They are considered to be in the growing stage until they reach 54.4 kg (120 lb),* at about 3 months of age, and then are in the finishing stage until they reach market weight of 108.9-122.5 kg (240-270 lb),[33] at approximately 6 months of age.[34]

Overcrowding

Pigs on commercial facilities are raised in much smaller spaces than they would normally occupy if permitted to roam freely. Radiotelemetry studies have reported that feral pigs sometimes travel several kilometers (miles) each day.[35] In observations of foraging behavior of domestic pigs in large, outdoor enclosures, members of social groups averaged 3.8 m (12.5 ft) from their nearest neighbor, while herds foraged 50 m (164 ft) or more apart.[36] In contrast, the average space allowance for a pig in a growing/finishing facility is 0.7 m^2 (7.7 ft^2).[37]

Wild and feral pig social groups are small herds composed of both young and adult animals, usually with 2-4 adults,[38,39] but in confinement operations, the typical recommendation is to keep pigs in group pens holding up to 30 animals,[40] some with approximately 1,000 animals under the same roof.[41] Some producers are

* For purposes of this report, the term "hog" will not be used to refer to pigs who weigh more than 54.4 kg (120 lb), as this industry term is not necessarily convention in the scientific literature.

experimenting with even larger group sizes, with 150-400 or more pigs in one pen.[42] Commercial pig producers often sort animals by size,[43] without regard to family group[44] or previously formed social bonds.

Lack of space and the artificial group structure imposed on intensively confined pigs can negatively influence social interactions. When pigs are sorted into new groups, fighting sometimes occurs, and although serious injuries or death are rare, they can result, especially when one pig is singled out by multiple aggressors.[45] When space is limited, submissive and flight reactions may be less effective in the establishment of social dominance.[46] In contrast, when given ample room, herds usually distance themselves, simply avoiding situations that would lead to aggression and thereby minimizing the frequency of antagonistic interactions.[47,48]

Although animals in any type of production system can suffer from health problems, the dense population of closely confined animals in industrial operations facilitates the transmission of disease.[49] For pigs in the fattening stage of production, respiratory and enteric diseases are common infectious disorders.[50] In fact, one veterinary text book notes that "under commercial conditions few pigs can be expected to reach slaughter weight without contracting some sort of respiratory lesion."[51] In contrast, another popular textbook notes that for pigs in their wild state, "diseases and parasites were almost unknown" due to the "roving nature" of naturally occurring pig populations.[52]

Barren Environment

Pigs are naturally active and inquisitive and have a well-developed exploratory drive.[53] In more natural environments, they spend the greater part of the day collecting and manipulating food items. Behavioral studies have reported that pigs in a forested enclosure occupy more than 50% of their daily time budget with foraging-related activities.[54] In the absence of enriched, interesting surroundings in industrial production facilities, pigs often redirect their natural curiosity to pen fixtures and pen mates. They may begin to nose and bite each other, or simply spend more time inactively.[55,56] Inactivity and unresponsiveness are particularly frequent in confined sows,[57,58] and are indicators of poor welfare associated with lack of stimulation and boredom.[59] Scientists have suggested that artificial environments, such as those found on commercial confinement operations, engender apathy, frustration, and an "enduring sense of boredom."[60,61]

Disharmony between an animal and the environment can also lead to an outbreak of abnormal tail-biting behavior.[62] Tail biting typically starts with one pig playing with, sucking, or chewing on the tail of a pen-mate. Tail-directed behavior can then escalate as tail-biting victims are chased and their tails are further damaged.[63] Not only is tail biting acutely painful, but it can result in injury to the tail base, abscess, and systemic infection.[64,65,66] In severe cases, the hind quarters may be bitten and tail biting can escalate into cannibalistic behavior.[67] To prevent tail biting, the tails of newborn piglets are usually cut off shortly after birth and without any pain relief. When tails are docked too short, pigs may resort to biting the ears of their pen mates instead.[68] Although the behavior is multifactorial and caused by a variety of inter-related elements, many studies have demonstrated that providing straw and other enrichments, e.g. additional space and rooting and nosing substrate, including peat[69] or spent mushroom compost,[70] would largely reduce or even prevent tail-biting behavior.[71,72,73,74,75,76,77]

Ear hematomas are broken blood vessels and bleeding under the skin of the ear. One cause is biting by pen mates. While lancing the wound and bandaging is the most effective treatment, some producers amputate the ear instead by using an elastic band to restrict circulation to the ear.[78] Such "solutions" are not only animal welfare concerns, but fail to address the environmental inadequacies that lead to such problems in the first place.

Bare, Concrete Flooring

Indoor operations are characterized by concrete, slatted floors and steel fixtures.[79] Slatted floors facilitate manure handling—animal waste falls through the flooring into a deep pit below, where it is collected under the facility and often subsequently transferred to an outdoor holding area, such as a lagoon. Bedding, such as straw, is usually eliminated in indoor operations due to cost, difficulty of cleaning, and incompatibility with slatted floors.[80]

Pigs can suffer from lameness and a variety of foot problems, therefore the surface on which they are kept is a key feature affecting their welfare. The initial introduction of slatted floors in production facilities led to hoof disorders such as foot lesions.[81] Although many factors can cause locomotory problems, poorly maintained or slippery flooring are still common causes of physical injuries.[82] In a British survey of indoor and outdoor pig farms published in 2008, pigs allowed outdoor access had a lower prevalence of foot and limb injuries, while those confined indoors on hard, slatted flooring customary in industrial pig production had more bruising, calluses, locomotion problems, and "adventitious bursae,"[83] accumulation of inflamed, fluid-filled, saclike structures between tendon and bone. It has been long-established by scientific preference testing studies that pigs prefer earthen floors over concrete.[84,85]

Gestation Crate Confinement

Pregnant sows are commonly confined to gestation crates,[†] small cages that typically measure 0.6 m (2 ft) wide by 2.13 m (7 ft) long.[86,87] Gestation crates restrict normal postural adjustments and are so narrow that they prevent the sow from even turning around.[88,89]

Gestation crate confinement negatively affects the health and welfare of breeding sows. The restriction of movement and lack of exercise can lead to a reduction in muscle weight and bone strength, making the most basic movements difficult and increasing the probability that the sow will slip and incur physical damage.[90] These restricted animals also have higher basal heart rates, suggesting they are less fit than sows allowed to exercise.[91] They can experience soreness and injuries from rubbing against the bars of their enclosures and from standing or lying on barren flooring,[92] and have a higher rate of urinary tract infections,[93] due to their inactivity, decreased water consumption, and infrequency of urination.[94]

Crated sows also suffer from psychological problems, as evidenced by abnormal behavior. Stereotypies are repetitive behavioral patterns induced by repeated coping attempts, frustration, and/or brain dysfunction,[95] and they are common in captive animals confined in barren or restrictive conditions.[96] Common stereotypies of crated sows include bar-biting (on the crate that confines them) and sham-chewing (with nothing in their mouth).[97] In addition, crated sows tend to become unresponsive over time,[98,99] a behavioral disorder scientists have linked to depression.[100]

Poor Air Quality

Odors, dust, and noxious gases, including ammonia, hydrogen sulfide, and methane, emanate from industrial confinement farming operations due to decomposing animal waste.[101,102] Prolonged ammonia exposure above 35ppm has been found to cause a physiological immune response in pigs, including increases in monocyte, lymphocyte, and neutrophil cell counts.[103] Although a maximum concentration of 25 ppm is recommended for safety,[104] in pig production buildings with poor environmental control, ammonia concentrations may exceed 30 ppm.[105] Studies have shown that juvenile pigs can detect and will avoid atmospheres that contain ammonia, even at concentrations as low as 10 ppm, and that they prefer fresh air.[106,107,108] High ammonia concentrations are known to suppress pigs' activity levels.[109]

Poor air quality is also caused by dust. Dust in pig production facilities is biologically active and distinct from ordinary dust, such as field dust, because it contains hazardous agents such as fungi, endotoxins, and bacteria. Sources of dust include feed particles, dander, and fecal material.[110] When fecal material dries, the fine, aerosolized dust particles become inhalable.[111] Dust and gases in pig confinement operations can have serious

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[†] For more information, see "An HSUS Report: Welfare Issues with Gestation Crates for Pregnant Sows" at www.humanesociety.org/assets/pdfs/farm/HSUS-Report-on-Gestation-Crates-for-Pregnant-Sows.pdf.

consequences for the health of people and pigs, including pulmonary disease of workers,[112,113] and pneumonia, pleuritis, and increased neonatal mortality of pigs.[114]

High concentrations of ammonia and dust can reduce the ability of pigs to resist bacterial infections, including infectious atrophic rhinitis. This disease of pigs is caused by bacterial infection of the upper respiratory tract and is characterized by severe and persistent inflammation of the nose that can cause distortion of the nasal bones and, in severe cases, can lead to facial deformity. Atrophic rhinitis is more severe when pigs are raised in environments with high concentrations of dust and ammonia.[115] Poor air quality may also lead to other diseases, including enzootic pneumonia, porcine reproductive and respiratory syndrome (PRRS), and swine influenza.[116] For growing pigs, the majority of deaths are due to respiratory problems.[117]

Lack of Individual Care

New technologies and increased mechanization, such as automated feeders and waterers, coupled with economic pressure to decrease the amount of time staff spend on each animal,[118] have reduced the amount of labor used to operate animal production facilities such that fewer workers now tend to more animals. As such, individualized attention to each animal is generally lacking.[119,120] Indeed, with the use of efficiencies in pen and barn design, one person may be responsible for the care of 8,000 pigs per day.[121]

On both large and small farms, workers can become desensitized to animal suffering, particularly if they are overworked or accustomed to the regular presence of sick and dying animals. Conflicting labor demands can compete for employees' attention and, depending on the level of priority assigned to caring for compromised animals, sick and injured individuals may go untended.[122]

Selective Breeding Problems

Breeding programs for pigs focus heavily on production traits, such as growth rate, feed conversion efficiency, and carcass leanness.[123] Although market weight is typically 113-118 kg (240-270 lb),[124] by keeping pigs longer and selecting for lean weight gain, the industry is moving toward heavier slaughter weights, averaging closer to 136 kg (300 lb).[125] Beginning in the 1990s, "ultralean hybrid" pigs became more common.[126]

Selectively breeding pigs for rapid growth and leanness has led to behavioral and health problems. Porcine stress syndrome (PSS) is an unintentional consequence of genetic selection within the industry for rapid growth of a lean, muscular carcass.[127,128,129] Pigs who have the specific genetic condition associated with PSS are highly sensitive to stress. Affected pigs may exhibit dyspnoea (difficulty breathing), cyanosis (discoloration of the skin), and have elevated body temperature when they become stressed during handling and transportation.[130] These pigs can suffer heart attacks when they become excited[131] and are at a much higher risk of mortality.[132,133] It has also been observed that very lean hybrid pigs are much more excitable and reactive, and more likely to balk, which causes handling problems when they are moved and transported for slaughter.[134] Selection for leanness may have also predisposed certain pig breeds to abnormal tail-biting behavior.[135,136]

Unnatural Feed

Pigs' stomachs are biologically designed for small amounts of high fiber feedstuffs.[137] However, in industrial confinement production, pigs have little access to roughage.[138] Finely ground or pelleted, low fiber diets can cause gastrointestinal acidity and mucosal damage,[139] leaving pigs prone to gastric ulcers.[140,141,142] The incidence is highly variable, but veterinarians report that the number of cases has increased with the intensification of pig production and may be due in part to the associated stresses of confinement, crowding, the emphasis on feed efficiency and digestibility, and thus the use of finely ground rations.[143,144] Reports vary widely, with incidence between operations ranging from 0-60% of pigs showing distinct signs of ulceration.[145,146,147,148] In one study of the effect of finely ground feeds on ulcer incidence, 53% of pigs already had signs of ulceration and five pigs had bleeding ulcers before the experiment even started, when pigs were just 30 kg (66 lb).[149] In severe cases, pigs may suffer from gastric hemorrhage, bleeding into the stomach, and sudden death.[150,151] The industrial production systems in which most pigs are kept seems to have a large impact on the incidence of these ulcers, as pigs with access to straw, sawdust, or outdoor paddocks have fewer ulcers than those confined on bare, solid or slatted concrete floors.[152,153,154,155]

Growing/finishing pigs in the United States are fed *ad libitum* and reach market weight at an earlier age than those in Europe, where pigs are fed a more limited grain ration. This unrestricted access to feed for pigs who are genetically selected for weight gain is a welfare concern, as it has been implicated as a possible reason that pig mortality rates are higher in the United States compared to some European countries.[156] The welfare conundrum created by this situation could be addressed by reducing emphasis on weight gain in breeding programs.

Feed Additives

Feed additives are routinely added for many reasons, including increased growth rate and improved feed utilization. There are many different classes of feed additives, such as anthelmintics (dewormers), zinc oxide, copper compounds, and probiotics. Pigs are also fed antibiotics and other drugs. The use of antibiotics may improve the welfare of pigs in industrial production, because they can reduce morbidity and mortality,[157] but nontherapeutic use can mask management issues.[158] Further, the agricultural use of important classes of antibiotics used in human medicine may lead to the emergence of antibiotic-resistant pathogens such as *Campylobacter*, *Salmonella*, *E. coli*, and methicillin-resistant *Staphylococcus aureus* (MRSA).[‡]

Recombinant bovine somatotrophin, rBST (also referred to as bovine growth hormone), is a genetically engineered hormone injected into dairy cows to increase milk yield.[159] Unlike cattle in the dairy industry, it is not economically feasible to regularly administer injectable growth hormones to pigs.[160] However, finishing pigs may receive ractopamine—a drug belonging to a class of compounds structurally resembling epinephrine (adrenaline) and norepinephrine, which are naturally occurring hormones—as a feed additive.[161]

Emerging research from Purdue University has demonstrated that ractopamine use is concerning from an animal welfare standpoint.[162,163,164] Ractopamine is a beta agonist; its metabolic effect is to repartition nutrients away from fat, moving them instead toward lean tissue. It is also used because it mobilizes body fat, improves feed efficiency, increases growth rate, and results in a leaner carcass.[165] In a series of studies, pigs "finished" with ractopamine have shown increased impulsive aggression,[166] more abnormal behavior,[167] and difficulty walking.[168] In the first study, published in 2003, pigs finished with ractopamine had elevated heart rates and catecholamine concentrations, were initially more active and more difficult to handle, and had increased stress reactions in response to transportation. These animals showed a marked increase in the number of pats, slaps, and pushes stockpersons used on them because they were difficult to move. The scientists stated that reluctance to move may leave pigs more likely to be subjected to rough handling during loading and unloading, for example.[169] Observations at slaughter plants corroborate the additional finding that difficulty walking due to ractopamine may contribute to a greater incidence of nonambulatory (or "downed") pigs, those too weak to stand and walk on their own accord.[170,171] Additionally, a 2009 publication reported that pigs fed ractopamine had a greater frequency of front and rear hoof lesions.[172]

Inhumane Handling

In commercial pig confinement operations, the animals are largely unaccustomed to novel experiences and unfamiliar places, so moving them between production sites or onto a transport truck can be difficult for both pigs and handlers. If the pigs have not previously experienced regular, gentle human handling, they may fear people and become flighty and nervous when they come into human contact.[173,174]

[‡] For more information see "An HSUS Report: Human Health Implications of Non-Therapeutic Antibiotic Use in Animal Agriculture" at www.hsus.org/web-files/PDF/farm/HSUS-Human-Health-Report-on-Antibiotics-in-Animal-Agriculture.pdf.

Apprehensive pigs entering a new environment may be reluctant to move, especially given the physical exertion that may be required to navigate alleyways, ramps, and truck interiors. There are many different tools available as driving aids, but handlers often make excessive use of electric prods (or goads),[175] a device that delivers a high voltage electric shock. These are more commonly used in poorly designed facilities or by stockpersons with little training in animal handling. Despite industry-wide recognition that electric prods are stressful for pigs, their use remains widespread.[176]

A more humane device for herding pigs forward is the sorting board, a large, rectangular plank slightly narrower than the width of the aisle through which pigs must walk. The handler stands behind the board, holding it by grips on each side, and walks forward, encouraging the pigs to move without use of force, electric prodding, or other more aversive means.[177] Although use of the sorting board is thought to achieve higher welfare, at least one study found no difference in heart rate (a measure of stress) among groups of pigs moved with a variety of tools, including an electric prod and sorting board.[178]

Scientists studying the transport of pigs have observed that as handling crews become fatigued after loading several trailers with pigs, they may become more aggressive in their attempts to move the animals. This has been proposed as an explanation as to why the number of nonambulatory pigs identified on-farm during loading for transport is positively correlated with the load number of the day.[179]

Willful acts of abuse and cruelty to pigs by workers have been documented. Video of mistreatment in recent years, including footage of several employees at a North Carolina pig breeding facility dragging and beating animals in 2007,[180] and employees at an Iowa breeding facility kicking and hitting sows with a metal rod, among other abuses in 2008,[181] have helped expose cases of deliberate cruelty to pigs. It is unknown how common these specific acts of violence occur throughout the industry.

On-Farm Killing

When animals become sick or injured and their pain and suffering cannot be controlled, or if producers do not deem treatment to be cost-effective, the pigs are sometimes killed on-farm.[182] Euthanasia is defined as killing an animal in a humane way for his/her own benefit.[183,184] Achieving true euthanasia—i.e., killing the animals in a humane way in order to end their suffering—can be challenging. Acceptable methods, according to the National Pork Board and the American Association of Swine Veterinarians, include gunshot, penetrating captive bolt gun, anesthetic overdose, and electrocution.[185] In one highly publicized incident, however, an undercover investigator videotaped an Ohio producer killing sick pigs by hanging, lifting them by a chain around their neck using a forklift.[186] This is certainly not euthanasia or humane killing. Killing is not always performed in a timely manner, and pigs who should be killed are sometimes left to languish, over the weekend for example, depending on staff availability and the facility schedule.[187]

Transport

Young pigs may be transported from farrowing operations in Canada, North Carolina, or other states to the Midwest for feeding[188] during the growing and finishing stages of production. When pigs reach market weight, they are transported from the finishing facility to the slaughter plant. Loading onto a truck, the subsequent journey, and unloading are stressful[189] and sometimes traumatic[190] events. Although conditions for each trip vary, pigs can experience a range of stressors, including potentially rough handling, unfamiliar surroundings, frightening situations, social stress (e.g., regrouping with unfamiliar individuals, which may lead to fighting),[191] crowding, temperature extremes, changes in acceleration, and vibration due to motion.[192,193,194]

Before the journey begins, the welfare of pigs may be poor during handling and loading. Long loading distances from the finishing shed to the transport trailer can lead to physical indicators of stress, such as open-mouth breathing and skin discoloration.[195] Climbing a loading ramp is more difficult for pigs compared to other farmed animals.[196] Steeper ramps cause an elevation in heart rate[197] and require more time to climb.[198] Pigs may become injured or bruised as they are loaded due to fighting among newly mixed pigs or abrasion from forceful contact with the walls of enclosures.[199,200] If pigs are loaded too quickly, there is a greater chance of subsequent mortality, an outcome that scientists have postulated may be a consequence of poor animal handling.[201]

Feed and water may be limited or withheld for 16-24 hours in preparation for transport of pigs to slaughter.[202] This practice is observed for many reasons, including to prevent pigs from vomiting due to motion sickness, to reduce the risk of puncturing the intestines during evisceration, because pigs who have full stomachs are more likely to die during transport,[203,204,205] and to reduce feed costs as the final feeding will not be assimilated prior to slaughter.[206] As a result, pigs experience hunger, dehydration, and accompanying stress and fatigue in response to nutrient withdrawal.[207]

During the journey, the comfort and postural stability of animals may be affected by the driver. Sudden breaking and acceleration, as well as turning rapidly, can cause animals to experience horizontal load forces of 20-33% of their own body weight, stress, and possible injury due to falls.[208] Pigs may experience motion sickness during the journey and retch while the truck is in motion.[209,210,211]

Transport may cause so much stress that animals experience physiological consequences that manifest in meat quality changes, an important economic concern to industry. Pigs in transport are prone to glycogen depletion of muscle, which is associated with fatigue, and a condition industry terms "dark, firm, and dry" (DFD) meat.[212] Rapid muscle acidification associated with pre-slaughter stress can lead to "pale, soft and exudative" (PSE) meat.[213,214]

Genetic differences may predispose pigs from certain breeding lineages to become more excitable during handling.[215] Pigs with porcine stress syndrome have increased stress susceptibility, often producing PSE meat.[216] They are also at a greater risk of experiencing severe distress and death during transport.[217,218] However, advances in technologies capable of identifying and eliminating the gene responsible for extreme cases of PSE are thought to have greatly reduced the incidence and severity.[219]

The temperature both outside and inside the truck trailer can affect the comfort and welfare of pigs during transport. Compared to the ambient temperature outside, temperatures inside the trailer will generally increase during loading, while the truck is not moving, and decrease when the vehicle is in motion.[220]

Pigs are susceptible to heat stress.[221] They are particularly intolerant to heat because they lack functioning sweat glands. Pigs naturally use behavioral means to cool themselves, such as wallowing in mud, if allowed to do so, but when confined to a transport vehicle, they are unable to thermoregulate behaviorally. Compounding these factors are the effects of transport stress, which can alter heat production, and dehydration due to lack of water.[222]

Studies of typical ambient conditions in North America as they relate to pig welfare during transport are limited.[223] Although a 2005 study replicated over several seasons found no correlation between trailer temperature and mortality, when average trailer temperature varied between 2.6-24.0°C (36.7-75.2°F),[224,225] studies in other countries have demonstrated that warm environmental conditions can be dangerous to animals. Published in 1994, a major survey of pig transport in England found that the effect of heat was detrimental, with a substantially higher mortality when pigs were moved while outside temperatures were above 15-17 0°C (59-62.6°F).[226] A 2008 survey of 739 journeys to 37 different slaughter plants in 5 European countries found that the risk of mortality increased as the average temperature during transport rose to the highest temperature recorded in the study, 39°C (102.2°F).[227] High temperatures[228] and summer transport[229] can also increase the occurrence of PSE meat. These problems can often be avoided by transporting the animals at night when temperatures are lower.

Humidity can lower the temperature at which animals will begin to experience heat stress, because it limits evaporative heat loss,[230] effectively amplifying the effects of high temperature. A 2008 study noted that "total losses" (including dead and nonambulatory animals) increase with the temperature-humidity index as well as with the stocking density of the transport trailer.[231]

Extremely cold conditions are also detrimental. Higher incidences of DFD carcasses[232] and nonambulatory pigs have been found in winter months.[233] Wind chill causes the temperature in a moving truck to drop considerably below the outside ambient temperature. If pigs become wet due to freezing rain, the situation can become fatal.[234]

While many journeys are short (less than 300 miles),[235] animals used for agricultural purposes are increasingly being transported over longer distances[236] due to movement of young pigs across state lines for feeding in the Midwest[237] and to concentration of the slaughtering industry into fewer, larger plants.[238] There is concern that a disease causing organism could potentially travel thousands of miles between farrowing and finishing before infected pigs would be discovered.[239,240] Fatigue from long-distance transport takes a physical toll. Longer transport times are associated with a greater risk of DFD meat[241] and are correlated with the number of dead-on-arrival (DOA) pigs.[242,243] This may be particularly relevant if the long journey is undertaken in warmer temperatures, in excess of 15°C (59°F).[244]

Upon arrival at the slaughter facility, some pigs are too sick, injured, stressed, or fatigued to walk on their own accord. Others do not survive the trip. Estimates of the number of DOA pigs in the United States range from 0.23-0.25%.[245,246] Scientists have suggested that about 1% of all transported pigs arrive at slaughter plants either dead or nonambulatory due to injury, fatigue, or illness,[247] an approximate figure that was corroborated in a 2008 study of more than 12,000 trailer loads of pigs transported to a slaughter plant in Iowa. This study found that a total of 0.85% of pigs arrived nonambulatory (0.60%) or dead (0.25%).[248] If the trailer loads in this study are representative of other pigs in U.S. transport, then of the 113.6 million pigs slaughtered in the United States in 2009,[249] over 681,000 pigs arrived nonambulatory and 284,000 arrived dead at slaughter facilities.

A number of interacting factors are thought to cause these deaths during transport, including environmental conditions, loading distances at the farm, specific handlers and drivers, and waiting times at the slaughter plant.[250] Pigs who have died during transport often show cardiac dilation, possibly from cardiac failure associated with stress.[251] Because the mortality rate is partially determined by transport conditions, it is an indicator of welfare for all pigs on the trip, even those who survive.[252]

Downed Pigs

Pigs may become nonambulatory if they are too sick or injured to stand and walk on their own accord, but many also become downed without obvious signs of illness or physical trauma, and these downed pigs are said to suffer from "fatigued pig syndrome."[253,254] The welfare of downed pigs is a serious concern, and their treatment and handling are critical.

A 2008 study found that nonambulatory pigs can be affected by a number of different health problems, and the prevalence of these problems may differ amongst slaughter plants. Conditions affecting downed pigs include ascarid (worm) infection, respiratory disease, liver damage, ulcers, subtle bone injury, and feet and leg problems. One factor or a combination may be involved. Changes in leukocyte percentages and albumin concentrations suggest that nonambulatory, non-injured pigs often suffer from active infections, and higher creatinine and blood urea nitrogen (BUN) concentrations are possibly due to kidney dysfunction. Both factors may contribute to pigs becoming nonambulatory during transport.[255]

In the same study, downed pigs were also found to have higher aspartate aminotransferase (AST) and alkaline phosphatase (ALP) concentrations. AST is an enzyme of the liver that is released into the bloodstream when the heart or liver is injured. ALP, also an enzyme, is found in the intestines, liver, bone, and kidneys. When these organs are damaged, ALP may leak into the blood. The increased AST and ALP concentrations may indicate damage to the liver or bone, and the study scientists suggest that this could be due to "slight bone injuries or fractures."[256]

There are a variety of factors that increase the risk of a pig becoming a downer. The trend toward raising the animals to heavier final body weight has been implicated as one likely cause.[257] Older sows are also more likely to become nonambulatory, due to the metabolic demand of lactation and traumatic or infectious arthritides.[258] The time pigs spend on the truck at the production facility and the unloading time at the slaughter plant are also important factors affecting their mobility.[259]

In a 2005 study of 74 trailer loads of pigs from two different finishing sites in the United States, 0.26% of pigs were found to be nonambulatory at the farm and 0.85% were nonambulatory by arrival at the slaughter plant. Of the 74 loads, 65 were further evaluated at the plant, and it was determined that 0.24% of pigs in those loads were nonambulatory due to injury and 0.55% were downed but not injured.[260,261] In another study, scientists estimated that the rate of fatigued pig syndrome is 0.3% of all pigs transported.[262] A 2008 study reported the incidence of "fatigued" pigs at 0.55% and the incidence of injured pigs at 0.05% per trailer.[263]

Slaughter

Following lairage at the slaughter plant, the pigs are moved through a series of chutes into position for stunning. The federal Humane Methods of Slaughter Act requires that all pigs must be rendered insensible to pain before being "shackled, hoisted, thrown, cast, or cut."[264] Pigs are usually rendered insensible prior to slaughter with the use of a captive bolt gun, an electric current, or by carbon dioxide (CO_2) gassing. A captive bolt gun fires a steel bolt powered by gun powder or compressed air into the forehead of the pig, causing concussion.[265,266] If an electrical method is used, current is applied using stunning electrodes (tongs) placed on both sides of the head, so that the current runs through the brain.[267] In plants where CO_2 stunning is used, groups of pigs are lowered into a gas-filled chamber until they become unconscious.[268] After being rendered insensible using one of these methods, the pig is shackled and hoisted by a hind leg. The pig is "stuck" with a knife, just below the point of the breast bone, severing arteries and veins, and the pig then dies from exsanguination (blood loss). The pig's body is then conveyed to a scalding vat, where 65.6°C (150°F) water loosens the hair in preparation for processing of the carcass.[269] All stunning methods depend on good equipment maintenance, personnel training, and proper use to be effective to full potential.[270,271]

The adequacy of stunning methods at producing unconsciousness (and insensibility) has been elucidated in laboratory studies using electroencephalogram (EEG) recordings and other neurological measures. Studies using cattle and sheep have demonstrated that the captive bolt gun is capable of producing an immediate, unequivocal stun based on electrical activity recorded in the brain.[272,273,274] When correct amplitude, frequency, and wave form is used, electrical stunning is also effective—EEG recordings show epileptiform activity,[275] a state associated with unconsciousness in humans.[276,277] CO_2 stunning, however, is not instantaneous, and neurological measures in a 2008 study reported that it took 60 seconds for pigs to become unconscious when lowered into a pit under commercially simulated conditions in the laboratory.[278] CO_2 is an acidic, pungent gas[279,280] that can induce severe respiratory distress.[281,282] As such, its use is thought to be aversive to pigs at high concentrations and is questionable on animal welfare grounds. The inert gas argon does not lead to the period of poor welfare before death that occurs when carbon dioxide is used for stunning. Gas stunning in well designed conditions allows better handling of animals and improves pre-stun welfare compared to electrical stunning.[283]

Immediately after an animal is rendered unconscious or is stuck, vigorous convulsions may occur.[284,285] Unconscious pigs may kick while hanging on the line, which can be misinterpreted as an ineffective stun.[286] Convulsions may occur because higher brain centers that have been rendered dysfunctional are no longer able to inhibit spinal reflexes.[287] Neurological recordings confirm that animals are unconscious if properly stunned.[288,289] However, it is not completely clear whether muscular movements that occur during CO2 stunning are reflexive, convulsive activity of unconscious animals, or if they are conscious attempts to avoid the gas. Some studies conclude the former,[290,291,292] while others find the latter may be true.[293,294,295]

Since 1999, there have been marked improvements in the welfare of both pigs and cattle at slaughter in major segments of the industry, in large part due to the work of Temple Grandin, professor of animal science at

Colorado State University and renowned designer of farm animal handling facilities world-wide. Grandin developed an objective scoring system to implement audits of slaughter plants supplying pork and beef to major retailers.[296, 297] In commercial practice, it can be difficult to correctly place electric stunning tongs, which should make contact with the pig between the eyes and the base of the ears on both sides of the head.[298] Pigs may struggle in the stun box, moving their head in a way that makes placement of the electrodes difficult. Grandin's work showed that in 1999, only 79% of audited pig slaughter plants correctly placed electric stunning tongs on the heads of pigs 99% of the time. By 2003, however, after auditing programs took effect, 91% of the audited plants were correctly stunning pigs 99% of the time. Prior to the audits, it was more common for animals to slip and fall as they were moved through the chutes and into position for stunning, whereas after the audits were implemented, floors were improved, preventing falls nearly completely. In 1996, the rate at which pigs were hoisted by the leg while still partially sensible was 1 per 1,000 animals slaughtered; by 2003, that number dropped to 1 in 4,900.[299] The audits also specified that if willful acts of abuse were observed, the slaughter plant automatically failed the audit.[300]

While there has been notable progress, slaughter practices remain in need of further improvements. For example, some slaughter plants do not pass audits or are not audited at all.[301] Grandin observed one plant where electric prods were used on 100% of the pigs and another where the captive bolt gun was improperly maintained, resulting in sows who were not rendered insensible.[302] Grandin has also noted that "atrocious abuses" have occurred in plants that are not audited.[303]

Conclusion

Most pigs are now raised on industrial confinement operations, massive agribusinesses where animal welfare concerns often remain unaddressed despite substantial scientific evidence that pigs in these conditions routinely suffer in a variety of ways. Low levels of environmental stimulation in barren surroundings, the lack of opportunity to express key natural behavior, such as rooting, wallowing, exploring, and nesting, and the inability to separate into natural social groups may lead to boredom, frustration, and aggression. Behavioral abnormalities and health problems are common, and pigs may not receive the individualized care they need. Improved on-farm killing methods for sick or injured animals who are suffering and unlikely to recover are desperately needed. Genetic selection programs and feed additives push the animals to their biological limit, and although most may be able to endure stressful handling and transportation, some pigs do not survive the journey or become so weak, injured, stressed, or ill that they become nonambulatory. The pig production industry has failed to fully recognize and adequately address these welfare concerns.

Improving the welfare of pigs does not necessarily mean returning to historic farming methods. Rather, it involves using science and technology to develop the best aspects of all of the techniques available to date for the betterment of the animals' welfare, and moving forward, to develop systems that enable the pigs to reach even higher levels of welfare. For example, the Food Animal Initiative (FAI), an experimental farm associated with Oxford University in the United Kingdom is testing new ideas and reexamining pre-confinement practices. In its program for pigs, FAI is perfecting new systems with animal welfare as a core principle, incorporating environmental enrichment and greater freedom of movement into new, commercially viable production methodology.[304] However, the philosophy behind programs such as the FAI has not yet been embraced by industry.

Improvements in welfare will depend upon not only employment of new ways of farming, but also on a new way of viewing farmed animals. Pigs have been commodified and treated simply as units of production. Individuals who do not grow large enough or fast enough are referred to as "junk pigs" in the trade literature,[305] rather than as the sentient beings they are. Such attitudes undoubtedly impair advances in ethical decision-making about the pigs' welfare on industrial production operations. Pigs are among the most intensively confined and harshly handled species in animal agriculture, and there is a desperate need to raise the bar for their housing, care, and treatment throughout the industry.

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