Animal Welfare Institute

The Critical Relationship Between Farm Animal Health and Welfare

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In This Report •

About the Animal Welfare Institute •

Since its founding in 1951, the Animal Welfare Institute (AWI) has been alleviating suffering inflicted on animals by people. AWI works to improve conditions for the billions of animals raised and slaughtered each year for food in the United States. Major goals of the organization include eliminating factory farms, supporting higher-welfare family farms, and achieving humane transport and slaughter for all farm animals.

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pigs and cows: Mike Suarez

Summary •

This report describes the establishment of a critical link between the health and welfare of farm animals, and how this relationship has been accepted by scientific authorities worldwide. The report begins with the internationally recognized definition of animal welfare from the World Organisation for Animal Health ("OIE"), and its association with the "Five Freedoms," a concept originating with the United Kingdom's 1965 Brambell Committee report on the welfare of farm animals in intensive rearing systems.

The OIE has declared that "a critical relationship" exists between animal health and animal welfare. This relationship has been extensively documented by the findings of hundreds of scientific studies conducted over the past half century.

In recent years, the link between animal health and animal welfare has been recognized by various animal health authorities, including national and international veterinary associations. The link has also been acknowledged by animal agriculture associations, including the Food and Agriculture Organization of the United Nations, and by food safety associations, such as the European Food Safety Authority.

The impact of animal welfare on animal health has led the animal agriculture industry in the United States to voluntarily limit or eliminate entirely certain previously common animal husbandry practices. This report presents four such examples: 1) administration of growth hormones to dairy cattle, 2) extreme confinement of calves raised for veal, 3) tailing docking of dairy cattle, and 4) forced molting of egg-laying hens. More than one dozen additional examples of the critical link between farm animal health and welfare are offered in the report's Appendix. As illustrated in the examples, the US Department of Agriculture, through its Agricultural Research Service, has played an essential role in documenting the link between animal health and welfare.

Introduction •

While a relationship likely exists between health and welfare within all animal species, the focus of this report is the nature of that relationship in animals raised for food or fiber (referred to in this report as "farm animals"). Historically, the primary concern of the animal agriculture industry in the United States, and of federal and state agricultural officials, has been animal production and food safety. It has long been understood that the health of farm animals affects the productivity of those animals, as well as the safety and quality of animal products. In recent years, it has become generally accepted that poor health affects an animal's mental state and their ability to perform natural behaviors (commonly referred to as "animal welfare" or "animal well-being"). There is also increasing recognition of the impact of poor animal welfare on animal health, and, consequently, on food safety and meat quality.

Animal Welfare is a Well-Established Scientific Concept •

The American Veterinary Medical Association (AVMA) defines animal welfare as follows:

> Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behavior, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment. Protecting an animal's welfare means providing for its physical and mental needs.[1]

The AVMA derived its definition of animal welfare from the World Organisation for Animal Health (also known as "OIE"—an initialism of its original French name, *Office of International des Epizooties*). With 181 member countries, including the United States, the OIE is the intergovernmental organization that coordinates, supports, and promotes animal disease control worldwide. The OIE has set international animal health standards since its founding in 1924. The World Trade Organization (WTO), upon its creation in 1995, recognized the OIE as the WTO reference organization for standards in the category of sanitary (health) measures.[2]

In 2002, the OIE broadened its mandate to include animal welfare, and it began drafting and publishing comprehensive sets of welfare standards three years later. To date, the OIE has established animal welfare standards for animal transport, killing for disease control purposes, and slaughter for human consumption, as well as for on-farm production systems for various animals, including beef cattle, dairy cattle, and broiler chickens (see Figure 1).[3] The OIE's welfare standards for farm animals are contained in Chapter 7 of its *Terrestrial Animal Health Code*.

The OIE code recognizes the "Five Freedoms" (see Figure 2) as providing valuable guidance in animal welfare.[4] The Five Freedoms concept originated with the United Kingdom's Brambell Committee report on the welfare of farm animals in intensive rearing systems (1965) and later the UK Farm Animal Advisory Committee (now the Farm Animal Welfare Council).[5] Originally drafted as merely the freedom to stand up, lie down, turn around, stretch their limbs, and groom all parts of the body, the Freedoms were eventually extended to other aspects of animal welfare and paired with Five Provisions that broadly delineate proactive steps necessary to achieve the

Figure 1. International Standards on Farm Animal Welfare •

TERRESTRIAL ANIMAL HEALTH CODE

Chapter 7.1	Introduction to the recommendations for animal welfare
Chapter 7.2	Transport of animals by sea
Chapter 7.3	Transport of animals by land
Chapter 7.4	Transport of animals by air
Chapter 7.5	Slaughter of animals
Chapter 7.6	Killing of animals for disease control purposes
Chapter 7.9	Animal welfare and beef cattle production systems
Chapter 7.10	Animal welfare and broiler chicken production systems
Chapter 7.11	Animal welfare and dairy cattle production systems
Chapter 7.X	Animal welfare and pig production systems (draft)

AQUATIC ANIMAL HEALTH CODE

Chapter 7.1	Introduction to recommendations for the welfare of farmed fish
Chapter 7.2	Welfare of farmed fish during transport
Chapter 7.3	Welfare aspects of stunning and killing of farmed fish
Chapter 7.4	Killing of farmed fish for disease control purposes

goals.[6] The Five Freedoms concept is utilized by various animal welfare standards and assessment programs, including the European Welfare Quality assessment system for farm animals.[7] The Five Freedoms focus on four physical domains related to the raising and handling of farm animals: feeding/nutrition, housing/environment, health, and behavior.

Figure 2. The Five Freedoms •

FREEDOMS	PROVISIONS
1. Freedom from thirst, hunger, and malnutrition	*Good nutrition*: By providing ready access to fresh water and a diet to maintain full health and vigor
2. Freedom from discomfort and exposure	*Good environment*: By providing an appropriate environment including shelter and a comfortable resting area
3. Freedom from pain, injury, and disease	*Good health*: By prevention or rapid diagnosis and treatment
4. Freedom from fear and distress	*Appropriate behavior*: By ensuring conditions and treatment that avoid mental suffering
5. Freedom to express normal behavior	*Positive mental experiences*: By providing sufficient space, proper facilities, and company of the animal's own kind

Animal Health and Animal Welfare Are Inextricably Linked •

According to the OIE, animal welfare standards should be science-based and "should always seek to maintain health as a basis of welfare."[8] In its *Guiding Principles for Animal Welfare*, the OIE asserts that there is "a critical relationship between animal health and animal welfare."[9] The Principles also note that "improvements in farm animal welfare can often improve productivity and food safety, and hence lead to economic benefits."[10] Further, in the glossary for its *Terrestrial Animal Health Code*, the OIE defines *animal health management* as "a system designed to optimize the physical and behavioural health and welfare of animals."[11]

This link between animal health and animal welfare is recognized by America's largest trading partners for agricultural products. Canada and the European Union, two of our largest trading partners, have adopted national organic regulations that recognize the significance of animal welfare to animal health. The United States has entered into organic equivalency agreements with both (Canada in 2009 and the European Union in 2012).[12] When Canada entered into its equivalency agreement with the United States, it exempted livestock stocking densities for animals other than ruminants, because the US organic regulations do not provide this specification.[13] Any US organic meat company desiring to market its products in Canada as *organic* must meet Canadian space requirements.

Canadian organic regulations recognize the link between animal welfare and animal health as follows:

> Under a system of organic production, livestock are provided with living conditions and space allowances appropriate to their

behavioural requirements and organically produced feed. These practices strive to minimize stress, promote good health and prevent disease.[14]

The EU organic regulations clearly articulate the importance of animal welfare to organic production, as in the following excerpt from the regulations' introduction:

> Organic stock farming should ensure that specific behavioural needs of animals are met. In this regard, housing for all species of livestock should satisfy the needs of the animals concerned as regards ventilation, light, space and comfort and sufficient area should accordingly be provided to permit ample freedom of movement for each animal and to develop the animal's natural social behavior. Specific housing conditions and husbandry practices with regard to certain animals, including bees, should be laid down. These specific housing conditions should serve a high level of animal welfare, which is a priority in organic livestock farming and therefore may go beyond Community welfare standards which apply to farming in general.[15]

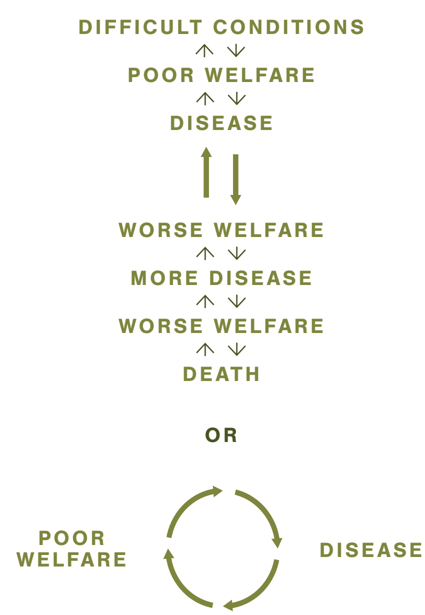
The Link Between Animal Health and Welfare Has Been Scientifically Proven •

Acknowledgement of the link between animal health and animal welfare by the OIE and many of its member countries is based on more than four decades of scientific research. Two pioneers in the field of farm animal welfare science—veterinarian Andrew Fraser and zoologist Donald Broom—discussed animal welfare and behavior in relation to disease in their veterinary textbook, *Farm Animal Behaviour and Welfare* (first published in 1974). They note that husbandry methods affect disease incidence, citing for example, a 1974 study that reported a gradual increase in chronic infections in poultry over a period when the frequency of intensive production practices was increasing.[16]

Fraser and Broom identify reduced resistance to disease as a consequence of poor welfare. They note: "This has been known for a long time in the medical and veterinary professions and is part of the more general process whereby poor welfare, whatever its cause, can lead to increased susceptibility to disease."[17] In 1988, Broom theorized a welfare-disease feedback effect, in which stressful living conditions leads to poor welfare, which leads to disease, which leads to worse welfare, which leads to more disease, worse welfare, and potentially death (see Figure 3).[18]

According to Broom, the scientific evidence linking welfare with susceptibility to disease is of three kinds: 1) clinical data concerning individuals showing signs of disease, 2) experimental studies and surveys comparing levels of disease incidence in different husbandry systems or after different treatments, and 3) studies of immune system function after different treatments.[19]

Figure 3. Interaction Between Poor Welfare and Disease •



The Link Has Been Acknowledged by Scientific Authorities •

In addition to the OIE, numerous other animal health and animal agriculture authorities, both in the United States and around the world, have publicly acknowledged the connection between animal health and animal welfare. A list of some of these authorities is provided in Figure 4.

Veterinary associations throughout the world, including the American Veterinary Medical Association (AVMA) and the Canadian Veterinary Medical Association (CVMA), acknowledge the significance of animal welfare to animal health. The AVMA[20] and the World Veterinary Association[21] give out annual animal welfare awards, and both the AVMA and the CVMA operate animal welfare committees. The United States Animal Health Association (USAHA), which is composed of federal, state, and agriculture industry veterinarians, also has a standing animal welfare committee.[22] The USAHA's stated purpose is to serve as "a forum for communication and coordination among State and Federal governments, universities, industry, and other concerned groups for consideration of issues of animal health and disease control, animal welfare, food safety and public health."[23]

The importance of animal welfare is also acknowledged by animal agriculture authorities worldwide. For example, the Food and Agriculture Organization (FAO) of the United Nations hosts a multi-stakeholder animal welfare knowledge exchange platform on its website called The Gateway to Farm Animal Welfare. The Gateway's purpose is "improvement of livestock welfare and thus animal and public health and livestock productivity worldwide."[24] The FAO identifies animal welfare as "a global common good," and the Gateway "addresses animal welfare not as a stand-alone topic, but as one topic among many others relevant or related to food safety and security, human and animal health, sustainability, rural development."[25] It sees animal welfare as "a tool that can generate benefits to producers, their animals and citizens at large."[26]

The European Food Safety Authority (EFSA) makes the case that animal welfare impacts not only animal health but food safety as well:

> The safety of the food chain is indirectly affected by the welfare of animals, particularly those farmed for food production, due to the close links between animal welfare, animal

Figure 4. Entities Acknowledging the Link Between Animal Health and Animal Welfare •

ANIMAL HEALTH AUTHORITIES:

- American Veterinary Medical Association
- Canadian Veterinary Medical Association
- European Food Safety Authority
- International Organization for Standardization
- United States Animal Health Association
- World Organisation for Animal Health
- World Veterinary Association

ANIMAL AGRICULTURAL AUTHORITIES:

- Canadian National Farm Animal Care Council
- Food and Agricultural Organization of the United Nations
- IFOAM – Organics International
- US Department of Agriculture, Agricultural Research Service

> health and food-borne diseases. Stress factors and poor welfare can lead to increased susceptibility to disease among animals. This can pose risks to consumers, for example through common food-borne infections like *Salmonella*, *Campylobacter* and *E. Coli*.[27]

The EFSA position reflects that of the European Commission, with which it is associated. In a communication to European Parliament and the European Council, the European Commission acknowledged the association between animal health, animal welfare, and food safety: "There is increasingly wide acceptance of the link between animal welfare and animal health, and even, by extension, between animal welfare and food safety and food quality."[28]

In Canada, efforts to address farm animal health and welfare are coordinated by the National Farm Animal Care Council (NFACC). It describes itself as "the only organization in the world that brings together animal welfare groups, enforcement, government and farmers under a collective decision-making model for advancing farm animal welfare."[29] The NFACC has developed codes of practice for several farm animal species, including dairy cattle, beef cattle, veal cattle, equines, farmed deer, goats, sheep, pigs, rabbits, chickens, turkeys, and laying hens, as well as for the transport of farm animals. The codes address such animal care issues as housing systems and space provisions for animals; painful practices such as castration, dehorning, and tail docking; care and treatment of sick and injured animals; use of electric prods; and other handling and euthanasia methods.[30] For nearly all of the codes, a scientific committee has prepared a *Review of Scientific Research on Priority Issues* that sets out the scientific evidence justifying the animal care standards provided in the code and establishing the link between the standards and animal health.

While the United States does not operate an equivalent process for the establishment of codes of practice, various programs within the US Department of Agriculture (USDA) address farm animal care and have acknowledged the link between health and welfare in farm animals. The Agricultural Research Service—the USDA's chief scientific in-house research agency—has conducted extensive research over the past few decades that illustrates the connection between farm animal health and welfare. The primary objective of its Livestock Behavior Research Unit (LBRU) is to conduct research to "improve animals' quality of life, improve their health, improve the animal/human relationship and improve the production of safe, healthy food, in a sustainable way."[31] Since 2010, the LBRU has published a series of fact sheets documenting the link between animal health and animal welfare. These informal reports cover a variety of animal husbandry topics, including dairy cow lameness, dairy cow heat stress, castration of pigs and other livestock, sow housing, sow lameness, laying hen housing, laying hen beak trimming, and genetic selection in laying hens.[32]

Strong Animal Welfare Standards Serve to Protect Animal Health •

Over the past half century, hundreds of scientific studies, including many conducted and/or funded by the USDA, have demonstrated a relationship between common farm animal husbandry practices and animal health. This report offers information on more than one dozen common husbandry practices that have been shown to negatively affect farm animal health (see Figure 5).

Four of the practices—confining veal calves to small crates, administering growth hormones to dairy cattle, docking the tails of cattle and pigs, and forcing the molts of egg-laying hens through feed withdrawal—are addressed in case studies appearing on pages 8–11. In each of these cases, the husbandry practice was voluntarily curtailed or eliminated by the animal agriculture industry after exposure of the health consequences.

Figure 5. Husbandry Practices That Have Been Linked to Health Problems in Farm Animals •

SPECIES	HUSBANDRY PRACTICE	ASSOCIATED HEALTH PROBLEM(S)
Dairy cattle	Slatted, concrete flooring	Lameness, hoof disorders
Dairy cattle*	Administration of growth hormones	Mastitis, lameness, reproductive problems
Veal calves*	Intensive confinement in crates	Impaired locomotion, leg injuries
Beef cattle	Frozen, muddy, or chronically wet pens	Lameness, including foot rot
Beef cattle	High concentrate (grain) diet	Acidosis, liver abscesses, lameness
Cattle, pigs*	Tail docking	Neuromas, prolonged healing, pain
Pigs	Barren housing (no bedding)	Tail damage (injures, wounds)
Pigs (sows)	Intensive confinement in crates	Musculoskeletal problems
All mammals	Stressful transport conditions	Foodborne pathogens in gastrointestinal tract
All chickens	Poor quality litter, high ammonia levels	Skin, respiratory, eye damage
All chickens	Unnatural lighting conditions	Leg abnormalities
All chickens	Crowding (high stocking densities)	Footpad dermatitis, injuries, bruising
Meat chickens	Genetic selection for rapid growth	Lameness, bone defects, deformities
Egg-laying hens	Barren environment—lack of perches	Bone weakness, footpad dermatitis
Egg-laying hens	Barren environment—lack of dustbaths	Feather pecking, parasites
Egg-laying hens	Beak trimming	Neuromas, acute and chronic pain
Egg-laying hens*	Forced molting by feed withdrawal	*Salmonella* infections

*Subject of a case study below; remaining topics are addressed in the Appendix of this report.

In addition, third-party animal welfare food certification programs prohibit or limit these practices,[33] and in some instances, the practices have been legally restricted by state legislation (including citizen ballot initiative) or regulation.

THE USE OF GROWTH HORMONES IN DAIRY CATTLE HAS BEEN ASSOCIATED WITH SEVERAL HEALTH CONDITIONS AND PREMATURE SLAUGHTER IN OLDER COWS.

• Case Study #1 •
Bovine Growth Hormone and Lameness, Mastitis in Dairy Cattle

Bovine somatotropin (bST) is a genetically engineered hormone that is administered to dairy cattle to increase milk production. According to the European Union's Scientific Committee on Animal Health and Animal Welfare, unnaturally high milk production is associated with poor body condition and increased rates of gastrointestinal problems, susceptibility to heat stress, mastitis, lameness, and reproductive problems.[34] Use of bST may increase the prevalence of clinical mastitis by as much as 25 percent.[35] Moreover, one study found that bST-treated cows were at a 50 percent higher risk of developing lameness,[36] and another study documented a 220 percent increase in foot problems among cows injected with the growth hormone.[37] The Canadian Veterinary Medical Association, in reviewing data related to bST use, reached a similar conclusion to that of the European Union regarding the risk of bST to dairy cattle health and welfare, finding that the hormone was associated with an increased risk of culling in older cows.[38]

While both Canada and the European Union decided against approving bST, the United States has allowed its use. However, in recent years, some dairy cooperatives and/or dairy processors in the United States have restricted the use of bST in their supply chains[39] due to public concerns regarding the potential negative effects of the hormone on both human and animal health. This move has resulted in a decrease in the reported use of bST by dairy producers, according to surveys conducted by the USDA's National Animal Health Monitoring System. In 2014, 28.6 percent of large dairy operations reported administering bST to a total of 18.7 percent of their dairy cows,[40] down from 54.4 percent of large dairy operations administering bST to 34.1 percent of their cows in 2002.[41] This represents a decline of nearly 50 percent over 12 years, and the decline is expected to continue into the future.

Farm Sanctuary

Jodie Nash

CALVES CONFINED TO SMALL CRATES ARE MORE LIKELY TO HAVE IMPAIRED LOCOMOTOR ABILITY THAN CALVES RAISED OUTSIDE IN GROUPS.

• Case Study #2 •
Intensive Confinement and Impaired Locomotion, Leg Injuries in Veal Calves

Veal is a light-colored meat that, until recently, came from young calves raised on a restricted diet and severely limited movement. Veal calves were tethered or confined in crates (also sometimes referred to as "stalls") only two feet wide, preventing exercise, grooming, and social interactions with other calves. This severe confinement and social isolation had a profoundly negative impact on the animals' health and welfare.

For example, confinement of calves to cramped crates has been associated with musculoskeletal injuries. Terosky et al. found that left front knee swelling in calves increased as crate or stall size decreased.[42] In another study, 20 percent of calves housed in individual crates had abrased, bruised, or swollen knees, with 3 percent of knee injuries diagnosed as serious.[43] In addition, crate-housed calves are more likely to have impaired locomotor ability than calves raised outside in groups. In an open field, animals who had been confined in crates were observed stumbling and falling, while animals who had not been confined experienced no walking problems.[44] Warnick et al. found that isolated calves required three times as many medical treatments as individually reared calves who could socialize with others,[45] suggesting that the stress associated with confinement decreases immune response in calves.[46]

As a result of publicity regarding the negative impacts of severe confinement, in 2007, two prominent American veal producers—Strauss Veal and Marcho Farms—pledged to stop using veal crates within 10 years. Soon after the corporate announcements, the American Veal Association (AVA)—the trade association for the industry in the United States—resolved to encourage all producers of veal to make the same commitment.[47] Since the industry's decision to phase out the practice, nine American states have limited or banned the use of veal crates.[48] According to the AVA, the industry's transition to group housing was completed December 31, 2017.[49]

Reinforcing the wisdom of this change, recent research conducted by the USDA's Livestock Behavior Research Unit on early group housing of dairy calves found "no adverse effects on health or performance and some benefits on social behavior for early (3 day) grouping of calves."[50]

CATTLE WITH DOCKED TAILS MAY EXPERIENCE PAIN AS A RESULT OF NEUROMA FORMATION IN THE TAIL STUMP.

• Case Study #3 •
Tail Docking and Neuromas, Chronic Pain in Pigs and Cattle

Tail docking has been a common practice in both pork and dairy production in the United States, and it is also practiced—although less frequently—in beef production. In piglets, the procedure is intended to reduce tail biting, while in dairy cattle it is to improve cleanliness during milking. A research team led by Susan Eicher, of the USDA's Agricultural Research Service, demonstrated that dairy heifers with docked tails had greater temperature sensitivity (a measure of pain used in human amputees).[51] Other research has shown an increase in the number of flies on cattle with docked tails.[52] Histological analysis of tail stumps shows neuromas in the tail stumps of cattle, suggesting neuropathic pain.[53] This has also been demonstrated in docked pig tails.[54] In piglets, neuroma formation was ongoing even four months after tail docking, suggesting long-term pain.[55] Herskin et al. found neuromas in 64 percent of tails in docked piglets.[56] Use of a hot-iron cautery to perform tail docking was implicated in the development of neuromas,[57] and tail docking with a hot-iron cautery has also been shown to result in prolonged healing.[58]

Research on the health impacts of tail docking in dairy cattle, including studies conducted by the USDA, was used to push through legal limits on the practice of tail docking of cattle in four states between 2009 and 2012.[59] This research also led the board of the National Milk Producers Federation (NMPF) to approve a resolution on July 23, 2012, altering its position on tail docking. The board voted to approve the following language: "NMPF's National Dairy FARM Animal Care Program opposes the routine tail docking of dairy animals, except in the case of traumatic injury to an animal. This practice is recommended to be phased out by 2022."[60] The decision aligned the organization's position with that of the leading veterinary care organizations for dairy, including the American Veterinary Medical Association and the American Association of Bovine Practitioners, both of which are opposed to tail docking. The board's position also reflected the view of the animal care specialists serving on the FARM Program's Technical Working Group and the NMPF Animal Health & Well-Being Committee.[61]

In October 2015, the board of the NMPF approved a resolution hastening by five years the deadline for discontinuing tail docking, from January 2022 to January 2017. "On this issue, the science, the advice of our technical experts and requests from our dairy customers and consumers are all aligned," said NMPF President and CEO Jim Mulhern.[62]

Dzīvnieku brīvība

George Clerk

SALMONELLA CONTAMINATION HAS BEEN SHOWN TO BE MORE COMMON IN HEN FLOCKS THAT ARE FORCED MOLTED, AND IN CAGE HEN HOUSING SYSTEMS VERSUS NON-CAGE (E.G., CAGE FREE, FREE RANGE) HEN HOUSING.

• Case Study #4 •
Forced Molting and Salmonella in Egg-Laying Hens

Forced molting is a practice used to improve egg production and eggshell quality in laying hens and decrease the time between laying cycles from 4 months to 2 months or less.[63] A common method to induce molting has been through feed deprivation of periods from 4 days to as much as 16 days. During feed deprivation, hens will lose as much as 30 percent of their body weight. Concurrent with feed deprivation, there is increased colonization of the crop and cecum with *Salmonella enteritidis*, the bacterium associated with foodborne illness in human beings.[64] Consequently, this common animal husbandry practice has been shown to affect the occurrence of *Salmonella* infections in hens and *Salmonella* contamination of eggs.

Denagamage et al. reviewed 17 previously published studies of Salmonella infection related to egg production and found that *Salmonella* contamination is associated with forced molting, larger hen flock sizes, and the housing of hens in barren cages, among other factors.[65] Moreover, the USDA's Southeast Poultry Research Laboratory found that the practice of forcing hens to molt by removing their feed depresses the birds' immune system. In the USDA experiments, molted hens had higher numbers of *Salmonella* in internal organs and exhibited more intestinal inflammation. Molted hens were 100- to 1,000-fold more susceptible to infection by *Salmonella*, according to the USDA researchers.[66]

The Scientific Advisory Committee of United Egg Producers (UEP)—the trade association for egg producers in the United States—began studying forced molting in 1999. At that time, it believed that only the feed withdrawal method of inducing molts would accomplish a successful flock molt. UEP requested scientific proposals to develop alternatives to feed removal, placing an emphasis on the impact of the method on performance and behavior. Five universities received research funds to pursue alternatives.

After reviewing the findings of the research projects, in February 2005, the UEP Scientific Advisory Committee modified its recommended guidelines for inducing a flock molt. The UEP animal husbandry guidelines were changed accordingly, and as of January 1, 2006, only non-feed-withdrawal molting methods are permitted under the United Egg Producers' egg certification program.[67]

Conclusion •

Scientific research—including many studies conducted and/or funded by the US Department of Agriculture—has demonstrated a critical association between farm animal health and farm animal welfare. The association goes in both directions: The compromised health of a farm animal negatively affects the animal's welfare, and vice versa. The link between the health and welfare of animals raised for food has been acknowledged by animal health and animal agricultural authorities worldwide. Demonstration of the negative consequences of poor animal welfare on animal health has led animal agriculture trade associations in the United States to voluntarily curtail or eliminate certain husbandry practices once considered routine. Evidence of the animal health-welfare link has also been used in the development of animal welfare standards for third-party food certification programs. In addition, some states have enacted legal restrictions on specific farm animal husbandry practices. For the well-being of humans and animals alike, it is imperative that research into the health and welfare impacts of common animal husbandry practices continue, and that the results from that research are used to shape public policy related to the use of animals for food.

EXAMPLES OF THE LINK BETWEEN THE HEALTH AND WELFARE OF MAMMALS

Scientific research has demonstrated an association between how livestock are raised and the health of the animals. Diet, physical alterations, housing and environmental conditions, and handling practices, including transport, have all been shown to impact animal health. Some examples follow:

CATTLE

Slatted, Concrete Flooring and Lameness in Dairy Cattle

In a 2016 survey of cattle arriving at slaughter establishments conducted by the National Cattlemen's Beef Association, 24 percent of dairy cows and 23 percent of dairy bulls were assessed as showing signs of lameness.[68] The type of flooring on which dairy cows walk when housed indoors has been found to affect their welfare by impairing locomotion and increasing the occurrence of hoof disorders and lameness. According to the USDA, lameness in cattle is a major concern for the dairy industry because it negatively affects dairy cow welfare, as well as milk production and dairy income.[69] Concrete is a poor choice for dairy cattle flooring because it is too hard[70] and provides inadequate traction.[71] Somers et al. noted a greater number of claw disorders among dairy cattle housed on concrete and slatted floors compared with dairy cows housed in a straw yard; over 80 percent of cows exposed to concrete flooring had at least one claw deformity.[72] Some types of hoof lesions are correlated with wet flooring,[73] and the prevalence of hoof lesions has been associated with how well concrete flooring is maintained.[74] The USDA recognizes the negative impact of dairy cow lameness on "cow comfort, health, and production."[75] It notes that rubber flooring has been associated with reduced lameness or risk of lameness for dairy cows.[76]

Environmental and Housing Conditions and Lameness in Beef Cattle

Lameness in animals raised for food, including cattle raised for beef, results in pain and reduces the animals' ability to move and consequently to access feed and water. Research conducted on beef cattle by the USDA found that lameness had a significant negative impact on average daily weight gain in steers.[77] Several health problems were identified as common causes of lameness, including joint infection, toe abscesses, laminitis, bruising and abrasions of the sole, and foot rot.[78] Other research has shown that certain environmental and housing conditions increase the incidence of various forms of lameness. For example, Stokka et al. note that foot rot is associated with frozen, muddy, or chronically wet pens and the presence of rough or sharp objects. The researchers observe: "Lameness due to physical injuries can be prevented by good handling practices and facility design."[79] Several researchers have also documented an increase in the prevalence of stress responses and physical injuries among cattle who have had negative experiences with human handlers.[80]

High Concentrate Feeding and Acidosis, Laminitis in Beef Cattle

Young cattle raised for beef typically forage for their food on the range or pasture. Most beef cattle are eventually moved to large confined feeding operations (or feedlots) to put on weight before slaughter. At this time their diet is changed from forage-based to grain-based, referred to as a "high concentrate" diet. Transition to an unnatural grain diet results in both animal welfare and animal health consequences for cattle. Nutritional diseases associated with high concentrate diets include acidosis, liver abscesses, and laminitis.[81] Acute acidosis—which occurs when the rate of acid production in the animal's rumen exceeds the rate of acid removal—causes overt illness and is potentially fatal.[82] In the 2016 National Beef Quality

Audit, more than 30 percent of livers from steers and heifers at slaughter did not pass inspection and were condemned,[83] and liver abscesses were found to be the leading cause of liver condemnation for market cows and bulls.[84] Laminitis refers to inflammation of the connective tissue located between the pedal bone and hoof horn and is a major cause of lameness in beef cattle.[85]

PIGS

Barren Housing and Tail Damage

Tail biting behavior in pigs is a common problem in barren housing environments.[86] Tail biting can result in significant tail damage and associated health problems such as wounds and abscesses. Ursinus et al. documented less tail biting and tail damage in pigs housed in an enriched environment versus pigs housed in a barren environment; 38 percent of pigs in barren housing were identified as tail biters, while only 5 percent of pigs in enriched housing were tail biters.[87] The researchers observed that straw bedding largely reduced tail biting and tail damage.[88] These results were similar to those found in a previous study by Beattie et al., which observed no tail biting among pigs housed in an enriched environment that contained peat and straw and extra space.[89] Kallio et al. conducted a study to compare various housing and management practices in 78 herds of undocked pigs with or without a history of tail-biting. Risk factors identified for tail biting injuries in piglets were slatted floors and the amount of the floor area that was slatted.[90] In older ("finisher") pigs, tail biting damage was associated with slatted floors, the amount of floor area that was slatted, the total number of finisher pigs on the farm, the absence of bedding, certain feeding practices, and a group size greater than nine pigs.[91]

Intensive Confinement and Musculoskeletal Problems in Sows

For the past half century, the typical method of housing gestating sows in the United States has been to confine the animals in small crates with slatted, concrete flooring. In its 2012 survey of pig producers, the USDA found that 25 percent of breeding-age females were culled in six months (between December 1, 2011, and May 1, 2012), with lameness being one of the top causes.[92] According to a USDA fact sheet on sow lameness and longevity, older sows are more prone to foot problems than younger sows, probably due to the amount of time spent on rough flooring.[93] Housing systems can affect the amount of physical trauma a sow experiences; for example, sows housed in crates tend to have more joint, foot, and leg problems.[94] A study conducted by the USDA's Livestock Behavior Research Unit documented that gilts (first-time gestating sows) housed in crates already show evidence of negative effects of intensive confinement on their musculoskeletal system, specifically the condition of cartilage and hooves.[95]

To reduce lameness in sows, the USDA recommends eliminating slatted flooring systems with inappropriate widths and use of a flooring material that is resilient to sow activity, yet yielding enough to relieve strain on the animal.[96]

ALL MAMMALS

Transport Stress and Foodborne Pathogens

The conditions under which farm animals are transported have impacts on the animals' health in terms of stress response, injuries, fatigue, dehydration, core body temperature, morbidity, and mortality. Transport conditions also affect carcass and meat quality (shrink, bruising, pH, color defects, and water losses).[97] The USDA's Livestock Behavior Research Unit has observed that animals being transported can be exposed to a range of challenging stimuli that disturb the animals' homeostasis, including human contact; transport vibration, movement and jolting; novel/unfamiliar environments; food and water restriction; changes in social structure; and changes in climatic conditions (i.e., heat and cold). In its *Food Safety Fact Sheet*, the USDA notes: "Stress reduces the fitness of an animal, which can be expressed through failure to achieve production performance standards or targets, or more drastically, through injury, disease and death. Stress in farm animals can also have detrimental effects on the quality of food products (meat, eggs, and milk)."[98] The USDA further explains that exposure of farm animals to transport-related stress "will lead to increased levels of foodborne pathogens in the gastrointestinal tract, and increased risk of contamination of their carcasses."[99]

EXAMPLES OF THE LINK BETWEEN THE HEALTH AND WELFARE OF BIRDS

Scientific research has also demonstrated a connection between how poultry are raised and the health of the birds. Space allowances, light regimens, litter characteristics, and air quality all have been shown to impact bird health. Some examples follow:

ALL CHICKENS

Aerial Ammonia and Skin, Respiratory Problems
Ammonia is an invisible, water-soluble alkaline gas that is a significant contaminant in hen houses.[100] Ammonia in poultry facilities primarily originates as uric acid, excreted by the birds into the litter and manure.[101] Chickens spend their life in contact with litter, and wet litter contributes to the development of foot pad dermatitis, and hock and breast blisters. Poor litter also results in higher aerial ammonia, which causes irritation to the mucous membranes in the eyes and the respiratory system and can increase the susceptibility to respiratory diseases.[102]

The USDA's Poultry Research Unit at Mississippi State University considers aerial ammonia "an important topic of interest in commercial poultry production due to its effects on bird health, well-being, and production efficiency."[103] A study conducted at the USDA's Poultry Research Unit documented greater mortality in birds exposed to aerial ammonia concentrations above 25 parts per million (ppm).[104] Ammonia levels greater than 25 ppm have been associated with keratoconjunctivitis and respiratory distress.[105] Oyetunde et al. demonstrated that 100 ppm of ammonia causes significant damage to the trachea of chickens.[106] Jones et al. demonstrated that given a choice, broiler chickens avoided areas where ammonia concentrations were above 20 ppm, actively seeking fresh air.[107] In addition to direct effects on poultry health, high levels of ammonia also affect egg production and quality. Hens exposed to high ammonia concentration produced fewer eggs, presumably due to respiratory damage[108] and reduced feed intake.[109]

Lighting Conditions and Leg Abnormalities
In an attempt to increase feed consumption and weight gain, the conventional chicken industry warehouses birds under near-continuous dim lighting. Day length is prolonged by allowing only a few hours of dark, while lighting intensity is kept low.[110] Natural light and dark cycles are important to stimulate activity in chickens and for the development of a circadian rhythm.[111] Poultry welfare scientists speculate that failure to provide the level of lighting required for effective vision may negatively affect behaviors such as feeding and social interaction, leading to distress and poor welfare.[112] Research has shown that increasing light intensity in chicken sheds enhances the birds' locomotor activity and reduces leg problems.[113]

Research has demonstrated that poultry also have a physiological need for periods of dark. According to sustainable agriculture specialist Dr. Anne Fanatico, "Birds need a dark period for good health; they only produce melatonin—a hormone important in immune function—during dark periods."[114] Leg problems such as tibial dyschondroplasia increase when chickens are kept in continuous light, while exposure to more natural intervals of light and dark results in reduced leg abnormalities, reduced physiological stress, and improved eye condition.[115]

Stocking Density and Leg Weakness, Skin Dermatitis

Poultry raised for meat grow rapidly, and as birds approach market age and weight, their bodies take up more and more of the available space, leaving less room for the performance of natural behaviors. Consequently, low space allowance (signifying high stocking density) has been shown to have negative effects on stocking bird welfare, including disturbing the resting behavior of birds and decreasing activity and ground pecking.[116]

High stocking density has also been shown to cause health problems in birds, including reduced body weight, decreased feed intake, increased foot-pad dermatitis, increased injury and bruising, increased mortality, increased bone abnormalities, and increased carcass condemnations. Kang et al. found that bone mineral density, egg production, and egg mass were significantly lower when hens were kept at densities of 10 birds per square meter when compared to 5 birds per square meter.[117] Kang et al. also found an increase in heterophils (a measure of infection) in birds stocked at higher densities.[118] A study by Bilgili and Hess demonstrated an increase in mortality of meat chickens at higher stocking densities.[119] Research conducted at the USDA's Poultry Research Unit found that foot-pad disease increased with the density of the flock, and the proportion of whole carcasses with scratches on the back and thighs increased as density increased.[120] High stocking density also results in more chicken waste products, including uric acid, being discharged into the air and into the litter on which birds sit and lie, which can lead to both health and welfare problems.

MEAT CHICKENS

Rapid Growth and Leg Disorders

As a result of genetic selection, over the past century, growth rates for meat chickens have increased significantly. According to the National Chicken Council, in 1950, chickens in the United States reached an average market weight of 3.08 pounds in 70 days, and in 2017, chickens reached twice that size (6.18 lbs.) in only 47 days.[121] Such rapid growth has serious consequences for the health and welfare of birds raised for meat. Researchers have shown that rate of growth is a primary risk factor for impaired locomotion and poor leg health in meat chickens.[122] Serious leg problems may prevent birds from such simple activities as standing and eating food.[123] In those who can walk, the rapid growth of breast muscle moves the bird's center of gravity forward and causes an altered gait that is inefficient and rapidly tires the bird.[124]

In addition to lameness, rapid growth has been associated with bone defects and deformities, tibial dyschondroplasia (birds suffering from this disorder are referred to as "creepers," moving around on their hocks), ruptured tendons, spondylolisthesis (or "kinky back"), and rickets.[125] The USDA's Livestock Behavior Research Unit (LBRU) has acknowledged the negative effect of rapid growth on bone defects. In a summer 2017 article titled "Improving Poultry Skeletal Health," the LBRU notes: "Skeletal disorders are common in commercial meat (broiler) and egg-laying poultry due to selection for fast growth and daily egg production. Leg bone disorders are particularly concerning as they cause pain, difficulty in walking, and economic loss."[126] Selecting breeds for a high muscle-to-bone ratio also predisposes the modern commercial chicken to metabolic and cardiovascular diseases, including ascites, pulmonary hypertension syndrome, cardiac arrhythmias, and sudden death syndrome where birds simply "flip over" and die.[127]

EGG-LAYING HENS

Lack of Perches and Bone Weakness, Dermatitis

Perching is a natural behavior of chickens in the wild, providing a means of protection from ground predators.[128] This behavior is maintained in domestic laying hens, who demonstrate increased signs of unrest[129] and are subjected to increased aggressive behaviors when perches are not provided.[130] Ventura et al. demonstrated significantly decreased aggression in chickens given access to perches, at all stocking densities.[131] Gunnarsson et al. showed that access to perches reduced the prevalence of cloacal cannibalism in loose-housed birds.[132]

In addition to behavioral benefits, the presence of a perch has many physical benefits, including increased bone strength,[133] improved feather condition,[134] and decreased footpad dermatitis.[135] Hester et al. showed that access to perches during rearing resulted in fewer broken back claws, improved bone mineral content, and improved bone strength in hens.[136] Campo et al. found that chickens housed in pens with perches showed decreased signs of infection and stress.[137]

Lack of Dustbathing and Plumage Condition, Feather Pecking

A number of studies document that dustbathing is a primary behavioral need of hens.[138] Providing litter of a sufficient quantity and quality for dustbathing also helps alleviate particular health problems by keeping a bird's plumage in good condition and removing parasites,[139] which in turn helps to shield the hen from temperature fluctuations and protect against skin injury. In addition, the provision of litter for dustbathing and scratching has been associated with reduced feather pecking and cannibalism, conditions that present major health and welfare risks for egg-laying hens.[140] (Litter has been shown to reduce fearfulness in hens, which is correlated with feather pecking.[141]) Further, research by Blockhuis and Wiepkema suggests a link between caging methods and feather pecking. They demonstrated that the incidence of feather pecking was nearly tripled when birds were housed in the battery cages most commonly used in the egg industry compared to birds housed on floors with suitable litter, allowing foraging and dustbathing. Their conclusion was that the main practical strategy to prevent feather pecking and cannibalism was to provide adequate substrate.[142]

Beak Trimming and Neuromas, Chronic Pain

Beak trimming is a common procedure in the poultry industry, where a portion of the bird's beak is cut off, either using a hot blade or infrared energy.[143] Approximately half the upper beak is removed. The poultry industry cites this procedure as a method to reduce injury and death associated with feather pecking, toe pecking, and cannibalism. The structure of the removed beak includes pain and heat receptors, touch receptors, blood vessels, and bone. Multiple studies have demonstrated short- and long-term pain and behavioral changes associated with beak trimming, which affect both hen health and welfare. Of particular concern are decreases in food and water intake,[144] decreased preening, and short-term pain and debilitation.[145] Research conducted by the USDA found that acute pain occurred with both infrared and hot-blade trimming, affecting the birds' eating and drinking behavior.[146] Other concerns include tongue damage and burnt nostrils,[147] neuroma formation, and long-term pain sensation.[148] Furthermore, Mullens et al.[149] and Chen et al.[150] both demonstrated an increase in parasitic load in birds that had trimmed beaks.

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