Poultry farming

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Poultry farming is the raising of domesticated birds such as chickens, ducks, turkeys and geese for the purpose of farming meat or eggs for food. Poultry are farmed in great numbers with chickens being the most numerous. More than 50 billion chickens are raised annually as a source of food, for both their meat and their eggs.[1] Chickens raised for eggs are usually called layers while chickens raised for meat are often called broilers.[1] In the US, the national organization overseeing poultry production is the Food and Drug Administration (FDA). In the UK, the national organisation is the Department for Environment, Food and Rural Affairs (Defra).

Contents

Intensive and alternative

According to the researchers and scientists, 74% of the world's poultry meat, and 68 percent of eggs are produced in ways that are described as 'intensive'.[2] One alternative to intensive poultry farming is free-range farming using lower stocking densities. Poultry producers routinely use nationally approved medications, such as antibiotics, in feed or drinking water, to treat disease or to prevent disease outbreaks. Some FDA-approved medications are also approved for improved feed utilization.[3]

Egg-laying chickens – husbandry systems

Commercial hens usually begin laying eggs at 16–20 weeks of age, although production gradually declines soon after from approximately 25 weeks of age.[4] This means that in many countries, by approximately 72 weeks of age, flocks are considered economically unviable and are slaughtered after approximately 12 months of egg production,[5] although chickens will naturally live for 6 or more years. In some countries, hens are force moulted to re-invigorate egg-laying.

Environmental conditions are often automatically controlled in egg-laying systems. For example, the duration of the light phase is initially increased to prompt the beginning of egg-laying at 16–20 weeks of age and then mimics summer day length which stimulates the hens to continue laying eggs all year round; normally, egg production occurs only in the warmer months. Some commercial breeds of hen can produce over 300 eggs a year!

Free-range


Commercial free range hens

Free-range poultry farming allows chickens to roam freely for a period of the day, although they are usually confined in sheds at night to protect them from predators or kept indoors if the weather is particularly bad. In the UK, the Department for Environment, Food and Rural Affairs (Defra) states that a free-range chicken must have day-time access to open-air runs during at least half of its life. Unlike in the United States, this definition also applies to free-range egg laying hens. The European Union regulates marketing standards for egg farming which specifies a minimum condition for free-range eggs that "hens have continuous daytime access to open-air runs, except in the case of temporary restrictions imposed by veterinary authorities".[6] The RSPCA "Welfare standards for laying hens and pullets" indicates that the stocking rate must not exceed 1,000 birds per hectare (10 m^2 per hen) of range available and a minimum area of overhead shade/shelter of 8 m^2 per 1,000 hens must be provided.

Free-range farming of egg-laying hens is increasing its share of the market. Defra figures indicate that 45% of eggs produced in the UK throughout 2010 were free-range, 5% were produced in barn systems and 50% from cages. This compares with 41% being free-range in 2009.[7]

Suitable land requires adequate drainage to minimise worms and coccidial oocysts, suitable protection from prevailing winds, good ventilation, access and protection from predators. Excess heat, cold or damp can have a harmful effect on the animals and their productivity.[8] Free-range farmers have less control than farmers using

cages in what food their chickens eat, which can lead to unreliable productivity, though supplementary feeding reduces this uncertainty. In some farms, the manure from free-range poultry can be used to benefit crops.[9]


Free range chickens being fed outdoors

The benefits of free-range poultry farming for laying hens include opportunities for natural behaviours such as pecking, scratching, foraging and exercise outdoors.[10]

Both intensive and free-range farming have animal welfare concerns. Cannibalism, feather pecking and vent pecking can be common, prompting some farmers to use beak trimming as a preventative measure, although reducing stocking rates would eliminate these problems.[11] Diseases can be common and the animals are vulnerable to predators.[11] Barn systems have been found to have the worst bird welfare.[11] In South-East Asia, a lack of disease control in free range farming has been associated with outbreaks of Avian influenza.[12]

Organic

In organic egg-laying systems, chickens are also free-range. Organic systems are based upon restrictions on the routine use of synthetic yolk colourants, in-feed or in-water medications, other food additives and synthetic amino acids, and a lower stocking density and smaller group sizes. The Soil Association standards[13] used to certify organic flocks in the UK, indicate a maximum outdoors stocking density of 1,000 birds per hectare and a maximum of 2,000 hens in each poultry house. In the UK, organic laying hens are not routinely beak-trimmed.

Yarding

While often confused with free-range farming, yarding is actually a separate method of poultry culture by which chickens and cows are raised together. The distinction is that free-range poultry are either totally unfenced, or the fence is so distant that it has little influence on their freedom of movement. Yarding is common technique used by small farms in the Northeastern US. The birds are released daily from hutches or coops. The hens usually lay eggs either on the floor of the coop or in baskets if provided by the farmer. This husbandry technique can be complicated if used with roosters, mostly because of aggressive behavior.

Battery cage

The majority of hens in many countries are reared in battery cages, although the European Union Council Directive 1999/74/EC[15] has banned the conventional battery cage in EU states from January 2012. These are small cages, usually made of metal in modern systems, housing 3 to 8 hens. The walls are made of either solid metal or mesh, and the floor is sloped wire mesh to allow the faeces to drop through and eggs to roll onto an egg-collecting conveyor belt. Water is usually provided by overhead nipple systems, and food in a trough along the front of the cage replenished at regular intervals by a mechanical chain.

The cages are arranged in long rows as multiple tiers, often with cages back-to-back (hence the term 'battery cage'). Within a single shed, there may be several floors containing battery cages meaning that a single shed may contain many tens of thousands of hens. Light intensity is often kept low (e.g. 10 lux) to reduce feather pecking and vent pecking. Benefits of battery cages include easier care for the birds, floor eggs which are

expensive to collect are eliminated, eggs are cleaner, capture at the end of lay is expedited, generally less feed is required to produce eggs, broodiness is eliminated, more hens may be housed in a given house floor space, internal parasites are more easily treated, and labor requirements are generally much reduced.

In farms using cages for egg production, there are more birds per unit area; this allows for greater productivity and lower food costs.[16] Floor space ranges upwards from 300 cm^2 per hen. EU standards in 2003 called for at least 550 cm^2 per hen.[17] In the US, the current recommendation by the United Egg Producers is 67 to 86 in^2 (430 to 560 cm^2) per bird.[18] The space available to battery hens has often been described as less than the size of a piece of A4 paper.[19] Animal welfare scientists have been critical of battery cages because they do not provide hens with sufficient space to stand, walk, flap their wings, perch, or make a nest, and it is widely considered that hens suffer through boredom and frustration through being unable to perform these behaviours.[20] This can lead to a wide range of abnormal behaviours, some of which are injurious to the hens or their cagemates.

Battery cages for layer hens[14]

Bank of cages

Furnished cage

In 1999, the European Union Council Directive 1999/74/EC[15] banned conventional battery cages for laying hens throughout the European Union from January 1, 2012; they were banned previously in other countries including Switzerland. In response to these bans, development of prototype commercial furnished cage systems began in the 1980s. Furnished cages, sometimes called 'enriched' or 'modified' cages, are cages for egg laying hens which have been designed to overcome some of the welfare concerns of battery cages whilst retaining their economic and husbandry advantages, and also provide some of the welfare advantages of non-cage systems. Many design features of furnished cages have been incorporated because research in animal welfare science has shown them to be of benefit to the hens. In the UK, the Defra "Code for the Welfare of Laying Hens"[21] states furnished cages should provide at least 750 cm^2 of cage area per hen, 600 cm^2 of which should be usable; the height of the cage other than that above the usable area should be at least 20 cm at every point and no cage should have a total area that is less than 2000 cm^2. In addition, furnished cages should provide a nest, litter such that pecking and scratching are possible, appropriate perches allowing at least 15 cm per hen, a claw-shortening device, and a feed trough which may be used without restriction providing 12 cm per hen.

Modern egg laying breeds often suffer from osteoporosis which results in the chicken's skeletal system being weakened. During egg production, large amounts of calcium are transferred from bones to create egg-shell. Although dietary calcium levels are adequate, absorption of dietary calcium is not always sufficient, given the intensity of production, to fully replenish bone calcium. This can lead to increases in bone breakages, particularly when the hens are being removed from cages at the end of laying.

Countries such as Austria, Belgium or Germany are planning to ban furnished cages until 2025 additionally to the already banned conventional cages.[22]

Meat-producing chickens – husbandry systems

Indoor broilers


Broilers in a production house

Meat chickens, commonly called broilers, are floor-raised on litter such as wood shavings, peanut shells, and rice hulls, indoors in climate-controlled housing. Under modern farming methods, meat chickens reared indoors reach slaughter weight at 5 to 9 weeks of age. The first week of chickens life they can grow 300 percent of their body size, a nine-week-old chicken can average over 9 pounds in body weight. At nine weeks a hen will average around 7 pounds and a rooster will weigh around 12 pounds, having a nine-pound average.

Broilers are not raised in cages. They are raised in large, open structures known as grow out houses. A farmer receives the birds from the hatchery at one day old. A grow out consist of 5 to 9 weeks according on how big the kill plant wants the chickens to be. These houses are equipped with mechanical systems to deliver feed and water to the birds. They have ventilation systems and heaters that function as needed. The floor of the house is covered with bedding material consisting of wood chips, rice hulls, or peanut shells. In some cases they can be grown over dry litter or compost. Because dry bedding helps maintain flock health, most growout houses have enclosed watering systems (“nipple drinkers”) which reduce spillage.[23]

Keeping birds inside a house protects them from predators such as hawks and foxes. Some houses are equipped with curtain walls, which can be rolled up in good weather to admit natural light and fresh air. Most growout houses built in recent years feature “tunnel ventilation,” in which a bank of fans draws fresh air through the house.[23]

Traditionally, a flock of broilers consist of about 20,000 birds in a growout house that measures 400/500 feet long and 40/50 feet wide, thus providing about eight-tenths of a square foot per bird. The Council for Agricultural Science and Technology (CAST) states that the minimum space is one-half square foot per bird. More modern houses are often larger and contain more birds, but the floor space allotment still meets the needs of the birds. The larger the bird is grown the fewer chickens are put in each house, to give the bigger bird more space per square foot.[23]

Because broilers are relatively young and have not reached sexual maturity, they exhibit very little aggressive conduct.[23]

Chicken feed consists primarily of corn and soybean meal with the addition of essential vitamins and minerals. No hormones or steroids are allowed in raising chickens.[23][24]

Issues with indoor husbandry

In intensive broiler sheds, the air can become highly polluted with ammonia from the droppings. In this case a farmer must run more fans to bring in more clean fresh air. If not this can damage the chickens' eyes and respiratory systems and can cause painful burns on their legs (called hock burns) and blisters on their feet. Broilers bred for fast growth have a high rate of leg deformities because the large breast muscles causes distortions of the developing legs and pelvis, and the birds cannot support their increased body weight. In cases where the chickens become crippled and can't walk farmers have to go in and pull them out. Because they cannot move easily, the chickens are not able to adjust their environment to avoid heat, cold or dirt as they would in natural conditions. The added weight and overcrowding also puts a strain on their hearts and lungs and Ascites can develop. In the UK, up to 19 million broilers die in their sheds from heart failure each year. In the case of no ventilation due to power failure during a heat wave 20,000 chicken can die in a short period of

time. In a good grow out a farmer should sell between 92 and 96 percent of their flock. With a 1.80 to a 2.0 feed conversion ratio. After the marking of birds the farmer must clean out and repair for another flock. A farmer should average 4 to 5 grow outs a year.[25]

Indoor with higher welfare

Chickens are kept indoors but with more space (around 12 to 14 birds per square metre). They have a richer environment for example with natural light or straw bales that encourage foraging and perching. The chickens grow more slowly and live for up to two weeks longer than intensively farmed birds. The benefits of higher welfare indoor systems are the reduced growth rate, less crowding and more opportunities for natural behaviour.[10]

Free-range broilers

Free-range broilers are reared under similar conditions to free-range egg laying hens. The breeds grow more slowly than those used for indoor rearing and usually reach slaughter weight at approximately 8 weeks of age. In the EU, each chicken must have one square metre of outdoor space.[10] The benefits of free-range poultry farming include opportunities for natural behaviours such as pecking, scratching, foraging and exercise outdoors. Because they grow slower and have opportunities for exercise, free-range broilers often have better leg and heart health.[10]

Turkeys on pasture at an organic farm

Organic broilers

Organic broiler chickens are reared under similar conditions to free-range broilers but with restrictions on the routine use of in-feed or in-water medications, other food additives and synthetic amino acids. The breeds used are slower growing, more traditional breeds and typically reach slaughter weight at around 12 weeks of age.[26] They have a larger space allowance outside (at least 2 square metres and sometimes up to 10 square metres per bird).[5] The Soil Association standards[13] indicate a maximum outdoors stocking density of 2,500 birds per hectare and a maximum of 1,000 broilers per poultry house.

Issues

Humane treatment

Animal welfare groups have frequently criticized the poultry industry for engaging in practices which they believe to be inhumane. Many animal rights advocates object to killing chickens for food, the "factory farm conditions" under which they are raised, methods of transport, and slaughter. Compassion Over Killing and other groups have repeatedly conducted undercover investigations at chicken farms and slaughterhouses which they allege confirm their claims of cruelty.[27]

Conditions in chicken farms may be unsanitary, allowing the proliferation of diseases such as salmonella, E. coli and campylobacter.[28] Chickens may be raised in very low light intensities, sometimes total darkness, to reduce injurious pecking. Concerns have been raised that companies growing single varieties of birds for eggs or meat are increasing their susceptibility to disease. Rough handling, crowded transport during various

weather conditions and the failure of existing stunning systems to render the birds unconscious before slaughter, have also been cited as welfare concerns.


Battery cages

A common practice among hatcheries for egg-laying hens is the culling of newly hatched male chicks since they do not lay eggs and do not grow fast enough to be profitable for meat. There are plans to more ethically destroy the eggs before the chicks are hatched by "in-ovo" sex determination.[29]

Beak trimming


Chickens transported in a truck.

Laying hens are routinely beak-trimmed at 1 day of age to reduce the damaging effects of aggression, feather pecking and cannibalism. Scientific studies (see below) have shown that beak trimming is likely to cause both acute and chronic pain.

The beak is a complex, functional organ with an extensive nervous supply including nociceptors that sense pain and noxious stimuli.[30][31] These would almost certainly be stimulated during beak trimming, indicating strongly that acute pain would be experienced. Behavioural evidence of pain after beak trimming in layer hen chicks has been based on the observed reduction in pecking behavior, reduced activity and social behavior, and increased sleep duration.[32][33][34][35] Severe beak trimming, or beak trimming birds at an older age, may cause chronic pain. Following beak trimming of older or adult hens, the nociceptors in the beak stump show abnormal patterns of neural discharge, which indicate acute pain.[30][36][37][38]

Neuromas, tangled masses of swollen regenerating axon sprouts,[39] are found in the healed stumps of birds beak trimmed at 5 weeks of age or older and in severely beak trimmed birds.[40] Neuromas have been associated with phantom pain in human amputees and have therefore been linked to chronic pain in beak trimmed birds. If beak trimming is severe because of improper procedure or done in older birds, the neuromas will persist which suggests that beak trimmed older birds experience chronic pain, although this has been debated.[41]

Beak-trimmed chicks will initially peck less than non-trimmed chickens, which animal behavioralist Temple Grandin attributes to guarding against pain.[42] The animal rights activist, Peter Singer, claims this procedure is bad because beaks are sensitive, and the usual practice of trimming them without anaesthesia is considered inhumane by some.[43] Some within the chicken industry claim that beak-trimming is not painful[44] whereas others argue that the procedure causes chronic pain and discomfort, and decreases the ability to eat or drink.[43][45]

Antibiotics

Overview of Antibiotic Use in Poultry

Antibiotics have been used in poultry farming in mass quantities since 1951, when the Food and Drug Administration (FDA) approved their use.[46] Three years prior to the FDA's approval, scientists were investigating a phenomena in which chickens who were rooting through bacteria-rich manure were displaying signs of greater health than those who did not. Through testing, it was discovered that chickens who were fed a

variety of vitamin B12 manufactured with the residue of a certain antibiotic grew 50 percent faster than those chickens who were fed B12 manufactured from a different source.[47] Further testing confirmed that use of antibiotics did improve the health of the chickens, resulting in the chickens laying more eggs and experiencing lower mortality rates and less illness. Upon this discovery, farmers transitioned from expensive animal proteins to comparatively inexpensive antibiotics and B12. Chickens were now reaching their market weight at a much faster rate and at a lower cost. With a growing population and greater demand on the farmers, antibiotics appeared to be an ideal and cost-effective way to increase the output of poultry. Since this discovery, antibiotics have been routinely used in poultry production, but more recently have been the topic of debate secondary to the fear of bacterial antibiotic resistance.[48]

Emerging Threats: Antibiotic Resistance

The Centers for Disease Control (CDC), has identified the emergence of antibiotic resistance as a national threat.[49] The concern over antibiotic use in livestock arises from the necessity antibiotics have in keeping populations disease-free. As of 2016, over 70 percent of FDA approved antibiotics are utilized in modern, high production poultry farms to prevent, control, and treat disease.[50] The FDA released a report in 2009 estimating that 29 million pounds of antibiotics had been used in livestock in that year alone.[51] However, surveillance of consumer exposure to antibiotics through poultry consumption is limited. More specifically in 2012, the FDA speculated the most significant public health threat in regard to antimicrobial use in animals is the exposure of antimicrobial resistant bacteria to humans.[52] These statements are challenged by the American meat industry lobbyists that antibiotics are used responsibly and judiciously in order to ensure effectiveness.[53]

Consumer Health effects

Consumers are exposed to antibiotic resistance through consumption of poultry products that have prior exposure to resistant strains. In poultry husbandry, the practice of using medically important antibiotics can select for resistant strains of bacteria, which are then transferred to consumers through poultry meat and eggs. The CDC acknowledges this transferral pathway in their 2013 report of Antibiotic Resistant Threats in the United States.[54] The annual rate of foodborne illness in the United States is one in six. For the 48 million individuals affected, antibiotics play a critical role in thwarting mortality rates.[55] In a literature review conducted by the Review of Antimicrobial Resistance 100 out of 139 studies found evidence of a link between antibiotic use in animals and antibiotic resistance in consumers.[51]

When a gram-negative bacterial infection is suspected in a patient, one of the first-line options for treatment is in the fluoroquinolone family. This, along with penicillin, is one of the first families of antibiotics utilized in the broiler industry. If this first-line treatment is not successful, a stronger class of antibiotics is typically used, however, there is a limitation on how many classes are available, as well as which medications are available on hospital formularies. There is also more drug toxicity affiliated with second and third line antibiotic options. This is one example why it is critical to keep as many first line antibiotic options available for human use.[56]

Other issues are associated with duration and complexity of infection. On average, treatment for non-resistant bacteria is administered 11.5 hours after diagnosis, and treatment for resistant bacteria is administered 72 hours after diagnosis.[56] This is a reflection of the additional threat of prolonged incubation, leading to greater potential for systemic disease, with higher morbidity and mortality associated with opportunities for complications, and prolonged treatment time. For example, of the two million people affected by resistant infections a year, 23,000 will die.[57] Severity in mortality is coupled when exposed to high risk populations such as immunocompromised and elderly individuals in hospital and nursing home settings.[58]

History of US Federal policy on antibiotic use in livestock

- 1940s – Beginning of utilization of antibiotics in livestock feed
- 1951 - Antibiotics first FDA approved for use in poultry. Approved uses included production (growth enhancement), treatment, control, or prevention of animal disease. Antibiotics were also available for purchase over the counter at that time.
- 1970 - FDA task force publication proposes limitations of utilizing antibiotics in livestock feed that are also used in humans.
- 1975 - Secondary to this publication, drug sponsors are required to submit studies demonstrating the antibiotics did not harm human health
- 1976 - Stuart Levy study demonstrating tetracycline resistant E. coli moving to consumers[59]
- 1977 - FDA proposal to remove penicillin and tetracycline in subtherapeutic doses, however, request by Congress for further studies to be conducted.
- 1980 - National Academy of Science recruited by the FDA to conduct further studies, specifically for penicillins and tetracyclines. Conclusion from these studies indicated no sufficient evidence to ban these antibiotics.
- 1980s-early 2000s - Further studies continued, supported by the FDA
- 2003 - FDA issued guidance to pharmaceuticals for an approval process utilizing new antibiotics in animal feed. For antibiotics already in use, the FDA would have to withdraw approval for each individual medication.
- 2005 - Enrofloxacin, an already utilized antibiotic, was removed from poultry production. This took 5 years to accomplish.
- 2010 - FDA first draft of “voluntary” limitations of medically important antibiotics in livestock, and requirement of veterinarian oversight, which would later become “Guidance for Industry #209.”
- 2011 - FDA removed original request from 1977 to remove penicillins and tetracyclines in feed.
- 2012 - FDA finalized “Guidance for Industry #209,” which was implemented under the Veterinary Feed Directives. These guidelines were issued to pharmaceuticals.[60]
- 2013 - FDA issues “Guidance for Industry #213,” which provided additional information to pharmaceuticals for recommendations from #209.
- 2014 - All 26 pharmaceutical companies producing antibiotics used in livestock feed agreed to the FDA guidelines in #213. Gave total of 3 years to make all recommended changes.

[61]

Current Federal Regulators

National Antimicrobial Resistance Monitoring System’s (NARMS) Enteric Bacteria program - Established in 1996, and represents a collaboration between the USDA, FDA, and CDC. Its purpose is to organize these organizations into a drug monitoring program for antibiotics utilized in animal feed with the goal of maintaining their medical efficacy. There are three branches which oversee humans, retail meat, and food animals.[61]

- USDA - Operating under the Food Safety and Inspection Service (FSIS). Main role is in charge of testing imported and domestic meat for antimicrobial resistant bacteria. If a ‘residue violation’ found, they may condemn the product. Regardless, funding and resources are not available for outbreak investigations at farms or ranches.
- FDA - Operating under the Center for Veterinary Medicine (CVM). Works with CDC to monitor retail meat.
- CDC - Monitors human samples.

[61]

Vertical Integration
This is the current business structure utilized almost universally in the broiler, or chicken bred for meat, industry. This also began in the 1940s when antibiotics began to be utilized in livestock feed. Perdue is credited as the pioneer of this structure.[62] The basis is centralization of production. 'Integrators' control cost, policy, and are the decision makers of production. They decide feed formulations, choice of antibiotic administration, and cover those costs in addition to veterinary services. They also own the poultry that is grown. Farmers are labeled as 'Growers' or 'Operators'. They own the land and buildings where the poultry is grown, and are essentially caretakers for the poultry growth to the Integrators.[61] The benefit for Growers in this business structure is they are guaranteed payment from the Integrators, which is compensated in weight gained by each flock.[63] Due to this structure, about 90% of broilers are raised within 60 miles of the processing plant. Integrators are large poultry companies such as Perdue, Tyson, Pilgrim's Pride, Koch Foods, etc. There are about 20 of these companies in the U.S. that control 96% of all broilers produced in 2011.[61]

Regulatory Surveys
There are two main surveys distributed to farmers by the federal government to aid in various regulations of the agricultural industry. They are the Agricultural and Resource Management Survey (ARMS) and the National Animal Health Monitoring Survey (NAHMS).[61]

Agricultural and Resource Management Survey (ARMS) - Ran by the USDA's Economic Research Service (ERS) and National Agricultural Statistics Service (NASS). The main focus is finances of farming, production practices, and resource use. Seventeen total states are sampled every 5–6 years per livestock type, with the most recent surveys distributed to broiler farmers in 2006 and 2011. There was one question about utilization of antibiotics in poultry food or water, excluding use for illness treatment.[61]

Antibiotic Resistant Outbreaks from Poultry Meat
In order to minimize and prevent any residues of antibiotics in chicken meat, any chickens given antibiotics are required to have a "withdrawal" period before they can be slaughtered. Samples of poultry at slaughter are randomly tested by the FSIS, and show a very low percentage of residue violations.[64] Although violations are minimal, these small amounts of antibiotics have still contributed to antibiotic resistant outbreaks in the U.S. There are five infectious agents that account for 90% of foodborne related deaths. Three consistently found in poultry are: Salmonella, Campylobacter, and Escherichia coli.[65]

- 2014: Outbreak of Salmonella in 634 people across 29 states (38% hospitalized) from eating chicken from Foster Farms that was sold at Costco. 44/68 tested isolates were resistant to at least 1 drug (65%), and 4 of 5 chicken samples tested were drug resistant (80%).[66]
- 2015: Outbreak of Salmonella in 15 people in 7 states (4 hospitalized) from eating frozen stuffed chicken produced by Barber Foods.[67]

Limitations & Challenges
One obstacle to gathering more comprehensive data on the use of antibiotics in feed is the majority of the poultry industry utilizes vertical integration. As a consequence, farmers are often unaware of what components go into the feed, including whether or not antibiotics are used.[68] Also in antibiotic usage in general, there are criteria to define bacterial resistance to specific antibiotics, however, there are no standards to divide the bacteria into resistant and susceptible categories based on antibiotics utilized.[69]

The poultry industry also plays a large part in the United States economy, both in domestic purchasing and through international demand. The USDA reports that the U.S. is the "world's largest producer and second largest exporter of poultry meat." In 2010, the U.S. produced 36.9 billion pounds of broiler meat and exported

6.8 billion pounds of broiler meat. This equates to an estimated retail value of 45 billion dollars in 2010.[70]

Both the agricultural and pharmaceutical industries have been lobbying against legislation that seeks to quell non-therapeutic antibiotic use in livestock since the first introduction of such legislation in Congress in the 1970s.[71] Despite scientific evidence suggesting a strong association between antibiotic use in poultry and other livestock, agribusiness lobbies such as The National Chicken Council argue that there is not sufficient evidence to purport that there is a measurable impact to humans and shifts the blame of the problem of antibiotic resistance to overprescribing in the field of medicine.[72]

With antibiotic restrictions, integrators will bare the immediate costs of these changes, and would likely result in modified finances and contracts with growers.[61] Also, public health agencies may not have adequate scientific evidence for making appropriate decisions for better public health outcomes, secondary to lack of research funds. As a reference, the US spends about $101 billion per year for both governmental and biomedical industrial research, which is only 5% of total health expenditures.[69]

Solutions

Several policies have been proposed to improve data collection and transparency in livestock production. For example, the 2013 Delivering Antimicrobial Transparency in Animals (DATA) Act proposed the enactment of policies to acquire more accurate documentation of antibiotic use in growth promotion by farmers, drug manufacturers, and the FDA.[73] Also, the Preservation of Antibiotics for Medical Treatment Act (PAMTA) was enacted to eliminate the use of medically important antibiotics in livestock.[73] In 2015, the Preventing Antibiotic Resistance Act (PARA) was passed with two components: requirement of drug companies to provide evidence that antibiotics that are approved for use in poultry, and that meat production does not add to the growing threat of antibiotic resistance in humans.[74] Antimicrobial Stewardship Programs (ASPs) serve as an example of systematic monitoring and analysis of data via interdisciplinary and multi-sectoral collaboration.[75]

Performing quality improvement in the process of livestock production is another focus. Some alternative methods include “improving hygiene, using enzymes, probiotics, prebiotics, and acids to improve health and utilizing bacteriocins, antimicrobial peptides, and bacteriophages as substitutes for antibiotics.”[75] Adaptations of methods by other countries is an additional focus. For example, the use of antibiotics in feed was banned in Sweden in 1985 with no compensatory increase in antibiotic usage in other sectors of production, proving that a ban can be successfully administered without unintended impacts on other categories.[76]

Major producers in the poultry industry have also begun to make strides towards change, largely due to public concern over the widespread use of antibiotics in poultry. Some producers have started eliminating the use of antibiotics in order to produce and market chickens that may legally be labeled "antibiotic free". In 2007, Perdue began phasing out all medically important antibiotics from its feed and hatcheries and began selling poultry products labeled “no antibiotics ever” under the Harvestland brand. Consumer response was positive and in 2014 Perdue also began phasing out ionophores from its hatchery and began using the "antibiotic free" labels on its Harvestland, Simply Smart and Perfect Portions products.[77]

Impacts of Change

As Guidance for Industry #213 has been voluntarily accepted, it will be a violation of the Federal Food, Drug, and Cosmetic Act to use antibiotics in livestock production for non-therapeutic purposes. However, as there is now a requirement for veterinary oversight and approval for antibiotics use, there is leeway in the interpretation of non-therapeutic purposes dependent on the situation. For example, per the FDA, “a veterinarian may determine, based on the client’s production practices and history, that weaned beef calves arriving at a feedlot in bad weather after a lengthy transport are at risk to develop bacterial respiratory

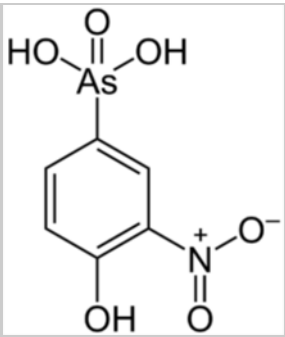
infection. In this case, the veterinarian might choose to preventively treat these calves with an antimicrobial approved for prevention of that bacterial infection."[78]

The FDA is not trying to regulate all antimicrobials at this time - only those antibiotics which are considered "medically important." For example, bacitracin, a common antibiotic found in over the counter antibiotic ointments, is not classified as "medically important." Also, ionophores, which are not apart of human medicine but given for improving the health of livestock, are also not included in this regulation.[79]

Arsenic

Poultry feed can also include roxarsone or nitarsone, arsenical antimicrobial drugs that also promote growth. Roxarsone was used as a broiler starter by about 70% of the broiler growers between 1995 and 2000.[80] The drugs have generated controversy because it contains arsenic, which is highly toxic to humans. This arsenic could be transmitted through run-off from the poultry yards. A 2004 study by the U.S. magazine Consumer Reports reported "no detectable arsenic in our samples of muscle" but found "A few of our chicken-liver samples has an amount that according to EPA standards could cause neurological problems in a child who ate 2 ounces of cooked liver per week or in an adult who ate 5.5 ounces per week." The U.S. Food and Drug Administration (FDA), however, is the organization responsible for the regulation of foods in America, and all samples tested were "far less than the... amount allowed in a food product."[81]

Growth hormones



Roxarsone, a controversial arsenic compound used as a nutritional supplement for chickens.

Hormone use in poultry production is illegal in the United States.[24][82][83] Similarly, no chicken meat for sale in Australia is fed hormones.[84] Several scientific studies have documented the fact that chickens grow rapidly because they are bred to do so, not because of growth hormones.[85][86] A small producer of natural and organic chickens confirmed this assumption:

> "Using hormones to boost egg production was a brief fad in the Forties, but was abandoned because it didn't work. Using hormones to produce soft-meated roasters lasted into the Fifties, but the improved growth rates of normal, untreated broilers made the practice irrelevant—the broilers got as big as anyone wanted without chemicals. The only hormone that was ever used in any quantity on poultry (DES) was banned in 1959, and everyone but a few die-hard farmers had given up hormones by then, anyway. Hormones are now illegal in poultry and eggs."[87]

E. coli

According to Consumer Reports, "1.1 million or more Americans [are] sickened each year by undercooked, tainted chicken." A USDA study discovered *E. coli (Biotype I)* in 99% of supermarket chicken, the result of chicken butchering not being a sterile process.[88] However, the same study also shows that the strain of *E. coli* found was always a non-lethal form, and no chicken had any of the pathenogenic O157:H7 serotype.[88] Many of these chickens, furthermore, had relatively low levels of contamination.[89]

Feces tend to leak from the carcass until the evisceration stage, and the evisceration stage itself gives an

opportunity for the interior of the carcass to receive intestinal bacteria. (The skin of the carcass does as well, but the skin presents a better barrier to bacteria and reaches higher temperatures during cooking.) Before 1950, this was contained largely by not eviscerating the carcass at the time of butchering, deferring this until the time of retail sale or in the home. This gave the intestinal bacteria less opportunity to colonize the edible meat. The development of the "ready-to-cook broiler" in the 1950s added convenience while introducing risk, under the assumption that end-to-end refrigeration and thorough cooking would provide adequate protection. *E. coli* can be killed by proper cooking times, but there is still some risk associated with it, and its near-ubiquity in commercially farmed chicken is troubling to some. Irradiation has been proposed as a means of sterilizing chicken meat after butchering.

The aerobic bacteria found in poultry housing can include not only *E. coli*, but *Staphylococcus*, *Pseudomona*, *Micrococcus* and others as well. These contaminants can contribute to dust that often cause issues with the respiratory systems of both the poultry and humans working in the environment. If bacterial levels in the poultry drinking water reach high levels, it can result in bacterial diarrhoea which can lead to blood poisoning should the bacteria spread from the damaged intestines.[90]

Salmonella too can be stressful on poultry production. How it causes disease has been investigated in some detail.[91]

Avian influenza

There is also a risk that crowded conditions in chicken farms will allow avian influenza (bird flu) to spread quickly. A United Nations press release states: "Governments, local authorities and international agencies need to take a greatly increased role in combating the role of factory-farming, commerce in live poultry, and wildlife markets which provide ideal conditions for the virus to spread and mutate into a more dangerous form..."[92]

Efficiency

Farming of chickens on an industrial scale relies largely on high protein feeds derived from soyabeans; in the European Union the soybean dominates the protein supply for animal feed,[93] and the poultry industry is the largest consumer of such feed.[93] Two kilograms of grain must be fed to poultry to produce 1 kg of weight gain,[94] much less than that required for pork or beef.[95] However, for every gram of protein consumed, chickens yield only 0.33 g of edible protein.[96]

Economic factors

Changes in commodity prices for poultry feed have a direct effect on the cost of doing business in the poultry industry. For instance, a significant rise in the price of corn in the United States can put significant economic pressure on large industrial chicken farming operations.[97]

Worker health and safety

Poultry workers experience substantially higher rates of illness and injury than manufacturing workers do on average.

Muscular Disorders

For the year 2013, there were an estimated 1.59 cases of occupation-related illness per 100 full-time U.S. meat and poultry workers, compared to .36 for manufacturing workers overall.[98] Injuries are associated with repetitive movements, awkward postures, and cold temperatures. High rates of carpal tunnel syndrome and other muscular and skeletal disorders are reported. Disinfectant chemicals and infectious bacteria are causes of respiratory illnesses, allergic reactions, diarrhea, and skin infections.[99]

Respiratory consequences

Poultry housing has been shown to have adverse effects on the respiratory health of workers, ranging from a cough to chronic bronchitis. Workers are exposed to concentrated airborne particulate matter (PM) and endotoxins (a harmful waste product of bacteria. In a conventional hen house a conveyor belt beneath the cages removes the manure. In a cage-free aviary system the manure coats the ground, resulting in the build-up of dust and bacteria over time. Eggs are often laid on the ground or under cages in the aviary housing, causing workers to come close to the floor and force dust and bacteria into the air, which they then inhale during egg collection.[100]

Excretory consequences

Oxfam America reports that huge industrialized poultry operations are under such pressure to maximize profits that workers are denied access to restrooms.[101]

World chicken population

The Food and Agriculture Organization of the United Nations estimated that in 2002 there were nearly sixteen billion chickens in the world, counting a total population of 15,853,900,000.[102] The figures from the *Global Livestock Production and Health Atlas* for 2004 were as follows:

1. China (3,860,000,000)
2. United States (1,970,000,000)
3. Indonesia (1,200,000,000)
4. Brazil (1,100,000,000)
5. Pakistan (691,948,000)
6. India (648,830,000)[103]
7. Mexico (540,000,000)
8. Russia (340,000,000)
9. Japan (286,000,000)
10. Iran (280,000,000)
11. Turkey (250,000,000)
12. Bangladesh (172,630,000)
13. Nigeria (143,500,000)

In 2009 the annual number of chicken raised was estimated at 50 billion, with 6 billion raised in the European Union, over 9 billion raised in the United States and more than 7 billion in China.[104]

In 1950, the average American consumed 20 pounds of chicken per year, but it is predicted that the average consumption will be 89 pounds in 2015. Additionally, in 1980 most chickens were sold whole, and by 2000 almost 90 percent of chickens were sold after being processed into parts. This increase in consumption and

processing has led to many of these occupation-related illness.[105]

See also

- Chicken harvester
- Controlled-atmosphere killing (CAK)
- Environmental issues with agriculture
- Henopause
- Poultry farming in the United States

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