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The Life of Commercial Laying Hens

Cynthia Schuck-Paim, Kaitlin Wurtz, Wladimir J. Alonso

The global production of eggs has reached 83 million tonnes in 2019, up from 19 million tonnes in 1970 [1]. This amounts to over 1.5 trillion eggs produced every year by a population of approximately 7.5 billion laying hens - a group of animals now as abundant as the human population.

As with other sectors of the livestock industry, the many-fold increase in egg production over the previous decades happened along with a radical transformation in the form and structure of animal farming, with subsistence and small-scale production being replaced by highly industrialized production processes and massive increases in per-animal production [2].

Productivity gains in the egg industry have stemmed predominantly from the selection of highly productive breeds, along with the manufacturing of highly specialized diets and additives designed to maximize feed conversion. Commercial layer lines now lay about 320 eggs over a period of 70-80 weeks, with goals for 500 eggs in about 100 weeks, compared to about 80 eggs per year in 1900.

Over-selection for early, elevated and extended egg production took a heavy toll on the health of laying hens, with a high incidence of metabolic and bone disorders, among other welfare challenges associated with acute and chronic pain. Some of these illnesses have been referred to as 'production diseases', defined as those illnesses that typically become more prevalent or severe in proportion to the potential productivity of the system [3]. Reductions of labor costs have further compounded the problem - nowadays, bird to caregiver ratios are so low (reaching in some cases 1 worker to 100,000 birds) that it is infeasible to inspect the health of individual birds [4].

In addition to the massive increases in output per animal, major shifts in raising methods included the confinement of animals at high densities in closed and barren environments, particularly those species fed on concentrated feed. In the case of laying hens, confinement has reached extreme levels through the adoption of cage systems (also known as battery cages) as a means to save labor costs and improve early chick viability [5]. In this system, hens are provided with approximately 430 to 450 cm² per bird, an area smaller than an A4 sheet of paper. As of 2021, most laying hens spend their entire lives in these systems (Figure 2.1).

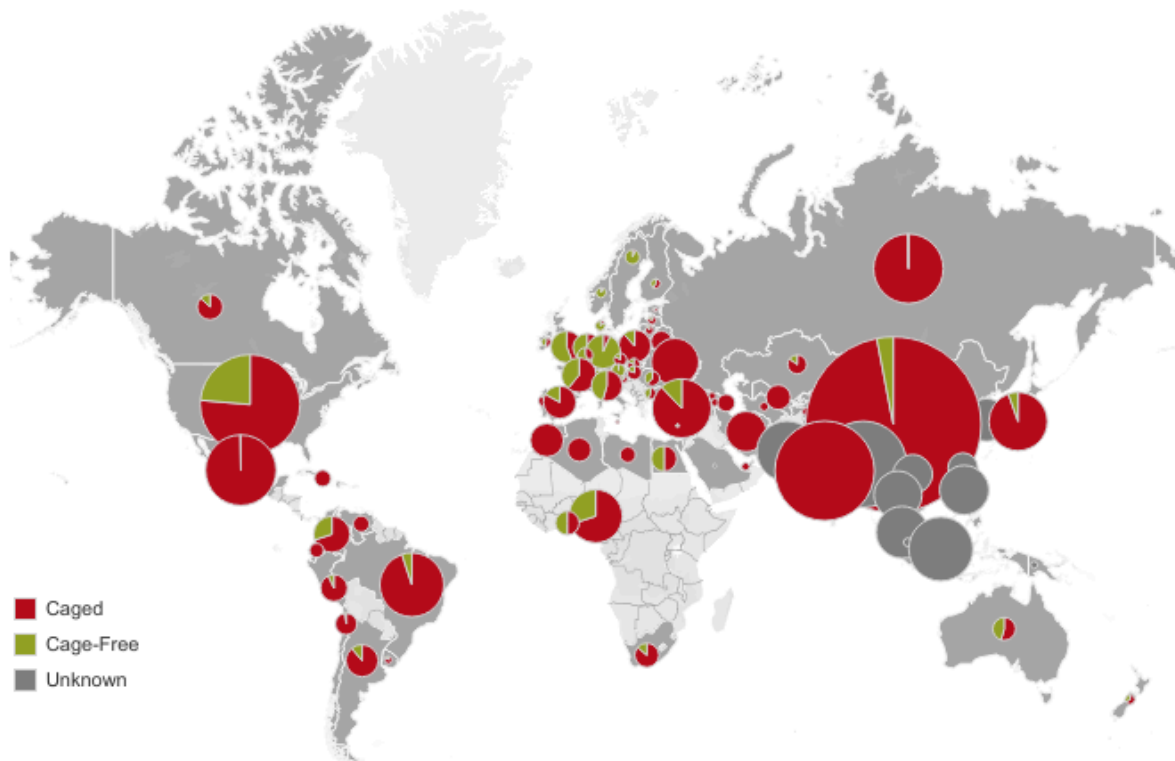


Figure 2.1. Global distribution of laying hens by housing system. Distribution of laying hens in caged (red: conventional; furnished) and cage-free (green: barns, aviaries, free-range) systems in 78 countries (dark grey) for which hen inventories are available. The size of circles is proportional to the hen population in the country. Dark grey circles: countries for which the hen population is known, but the proportion of hens in each housing system is unknown. An interactive version of this figure is available at <https://welfarefootprint.org/research-projects/laying-hens>, with further information available on data sources, proportion of hens in each system and layer populations.

Although in captivity food and shelter are provided by humans, the highly adaptive drive to seek, choose and care for critical resources, and to nurture such abilities, did not suddenly vanish. Despite thousands of years of domestication [1], there is no evidence that the cognitive abilities and complex behavior of farmed breeds has changed substantially compared to that of their wild ancestors [2]. Given the opportunity, modern laying hens will forage for several hours per day [3], build a nest, roost at night, dustbathe, flap their wings, and move around, in the same way that their ancestor, the red jungle fowl, did. The impossibility to fulfill these needs in caged systems (Figure 2.2) has been widely recognized as an important source of poor welfare.

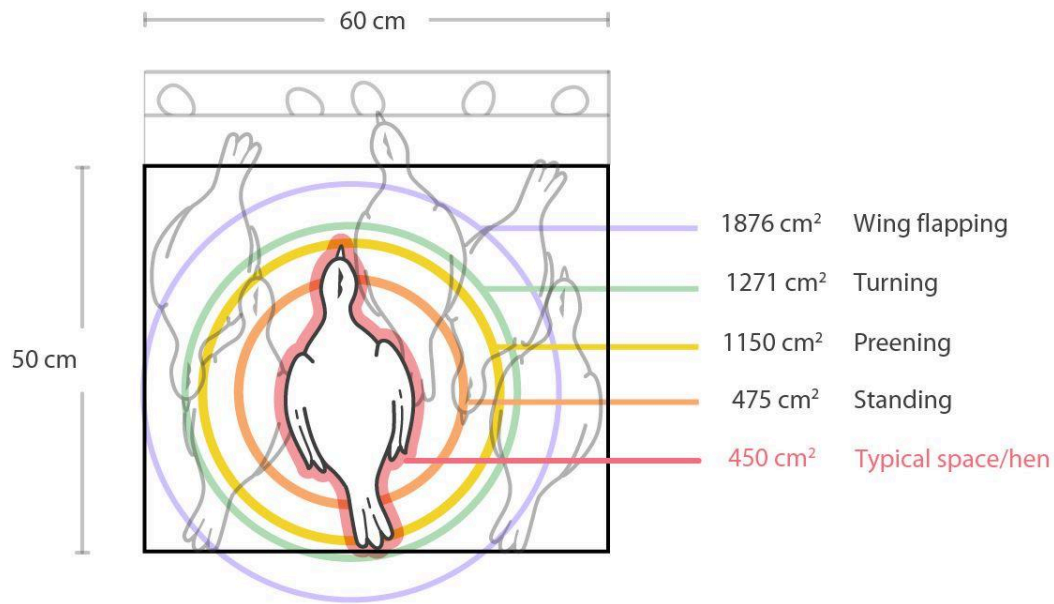


Figure 2.2. Area required to perform several comfort behaviors relative to the space typically available in conventional cage systems. Adapted from Dawkins and Hardie [6]. Illustration: Alberto Gareppe.

Additionally, many of the selective pressures previously acting to maintain animals physically fit for survival in a natural environment were relaxed in captivity. In many cases, what would be life-threatening ailments and disabilities in free-living animals were allowed to persist with the use of workarounds enabling survival until the slaughter age. One such workaround has been the large-scale use of broad-spectrum antibiotics as prophylactics to prevent disease - a practice that has raised serious concerns for global health [2,7,8]. By limiting mobility, caged systems have also enabled the survival of individuals with poor skeletal integrity, as movements that could increase the likelihood of fractures (jumps, flights) are absent in these systems. More importantly, when fractures do occur, fractured individuals can still keep eating, drinking and laying eggs, as nearly no displacement is required to perform these activities in a cage. As a consequence, there has been little incentive for the selection of individuals with good bone health.

Transition to cage-free systems

Public attention to the welfare of laying hens has been fostering a transition away from conventional battery cage systems, with an increase in the proportion of furnished cages (which provide hens with some additional space, a nest, and perches) and cage-free systems in some countries, either through legislation or corporate commitments for the sourcing of cage-free eggs. For example, as of 2018, most US food retailers and restaurants had made pledges to sell only cage-free eggs [9], and as of March 2020, nearly 24% of all hens in the United States were raised in cage-free systems, up from 12% in 2016 and 4% in 2010 [10]. Emerging cage-free markets in other regions of the world, such as Latin America, are also increasingly prevalent [11].

Still, although cage-free housing is widely associated with improved welfare, some authors have argued that each housing system has unique welfare challenges [12–14]. For example, in a qualitative

comparison of hen welfare in different housing environments, Lay and collaborators [13] comment that *‘more space allows for hens to perform a greater repertoire of behaviors, although some deleterious behaviors such as cannibalism and piling, which results in smothering, can occur in large groups’*, or that conventional cages *‘can lead to osteoporosis, but environments that have increased complexity, such as non-cage systems, expose hens to an increased incidence of bone fractures’*. A similar argument is put forth by Nicol [15], who highlights that the more complex and varied social environment of cage-free settings have the potential to exacerbate problems such as injurious pecking and keel bone damage. Concerns have also been raised over potentially higher disease and mortality rates in cage-free systems [16–18].

These observations suggest that some welfare challenges could see their prevalence increased in the initial period following a transition to cage-free systems, before producers acquire experience with the new systems and genetics are optimized to ensure that laying hens gain back the necessary resilience and good health required for life in a more natural setting [19]. Cage-free environments undeniably provide hens with multiple behavioral opportunities that are unavailable in cages, but it is not yet clear the extent to which these opportunities compare against the potential impoverishment of some other dimensions of their welfare.

In this book we apply the analytical framework presented in Chapter 1 [20] to quantify the welfare impact of cage-free reform as measured by the cumulative time in pain (i.e. affective states of negative valence) potentially averted for every laying hen raised in an aviary instead of a cage. Because the framework uses a common metric (time in pain) that enables comparing negative experiences of very different nature, it makes it possible to weigh the welfare impact of behavioral deprivations in caged environments against that associated with putative changes in disease and injury risk in cage-free settings. The quantification of the time in pain endured by laying hens as a result of various welfare challenges should also enable the identification of hotspots of welfare loss in the production cycle, supporting informed policy and research funding.

We focus the analysis on conventional cages, furnished cages and indoor aviary systems (single-tier and multi-tier), considered by the industry as the preferred cage-free alternative for large scale egg production. Because our objective is to quantify the welfare impact of changes in housing conditions during the laying cycle, the analysis is also focused on one life-fate in the egg production chain (laying hens) and one production phase (the laying cycle) ¹.

For each housing system we estimated the total time a laying hen is expected to spend in different categories of pain intensity as a result of key welfare challenges. Instead of considering an exhaustive list of every possible harm affecting commercial layers, we examined thoroughly key sources of physical pain and psychological pain understood to be among the most serious welfare problems they endure, particularly those likely to be affected by the transition from cages to cage-free aviaries. Among these are keel bone fractures, injurious pecking (e.g. skin wounds, vent wounds, cannibalism), the deprivation of a number of highly motivated behaviors and egg peritonitis syndrome, the most common production disease in modern breeds of laying hens and the leading cause of mortality. We also quantify the cumulative time in pain resulting from the process of depopulation and transport, as it remains one of the most serious welfare problems in the poultry industry.

¹ Different goals would entail a different scope of analysis. For example, should we wish to determine the welfare footprint of an egg (i.e. time in pain embedded in each egg), we would need to consider the loss of welfare of all life-fates involved in the production chain (male chicks, pullets, breeders) and all production phases experienced by every life-fate (from the hatchery to the slaughterhouse).

Naturally, not all individuals of a flock will experience all welfare offenses. For example, while the possible frustration emerging from behavioral deprivation is experienced by every hen kept in a cage, only a few birds are victims of fatal cannibalistic attacks. The prevalence of each welfare challenge must be in this way taken into account, so that the cumulative load of negative experiences in each system and condition is determined for the “average flock member” (Chapter 1). Therefore, where appropriate, literature reviews were conducted to determine the prevalence of the welfare challenges examined in commercial populations.

In comparing housing conditions, it is important to establish the extent to which the differences in the prevalence of challenges are intrinsic to the systems analysed, or are instead by-products of confounding factors. As demonstrated in a recent meta-analysis [21], management experience can act as an important confounder of the prevalence of different welfare problems in comparisons of production conditions, hence comparisons among housing systems should control for this factor. Unfortunately, as it will become clear in the next chapters, the data needed to do so is not yet available in most cases, so estimates of the prevalence of different welfare challenges discussed in the book are most likely to reflect a situation where the technological, genetic and managerial maturity of cage-free housing is not yet on par with that already achieved by caged systems.

In the next section we describe each of the housing conditions examined. We focus on conventional cages, furnished cages and indoor aviary systems (single-tier and multi-tier aviaries with no outdoor access), considered by the industry as the preferred cage-free alternative for large scale egg production.

Early Life

The life of a laying hen begins at a commercial hatchery. Fertilized eggs are placed in climatically controlled incubators which maintain the eggs at the appropriate temperature and humidity for development. After approximately 21 days in the incubator, birds begin hatching from their shells. At a day old, chicks are removed from the incubator for processing. In many cases, this process is mechanized, and chicks travel along a conveyor belt for further processing. The sex of the chicks is determined and male chicks are killed, typically by a maceration process in which their bodies are passed through a shredder. Some facilities kill male chicks using a CO₂ gas chamber instead [22], though the extent to which it causes less pain is not yet clear since the maceration process takes about a second, whereas CO₂ is known to be aversive to birds and death takes a longer time to be achieved [23]. Female chicks will continue along the mechanized conveyor belt system where they will be vaccinated, have their beaks trimmed (Box 2.1), and be placed into boxes for shipment. Overall, evidence indicates that laying hens experience important levels of stress during the commercial hatchery processing, with several behavioral and hormonal effects later in life, including higher levels of fearfulness, feather damage and injuries [24].

Box 2.1 Beak Trimming

Beak trimming is the process of removing the tip of the mandible, and is widely used as a band-aid solution to prevent problems of feather pecking and cannibalism in layer flocks (beak trimmed flocks are less likely to experience damage from injurious pecking or cannibalism; Chapter 4 [25]). Still, beak trimming is recognized as a painful procedure, as the beak is richly innervated and acts as a sensory organ [26] as well as a tool [27]. Welfare consequences include loss of normal beak function and sensory function, pain and temporary debilitation, neuromas and scar tissue [28–31]. Additionally, it is possible that early-life pain increases pain sensitivity later in life and chronic pain risk. When beak-trimming is performed correctly, the hen should retain the ability to feed, peck the ground during foraging, and to preen herself, though evidence indicates that a large fraction of hens have beak abnormalities [32,33].

The vast majority of laying hens will have their beaks trimmed using one of two methods: infrared beak trimming (IRBT) or hot blade beak trimming. IRBT is usually performed at a day old at the hatchery. Chicks are restrained by their heads and infrared energy is directed towards the tip of their beak. The beak remains intact after this procedure but will gradually soften and erode over a period of roughly 2 weeks. Hot blade beak trimming is often performed at any time before 10 days of age. This procedure involves the use of a heated blade which removes and cauterizes the tip of the upper and lower mandibles. Current research suggests that IRBT is less harmful than the use of hot blades, as it is more precise and eliminates open wounds, being less likely to result in hens experiencing chronic pain during their adult life [34].

Within approximately 1-2 days of hatching [35], female chicks are shipped to a rearing facility where they will remain up until they are ready to begin laying eggs. Shipping most often occurs through road transportation, exposing chicks to challenging thermal conditions, noise, vibration, and a period of food and water deprivation. Mortality is common during transport and mortality rate is associated with travel time, with longer travel times resulting in greater numbers of chicks dead on arrival [36,37]. The rearing facility in which chicks are housed can vary widely, from cages to single level floor systems to modified aviary systems for those expected to be placed in multi-tier aviaries later in life. Pullet housing systems ideally should expose pullets to environments similar to their laying environment to ease their transition, facilitate their ability to access food, water, and other resources, and to prevent injury. Laying hens that will need to navigate complex three dimensional spaces later in life must develop spatial navigational skills as well as the physical fitness at a young age otherwise they may struggle to reach upper tier levels containing food and water and may be more likely to lay floor eggs [38]. Additionally, pullets raised in single level systems may be more prone to collisions when required to navigate vertical environments [39].

Inside the Hen house

The description of processes typically associated with different housing and production conditions presents challenges of technical nature to specialists and of understanding to laypersons. The same type of system can vary widely, depending on factors such as legislation, its enforcement, market

requirements and regional traditions. Differences may be present in the breeds used, stocking densities, the size of enclosures, the provision of enrichment, the timing and length of production phases, veterinary interventions, management style, among other factors.

To convey information about typical and relevant processes involved in animal production, we have recently developed a temporal data visualization solution, which we refer to as ‘Processogram’ [40]. A processogram is a process diagram that depicts the spatial and temporal configuration of the production chain, focusing on the physical and social environments to which animals are exposed during each phase of their lives. The horizontal dimension represents time, and is subdivided into the corresponding phases that are typical of the system, with their corresponding average duration. Within each phase, the spatial dimensions of living beings and physical objects depict, with realistic proportions, the circumstances to which animals are exposed. Features such as the size of living beings or space availability in each life stage can thus be assessed and compared. The number of components shown in the graph (e.g. animals, nests, feeders, drinkers) is also intended to be representative of commercial practice.

Next we briefly describe the main features of each housing condition using processograms, focusing on their main defining features (considering the diversity of systems at a global scale).

Conventional Cages

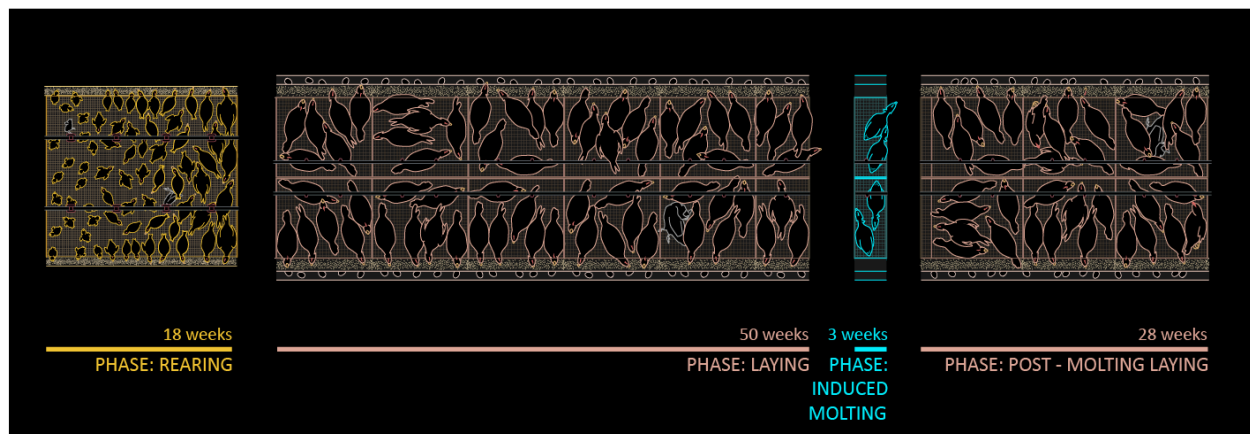


Figure 2.2. Processogram depicting the life of laying hens housed in conventional cage systems. A phase of induced molting is included (blue), as it is still widely practiced outside Europe. Elements are spatially scaled to illustrate the space available to individuals.

Conventional cage systems are still the most common housing condition in major egg producing countries outside of the European Union. In this system, laying hens are kept in what are often wire cages holding about 5 to 10 birds, with a floor space allowance of approximately 430 to 450 cm² per hen (Figure 2.3). Conventional cages are fitted with a drinker and a feed trough outside the cage, and are devoid of nests, perches, or any form of enrichment. Hens are not provided with any litter material and thus are unable to forage or dustbathe. Floors are sloped, to allow for eggs to roll onto a conveyor belt in front of the cage. Many cages may be stacked on top of one another, separated by a manure belt. Conventional cage houses are often equipped with temperature and ventilation control

systems and can vary greatly in size, though in major egg producing countries a single house will typically contain anything from 20,000 to 200,000 hens.

The laying cycle starts at approximately 16-18 weeks of age, when pullets (female birds that have not yet started laying) are transferred to the laying house, where they will stay for a period of 50 to 80 weeks. In some countries outside Europe, a practice known as 'induced molting' is still conducted by some producers, whereby molting of the entire flock is artificially provoked by total or severe food restriction for 1–3 weeks (in some cases water withdraw), as well as reduction of the hours of light, with the goal of increasing productivity in the subsequent laying period.

Furnished Cages

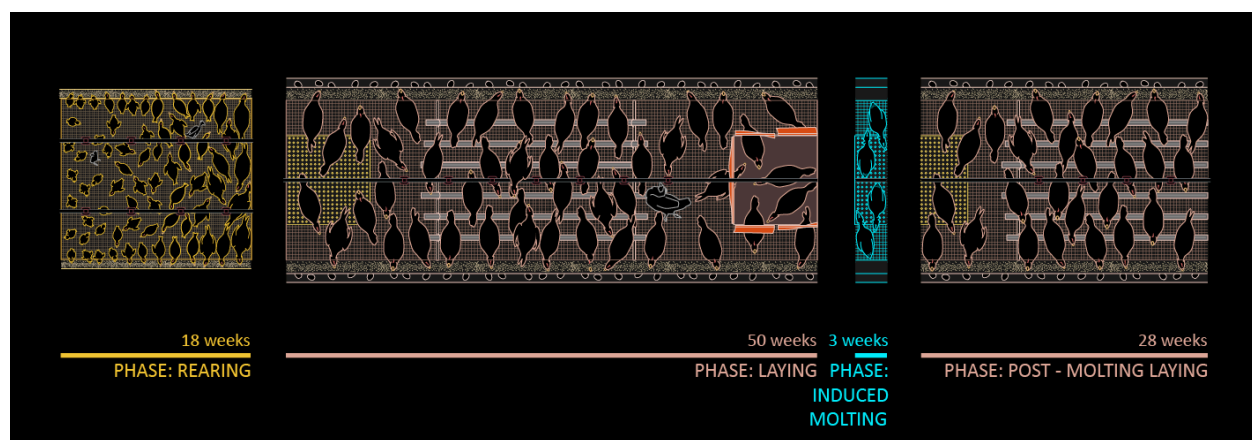


Figure 2.4. Processogram depicting the life of laying hens housed in furnished (enriched) cage systems. A phase of induced molting is included (blue), as it is still widely practiced outside Europe. Elements are spatially scaled to illustrate the space available to individuals and their possible locations (although cage design can vary greatly). A nest box is shown in orange, scratch pads in yellow and perches in light grey.

Furnished cages, also called enriched or colony cages, have been designed in response to concerns over the welfare of laying hens kept in conventional cages. They are similar to conventional cages, but typically include a nest box, perch (15 cm of perch space per hen), a small scratch pad (litter area), greater height and increased space per hen compared to conventional cages (in the European Union, a minimum of 750 cm² per hen - including the space within the nest - is required). Feed is delivered in a trough, and water is provided by nipple water lines. Manure falls through the wire floor onto a manure belt that periodically runs to remove waste from the building. While allowing for the expression of some motivated behaviors, the locomotory restriction in furnished cages is still severe, preventing even some comfort behaviors such as wing flapping.

A typical cage may hold anywhere from 10 to 80 birds. Birds also tend to cluster within preferred areas of the pen (often the nest area or the scratch pad). The buildings housing furnished cage systems share many of the same features of conventional cage systems such as controlled ventilation, temperature, and lighting.

Single-tier aviaries

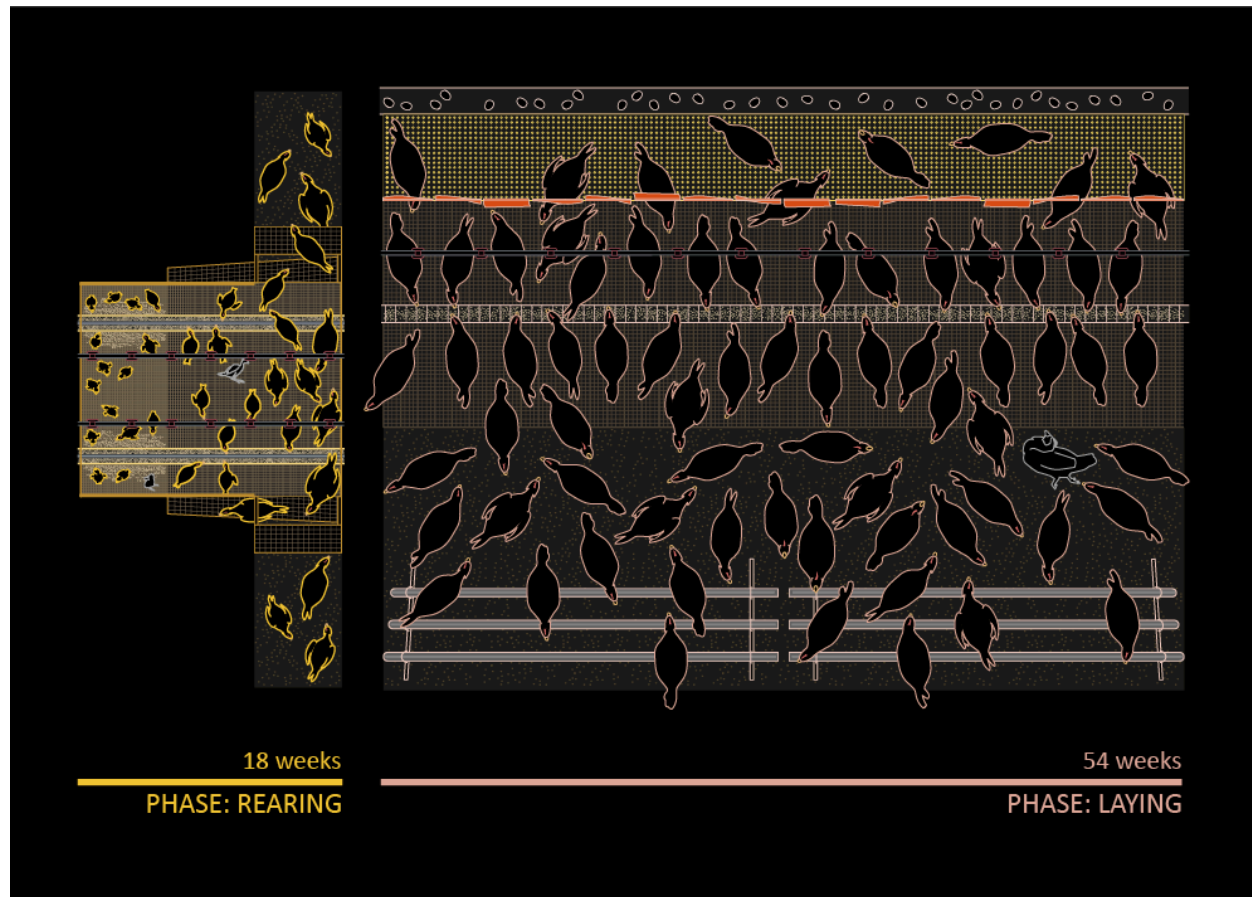


Figure 2.5. Processogram depicting the life of laying hens housed in single-tier aviary systems. Elements are spatially scaled to illustrate the space available to individuals and their possible locations (although cage design can vary greatly). Nest boxes are shown in orange, and perches in light grey.

Single-tier aviaries are a cage-free housing system that allow hens to move freely throughout the house. The space typically available for non-cage laying hens is 1115 cm² (9 hens per m²). Designated scratch areas covered in litter are available at ground level. Substrates such as sawdust or shavings are typically added initially to allow for foraging and dust-bathing, but litter must be properly managed so that it remains dry and friable. Feed, water, nest boxes, and perches are often provided over a raised manure droppings pit. Nest boxes are slightly sloped so eggs roll onto an egg belt. Feed is provided by linear feed troughs or round feeders. Water is typically provided by nipple lines or water troughs. Similar to cage systems, ventilation, temperature, and lighting are all highly regulated. Some single-tier aviary systems allow hens access to an outdoor range area, but only completely indoor systems are analysed in this book.

Multi-tier aviaries

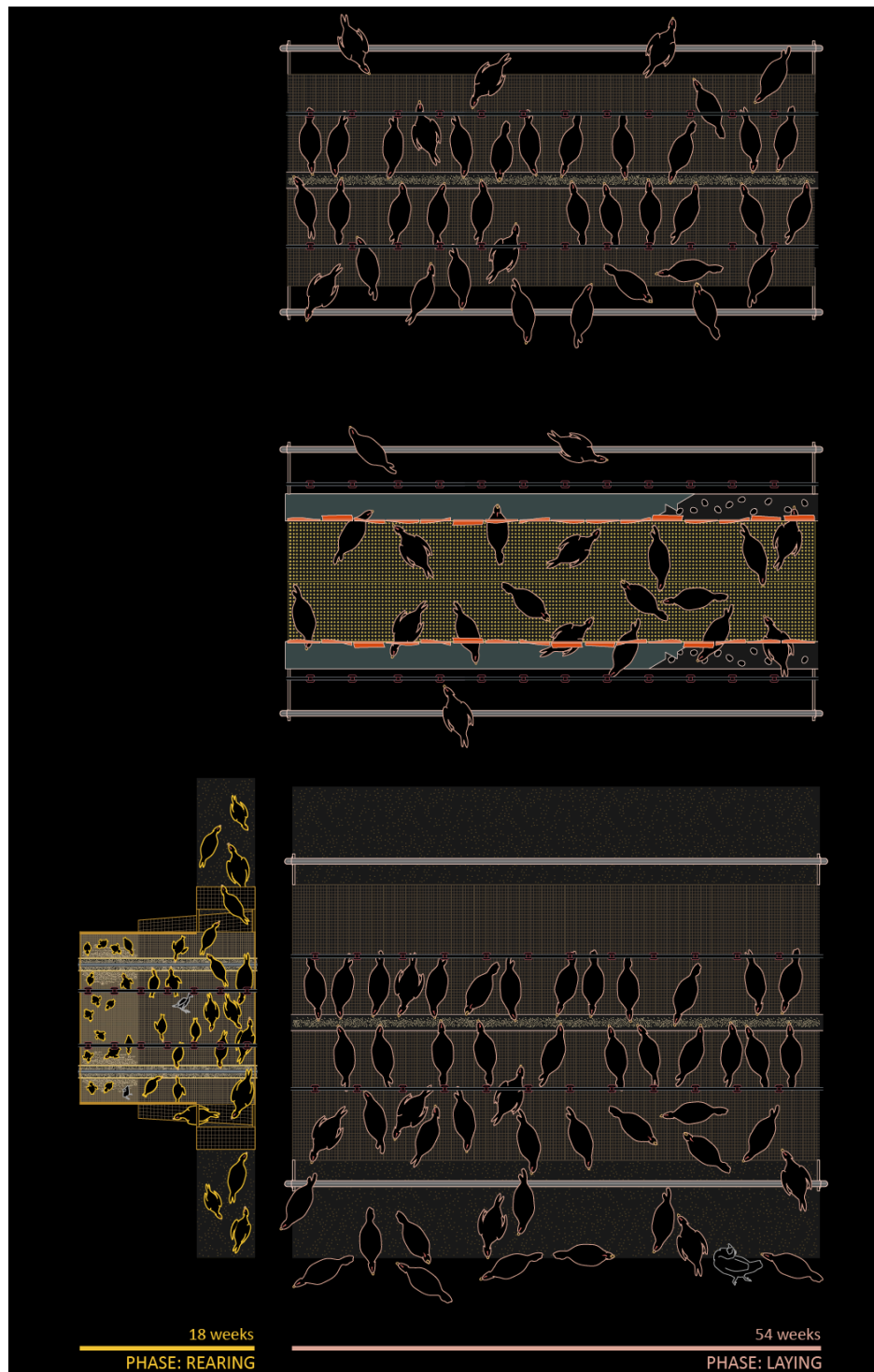


Figure 2.6. Processogram depicting the life of laying hens housed in multi-tier aviary systems. Elements are spatially scaled to illustrate the space available to individuals and their possible locations (although cage design can vary greatly). Tiers are vertically stacked, but here each tier is represented separately for greater clarity of their internal structure and resources available. Nest boxes are shown in orange, and perches in light grey.

In multi-tier aviary systems birds have access to several stacked tiers with integrated feed and water lines, perches, nest boxes, and manure belts. Birds also have access to litter at the ground level. Since hens can occupy the space vertically, multi-tiered housing systems have a higher number of hens per ground surface area than single-tier systems (9 hens per m², distributed horizontally and vertically), with recommendations for a maximum of 15 hens/m² at the floor area. Location of hen provisions and number of tiers within multi-tier aviary systems can vary widely. Under natural conditions, birds tend to perch in trees at night. Aviary systems that do not provide enough perching at the highest tiers can lead to frustration and compromised welfare [41]. Proper litter management is essential to prevent high ammonia levels, poor foot health, and pathogen build-up [42].

To encourage egg laying in the nest boxes, many aviary systems implement an initial training period at the start of lay where birds are confined to the aviary tiers [43]. Once birds have become accustomed to navigating the tiers and laying in the nest locations, the birds are granted access to the litter. Some systems keep birds enclosed during peak laying times to further discourage laying of eggs in the litter. Some systems include ramps or shelves to help facilitate hen movement within the aviaries to help reduce the prevalence of falls and broken bones [44]. Bone breaks from impact with system components or other hens, feather pecking, cannibalism, piling, and excessive laying of eggs in the litter are all common welfare and management challenges faced in multi-tier aviary systems. Similar to the previously mentioned systems, ventilation, temperature, and lighting are all highly regulated. Some aviary systems contain additional lighting within the aviary system to encourage roosting at night within the tiers. In addition, some multi-tier aviary systems may allow hens to access an outdoor range area.

End of Life

When laying hens' egg production rates drop below a profitable rate, typically between 1.5 and 2 years of age, houses are depopulated to make room for a new flock of birds. The last day of life of hens is described thoroughly in Chapter 7 [45]. Briefly, human catching crews are brought in to manually catch birds and place them in crates for transportation. Catching is typically performed during the dark period when birds are roosting and easier to catch, and when temperatures are likely cooler. Hens are usually carried in an inverted position by their legs. Their weak bones from intense egg laying make them prone to painful fractures from handling or collisions with surfaces in the facility and the crates [46]. These crates are then loaded onto trucks for transportation. During transport, birds will experience stressful thermal conditions, noise, vibrations, and feed and water restriction. Some birds may be transported to live markets, but most will be killed for meat production or rendering.

The next chapters

Throughout this book our focus is on estimating the possible physical and psychological pain endured by laying hens as a result of a number of aversive conditions. The remaining chapters are organized as follows: Chapters 3-7 [25,45,47,48] are each a case study of the pain experienced by affected individuals as a result of, respectively, keel bone fractures, injurious pecking, egg peritonitis syndrome, behavioral deprivations, depopulation and transport. Each chapter starts by presenting a background of the welfare challenge of interest, a review of evidence (empirical data on behavior, preference tests, neurophysiological indicators, homologies with other species and evolutionary reasoning) to infer the experience of pain emerging from the challenge, and estimates of the time in pain individuals affected by the harm endure. In Chapter 8 [49] the prevalence of these welfare offenses in commercial flocks kept in each housing system is investigated, as it is necessary to infer their corresponding impacts at the population level. The quantification of the total time in pain of different intensities undergone in different housing systems, when the cumulative effect of all welfare offenses is considered together, is presented in Chapter 9 [50]. In this chapter, estimates of the welfare impact of cage-free reforms for commercial egg-laying hens are presented. To help inform decisions on research projects and funding, a list of the main research gaps is also provided at the end of each chapter.

The book is accompanied by a web application (<https://pain-track.org/hens>), where it is possible to test the extent to which the estimates are sensitive to the choices and assumptions on the duration, intensity, number of occurrences and prevalence of the welfare challenges under various systems. All parameters (probabilities, durations, occurrences, prevalence) can be changed, with the immediate update of the results showing the time in each level of pain due to one occurrence of the challenge, the time in pain expected for the average member of the population as a consequence of the challenge (i.e. when its prevalence is considered), and the time in pain expected for the average member of the population as a consequence of all challenges combined.

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