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Where Is the Chicken's Welfare? Rethinking Broiler Housing Systems in Modern Production

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SUMMARY

Broiler production is a major contributor to global food supply and economic growth, yet housing systems vary significantly in their ability to support welfare, productivity, and sustainability. This review critically evaluates the capacity of different broiler housing systems to support animal welfare by identifying the main biological, environmental, and management-related drivers that shape welfare outcomes under commercial conditions, drawing on recent peer-reviewed literature. Conventional indoor systems, while efficient, are often linked to welfare problems such as lameness, contact dermatitis, heat stress, and restricted behaviour due to high stocking densities and limited stimulation. Enriched systems, which incorporate perches, platforms, barriers, and manipulable materials, can promote natural behaviours, activity, and leg health, though their impact depends on the enrichment design and the bird's genotype. Free-range and organic systems offer outdoor access and support natural foraging and exploration, but introduce challenges related to weather, predation, parasites, and inconsistent litter quality. Welfare outcomes across systems are strongly influenced by ventilation, lighting, stocking density, enrichment strategies, and breed selection, with slower-growing genotypes showing better suitability for enriched and outdoor environments. Overall, no single housing system provides optimal outcomes across welfare, productivity, and sustainability. Progress in broiler production will require integrated approaches that balance welfare with environmental and economic considerations, supported by continued innovation in housing design and management.

KEY WORDS: broiler chickens; housing systems; welfare; outdoor access

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INTRODUCTION

Broiler production is a cornerstone of the global poultry industry, contributing to food security, economic growth, and dietary diversity (Wong et al., 2017). Several factors, from regional preferences and technological development to socio-economic conditions, have influenced the path of change in this industry. As an important dietary protein source, chicken meat plays an essential role in meeting nutritional needs and shaping culinary choices across cultures and populations (Hui et al., 2001). From a global perspective, the broiler chicken industry has experienced significant growth due to technological innovation, genetic improvement, and changing consumer preferences. These developments led to intensive production systems, new housing designs, and improved management techniques, increasing broiler production to unprecedented heights (Siegel et al., 2014). However, this exponential growth has also raised concerns about environmental sustainability, animal welfare, and public health, prompting a reassessment of production methods and their broader impacts (Marchewka et al., 2023; Mostert et al., 2022; Guèye, 2000). Consumer preferences and purchasing power greatly influence broiler production methods. In the EU, consumer demand for higher animal welfare standards and sustainable production methods is driving the adoption of enriched housing and organic housing systems (AVEC, 2022). Moreover, EU countries are characterized by strict animal welfare regulations, including regulations on stocking density, housing conditions, and transportation. Council Directive 2007/43/EC (as amended by Regulation (EU) 2017/625) establishes minimum welfare rules for chickens kept for meat production in the EU. It primarily targets intensive indoor floor systems, which EFSA identifies as the dominant housing system. The Directive excludes holdings with fewer than 500 birds and extensive free-range systems, making intensive indoor housing its primary regulatory focus. The Directive sets a baseline maximum stocking density of 33 kg/m², with derogations allowing 39 kg/m² or 42 kg/m² where additional environmental controls, documentation, and mortality monitoring are in place. EFSA identifies stocking density as a major welfare hazard, linking higher densities to restricted movement, locomotory disorders, impaired resting, reduced behavioural expression, and increased integument damage. Using expert knowledge elicitation, EFSA concludes that welfare is increasingly compromised above 11 kg/m², highlighting a substantial gap between scientific welfare assessment and legal limits. The Directive requires permanent access to dry, friable litter and sets environmental thresholds of ≤ 20 ppm ammonia and ≤ 3,000 ppm carbon dioxide. EFSA considers ammonia a significant welfare hazard and recommends a lower limit of 15 ppm, indicating that compliance with legal thresholds may still permit adverse welfare outcomes. Temperature, humidity, and ventilation must be managed to avoid unnecessary suffering, though no quantitative limits are specified. Lighting provisions require a minimum of 6 hours of darkness per day, including at least one uninterrupted 4-hour dark period after the first week of life. EFSA supports this requirement and further recommends a minimum light intensity of 20 lux, with darker functional areas for resting. These regulations often affect housing construction, management practices, and breeding strategies.

The goal of this review is to examine the similarities, differences, and development opportunities associated with broiler housing systems commonly used in Europe. Drawing on recent peer-reviewed literature, this review critically evaluates how these housing systems affect broiler welfare, productivity, and management outcomes, with particular attention to key environmental and regulatory factors, including stocking density, enrichment, and outdoor access. The novelty of this work lies in its integrated assessment of conventional, enriched, free-range, and organic systems within the context of current European regulations and evolving consumer expectations. By synthesizing recent scientific evidence and highlighting system-specific challenges and opportunities, this review provides a clearer understanding of where welfare improvements are most achievable and identifies practical directions for innovation in broiler housing design and management.

MATERIALS AND METHODS

Various sources were utilized, including academic journals, articles from reputable online databases, and relevant websites focusing on poultry science and animal welfare. The literature search process began with identifying key terms and concepts related to the research topic. These included terms such as "enriched housing," "broiler chickens," "meat quality," and variations thereof. A variety of academic databases were utilized to conduct the literature search, including PubMed, Web of Science, Scopus, and Google Scholar. The literature search covered publications from 1990 to 2024, reflecting both foundational and contemporary research. Inclusion criteria included peer-reviewed studies focusing on broiler housing systems, welfare outcomes, environmental enrichment, genotype effects, and outdoor access. Exclusion criteria included studies on laying hens, non-commercial breeds, non-housing-related interventions (e.g., feed additives), and papers lacking empirical data.

Data synthesis involved summarizing and organizing extracted information to facilitate analysis and interpretation in subsequent stages of the research process.

THE ABILITY OF BROILER CHICKEN HOUSING SYSTEMS TO SUPPORT WELFARE

Welfare issues under non-enriched housing conditions

Approximately 90% of broilers in the EU are reared in intensive indoor systems characterized by high stocking densities, fast-growing genotypes, and controlled environments (EFSA, 2023). While these systems are efficient in terms of productivity, welfare outcomes are primarily shaped by a limited number of interacting drivers: growth rate, stocking density, litter quality, thermal load, and management practices. One of the most consistently reported welfare concerns is lameness, strongly associated with rapid growth, high body weight, and reduced locomotor activity (Sørensen et al., 1999; Kestin et al., 2001; Knowles et al., 2008; Reiter and Bessei, 2009). Genetic selection for growth performance increases metabolic demand and skeletal strain, predisposing birds to gait abnormalities (Bradshaw et al., 2002; EFSA, 2010). However, the prevalence and severity of lameness are not determined solely by genotype. Stocking density, litter management, lighting programs, and early-life activity stimulation significantly influence locomotor development. Contact dermatitis (footpad dermatitis, hock burn, breast blisters) represents another major welfare outcome and is primarily driven by litter moisture and ammonia concentration (Ekstrand et al., 1997, 1998; Bessei, 2006). Although high density contributes indirectly, the proximate determinant is litter condition, strongly dependent on ventilation efficiency, drinker management, feed composition, and climate control. Thus, the prevalence of dermatitis reflects not only housing type but also the effectiveness of daily husbandry practices. Thermal stress is an additional systemic driver. High feed intake and elevated metabolic heat production increase susceptibility to heat stress, particularly under suboptimal ventilation (Syafan et al., 2011; Reiter and Bessei, 2000). Heat stress interacts with stocking density and litter moisture, exacerbating both inactivity and contact lesions. Behavioral restriction and fear responses further compromise welfare. High density and limited structural complexity restrict expression of species-specific behaviors (EFSA, 2010). Fear-induced panic flights may result in crowding, injuries, or suffocation (Jones, 1989; Mills and Faure, 1990). Importantly, fear responses are susceptible to handling quality, light management, and human–animal interactions, underscoring the role of stockperson competence. Although these welfare concerns are well documented, many studies are conducted in controlled experimental settings that differ from commercial barns in flock size, ventilation patterns, and litter management. Consequently, welfare challenges in commercial-scale production may be underestimated. Across conventional systems, management quality rather than housing concept alone often determines whether risk factors translate into clinical welfare problems.

Environmental Enrichment: Mechanisms and Practical Constraints

Environmental enrichment is frequently proposed as a corrective strategy. Conceptually, enrichment aims to: increase performance of species-specific behaviors, reduce abnormal behaviors, enhance ecological use, and improve coping capacity under behavioral and physiological challenges (Van de Weerd et al., 2009; Riber et al., 2018). Increased activity stimulated by enrichment can improve bone and muscle development, particularly during early growth (Reiter and Bessei, 2000, 2009; Bizeray et al., 2002a). Stronger musculoskeletal systems may reduce lameness risk, although empirical confirmation is inconsistent. Reduced lying time decreases prolonged contact with moist litter, potentially lowering the incidence of dermatitis (De Jong et al., 2013). Because lameness and dermatitis are correlated (Sørensen et al., 2000; Kristensen et al., 2006; Haslam et al., 2006), improvements in litter quality and activity may produce synergistic welfare effects. Beyond biological indicators, enrichment may improve affective states. Reduced fearfulness and increased environmental control are frequently cited benefits (Jones, 1996; Mellor and Webster, 2014). However, the magnitude of these effects depends heavily on the quality of implementation. The evidence base remains heterogeneous. Many enrichment trials involve small groups (<100 birds), limiting external validity. Structural design varies in height, material, accessibility, and spatial distribution. Genotype strongly moderates outcomes: fast-growing strains often lack the physical capacity to use elevated structures effectively, whereas slower-growing birds demonstrate greater engagement. Environmental conditions, temperature, litter moisture, and lighting are inconsistently reported yet critically influence enrichment use. Therefore, inconsistent findings likely reflect methodological variability and management differences rather than the intrinsic inefficacy of enrichment. In commercial practice, the success of enrichment depends on: appropriate design relative to genotype and body weight, strategic placement to avoid overcrowding, maintenance to prevent hygiene deterioration, integration with stocking density, and climate control. Without proper management, enrichment may provide minimal welfare benefit.

Perches and Elevated Structures: Function Versus Feasibility

Perching behavior reflects ancestral roosting tendencies (Sandilands et al., 2009). Elevated structures may promote thermoregulation, spatial complexity, and behavioral diversification. Access design is critical. Broilers more readily use perches that require short jumps (~8.5 cm) rather than ramps (LeVan et al., 2000). Shallower angles and transitional elements increase usage (Stratmann and Ringgenberg, 2024). Cooling perches (10°C water circulation) demonstrate thermoregulatory benefits under heat stress (30–34°C), with birds preferentially selecting cooled areas (Estevez et al., 2002). However, most perch studies involve fast-growing genotypes in small-scale trials. In commercial settings, heavier birds may struggle with balance, and perch heights often differ from those used in experimental designs. High stocking density may limit access, increasing competition. Perch use declines at elevated ambient temperatures (~28°C) unless cooling mechanisms are provided (LeVan et al., 2000). Thus, perch-based enrichment is functionally promising but operationally dependent on the suitability of the genotype, bird weight, stocking density, and thermal management. Structural provision alone does not guarantee improvements in welfare.

Outdoor Access in Organic and Free-Range Systems

Organic broiler production has expanded in response to consumer demand, with certified EU poultry farms increasing from 3% (2017) to 8% (2019) (Guarino Amato and Castellini, 2022). Outdoor access enables foraging, dust bathing, and environmental exploration. Organic systems typically employ slower-growing genotypes that exhibit greater locomotor capacity and range use (Stadig et al., 2016). Outdoor area attractiveness strongly influences utilization. Provision of shelter (natural vegetation or artificial structures) increases range exploration and distance from the house (Dawkins et al., 2003; Stadig et al., 2016). Structural enrichment may reduce sitting behavior and promote activity (Fanatico et al., 2016). However, range use is climate-dependent. Many studies occur during favorable seasons, potentially overestimating year-round usage. In temperate climates, rain, mud, and low temperatures significantly restrict access. Additionally, small experimental flock sizes may not replicate commercial social dynamics. Consequently, outdoor access is not inherently synonymous with improved welfare. Effective implementation requires: adequate shelter distribution, drainage and soil management, genotype compatibility, and careful biosecurity planning.

Welfare Outcomes and Health Challenges in Outdoor Systems

Outdoor access does not uniformly reduce contact dermatitis. Prevalence of footpad dermatitis ranges from low to high across studies (Haslam et al., 2006; Pagazaurtundua and Warriss, 2006; Tuyttens et al., 2008). High levels observed in some organic systems are often linked to wet litter in mobile houses and suboptimal ventilation (Stadig et al., 2016). Genotype influences locomotion: slower-growing strains demonstrate improved gait scores (Steenfeldt et al., 2014). Yet enrichment additions (e.g., perches, panels) in outdoor systems sometimes show no measurable effect on lameness (Rodriguez-Aurrecoetxea et al., 2014; Ruis et al., 2004). Predation risk is a distinct welfare trade-off. Mortality from foxes, crows, and raptors varies (Jones et al., 2007; Dal Bosco et al., 2014). Providing tall vegetation reduces predation mortality, underscoring the importance of landscape design. Conversely, outdoor feed and water can increase the attraction of predators and the risk of disease (Sossidou et al., 2015). Parasite prevalence data in broilers remain limited, despite concerns. Organic systems restrict prophylactic medication, increasing reliance on preventive management. Variability in outcomes frequently reflects uncontrolled environmental variables: rainfall, soil type, vegetation cover, and ventilation quality. Many studies omit weather data, yet climate strongly determines range use and litter moisture. These confounders complicate cross-study comparison.

Synthesis: Main Drivers Shaping Welfare Outcomes

Across all housing systems, conventional, enriched, organic, or free-range, welfare outcomes are primarily shaped by the interaction of: genotype and growth rate, stocking density, litter moisture and ventilation quality, thermal load, and climate control. Housing concept alone does not determine welfare status. Intensive indoor systems can achieve acceptable welfare when litter, ventilation, and density are well managed. Conversely, organic and outdoor systems may experience significant welfare problems under poor management or unfavorable environmental conditions. Thus, welfare is best understood not as a function of a production model alone, but as the outcome of system design and implementation quality. Future research should prioritize large-scale commercial trials with standardized reporting of management variables and environmental conditions to improve external validity and identify the most influential drivers.

DISCUSSION

Welfare Challenges in Conventional Intensive Systems

The comparative assessment of broiler housing systems presented in this review highlights the complex interplay between environmental conditions, animal welfare, and production outcomes. Conventional intensive systems remain the most economically efficient. Yet, the evidence reviewed demonstrates consistent welfare challenges, including lameness, contact dermatitis, heat stress, and behavioural restriction, primarily driven by rapid growth rates and high stocking densities (Bradshaw et al., 2002; Bessei, 2006; EFSA, 2010). These findings align with previous studies indicating that modern broiler genotypes, when raised in barren environments, exhibit reduced activity, compromised leg health, and limited behavioural repertoires (Kestin et al., 2001; Knowles et al., 2008).

Effectiveness and Limitations of Environmental Enrichment

Environmental enrichment emerged as a promising strategy to mitigate several of these welfare concerns. Enrichments such as perches, platforms, straw bales, and barrier structures can increase physical activity, improve bone and muscle development, reduce contact dermatitis, and expand the behavioural repertoire (Bizeray et al., 2002a; Riber et al., 2018; Van de Weerd et al., 2009). However, effectiveness varies substantially with design and accessibility. For example, straw bales improved latency-to-lie and lameness indicators in some studies (Bailie et al., 2013), while others found negligible impacts on activity or performance (Bailie & O'Connell, 2014). Similarly, perch use depends heavily on height, stability, and temperature, with cooling perches offering particular benefits in warm climates (Estevez et al., 2002;

LeVan et al., 2000). These inconsistencies underscore the need for system-specific optimization rather than one-size-fits-all enrichment strategies.

Methodological Constraints and Confounding Factors in Enrichment and Outdoor Studies

Although numerous studies have examined enrichment strategies and outdoor access, many findings must be interpreted with caution due to methodological limitations. Sample sizes in enrichment trials are often small or based on pen-level rather than flock-level observations, which limits statistical power and generalizability to commercial settings (Bizeray et al., 2002a; Bailie & O'Connell, 2014). Outdoor access studies frequently rely on short observation periods or small experimental flocks, which may not reflect the behavioural dynamics of commercial broiler houses housing thousands of birds. Confounding factors, such as genotype, climate, litter management, ventilation, and shelter design, are not always controlled or reported consistently, making it challenging to attribute welfare outcomes to a single intervention. For example, differences in range use across studies may stem from weather conditions, vegetation structure, or flock age rather than from the enrichment or the system itself. Similarly, enrichment studies often vary in perch height, material, accessibility, and placement, which complicates comparisons across experiments. Highlighting these limitations is essential for understanding why results sometimes diverge and for identifying which findings are robust enough to inform commercial practice.

Interactions Between Housing, Enrichment, and Meat Quality

Some research examined a broader field of study and linked husbandry practices to broiler meat quality. Ludwiczak et al. (2025) examined the effect of access to perches and different stocking densities on physicochemical meat quality attributes. Taken together, the findings indicate that stocking density plays a limited role in shaping meat quality in fast-growing broilers. In contrast, perch enrichment can improve selected quality parameters, notably moisture, fat content, and post-storage tenderness. However, perches alone produce modest effects; the most substantial improvements occur when perches are used alongside roughage provision. Thus, in commercial Ross 308 systems, environmental enrichment, rather than stocking density, is a more effective means of enhancing meat quality. However, its impact remains constrained by the inherently low activity levels of fast-growing broiler strains. Sztandarski et al. (2025) in their study on husbandry practices influencing broiler welfare point out that targeted husbandry modifications can improve broiler welfare, but their effects act independently rather than synergistically. In fast-growing Ross 308 birds, reduced stocking density and lucerne supplementation consistently improved footpad health and lowered aggression-related injuries. At the same time, perch enrichment was detrimental because of these birds' limited locomotor capacity. Medium-growing Hubbard hybrids benefited most from outdoor access, which reduced footpad dermatitis and comb wounds, although perch enrichment again increased plumage and footpad damage. Welfare differences between JA757 and JA787 hybrids indicate meaningful genotype-level variation, with JA757 showing more favorable outcomes. Overall, welfare gains are best achieved through genotype-appropriate, single-factor interventions tailored to the biological and behavioral characteristics of each broiler type.

Welfare Benefits and Challenges in Free-Range and Organic Systems

Free-range and organic systems offered clear advantages in terms of behavioural diversity, natural foraging, and environmental stimulation (Fanatico et al., 2016; Stadig et al., 2016). Nonetheless, their benefits were constrained by highly variable outdoor use, often influenced by shelter provision, vegetation structure, and genotype. Studies indicate that slow-growing lines utilise outdoor areas more consistently than fast-growing broilers (Rodriguez-Aurrekoetxea et al., 2014; Dawkins et al., 2003), suggesting that genotype–environment matching is essential for welfare gains in outdoor systems. These systems also present unique challenges, including exposure to adverse weather, parasitism, and predation (Kaufmann et al., 2011), which can offset welfare benefits if not carefully managed. Beyond welfare, free-range can affect meat quality. Składanowska-Baryza et al. (2025) in the study of two lines of Hubbard chickens found that free-range housing primarily improved breast meat pigmentation, modified pH (measured 48 hours post-mortem), and reduced fat content, while genotype exerted more potent effects on water-holding capacity, texture, and susceptibility to myopathies; overall, JA757 birds in free-range systems showed the most favorable meat quality characteristics, whereas JA787 and indoor rearing conditions were associated with firmer texture and greater processing-oriented attributes.

Climatic and Seasonal Constraints on Outdoor Access

Climatic and seasonal constraints play a critical role in determining the actual welfare benefits of free-range and organic systems, particularly in temperate regions of Europe. Outdoor access is often limited during autumn and winter due to low temperatures, heavy rainfall, muddy ground, and reduced daylight hours. These factors substantially restrict the use of range, even when access is technically available (Dawkins et al., 2003; Stadig et al., 2016). Birds may avoid the range during periods of cold stress, strong winds, or persistent precipitation, leading to prolonged indoor confinement and reduced behavioural opportunities. In addition, wet, muddy outdoor areas can increase the risk of footpad dermatitis and litter contamination when birds track moisture back into the house. These seasonal limitations mean that the welfare advantages of outdoor systems are highly variable throughout the year and may be significantly reduced during long periods of unfavourable weather. Addressing these climatic constraints is essential for accurately evaluating the practical relevance and consistency of welfare outcomes in free-range and organic production systems.

Economic Feasibility and Productivity Implications of Welfare Improvements

While the review primarily evaluates welfare outcomes, it is equally important to consider how welfare-oriented modifications influence productivity and economic feasibility across housing systems. In conventional intensive systems, high stocking densities and rapid-growth genotypes support low production costs and high output (Gocsik et al., 2016), but these same factors contribute to lameness, dermatitis, and heat stress. Such welfare issues can indirectly reduce productivity through increased mortality, reduced carcass quality, and higher veterinary costs (Knowles et al., 2008; Haslam et al., 2006), illustrating that poor welfare can carry hidden economic penalties. Enriched housing systems often improve behavioural expression, leg health, and litter quality, yet their economic impact is mixed. Some enrichments, such as straw bales or simple platforms, are relatively inexpensive and can reduce losses associated with contact dermatitis or lameness (Bailie et al., 2013; Riber et al., 2018). However, more complex structures (e.g., multi-level platforms, cooled perches) require additional investment, labour, and maintenance (Estevez et al., 2002; Kells et al., 2001). Their benefits may not always translate into measurable performance gains, especially in fast-growing genotypes with limited locomotor capacity (Bizeray et al., 2002b). This highlights the need for genotype-specific cost–benefit analyses rather than assuming universal economic advantages. Free-range and organic systems provide the greatest behavioural freedom and align strongly with consumer expectations for ethical production (Fanatico et al., 2016; Stadig et al., 2016). However, they also involve higher feed conversion ratios, slower growth rates, increased land use, and greater labour demands (Dal Bosco et al., 2014; Castellini et al., 2016). Seasonal limitations in temperate climates further reduce the consistency of outdoor use (Dawkins et al., 2003), meaning that welfare benefits may not always be realized in practice. Although premium market prices can offset these costs, profitability depends heavily on consumer willingness to pay and on effective management of predation, parasitism, and weather-related challenges (Gocsik et al., 2016; Sossidou et al., 2015). Overall, the interaction between welfare improvements and productivity is highly context-dependent. Some welfare interventions reduce economic losses by improving health and carcass quality (Abudabos et al., 2013; Ekstrand et al., 1997), while others increase production costs without clear performance benefits. A more integrated evaluation, combining welfare indicators with economic modelling and genotype-specific responses, is essential for identifying housing strategies that are both ethically and financially sustainable.

A crucial cross-cutting finding is that improvements in welfare often coincide with enhanced consumer acceptance but may reduce cost-efficiency (Gocsik et al., 2016). As European consumers increasingly prioritise ethical production, producers face pressure to adopt enriched or outdoor-based systems despite higher operating costs and management complexity (AVEC, 2022; Escobedo del Bosque et al., 2021). Balancing profitability with welfare-focused innovations, therefore, remains a central challenge. Emerging design solutions, such as climate-controlled facilities, structured outdoor enrichment, and targeted health management tools, demonstrate potential to reconcile these competing demands (Fairchild, 2005; Riber et al., 2018). Overall, the comparative evidence suggests that no single housing system is universally optimal. Instead, adequate progress in broiler welfare depends on adopting nuanced, context-specific strategies that integrate environmental design, genotype selection, health management, and economic considerations. The findings support a shift toward holistic, sustainability-oriented frameworks that recognise welfare as both an ethical priority and a driver of long-term system resilience.

This review examined the principal broiler housing systems used in Europe, conventional, enriched, and organic (outdoor access), and evaluated their implications for welfare and sustainability. The evidence demonstrates that housing design and management practices exert substantial influence on broiler health outcomes, behavioural expression, and economic performance. While conventional systems provide high production efficiency, they are consistently associated with welfare challenges due to high stocking densities, limited environmental stimulation, and rapid-growth genotypes. Enriched systems and outdoor-based alternatives offer opportunities to improve welfare, but their effectiveness depends on enrichment design, genotype suitability, and environmental conditions.

Key Findings (Table 1)

Table 1.
The key comparisons across broiler housing systems.

Housing System	Welfare Outcomes	Behavioural Opportunities	Health Challenges	Productivity / Economics	Key Notes
Conventional	Moderate to poor; lameness, contact dermatitis, heat stress (Bradshaw et al., 2002; Bessei, 2006; EFSA, 2010)	Restricted; limited space and environmental stimulation	High risk of footpad dermatitis and poor leg health	Highest efficiency and lowest cost	Welfare issues are mainly driven by stocking density and fast growth
Enriched	Improved leg health and comfort; more activity (Bizeray et al., 2002a; Riber et al., 2018)	Perching, exploration, object manipulation	Effectiveness depends on design, accessibility, and genotype	Moderate cost increase; variable productivity	Straw bales, platforms, and barriers improve behaviour and health
Free-Range	Generally better welfare; increased natural behaviours (Stadig et al., 2016a; Dawkins et al., 2003)	Foraging, exploration, and locomotion outdoors	Vulnerable to weather, parasites, and predators	Higher costs, lower productivity, and variable	Outdoor use depends on vegetation, shelters, and climate
Organic	High welfare expectations; slow-growing strains improve locomotion (Fanatico et al., 2016)	Similar to free-range, with more consistent outdoor access	Parasites, predation, and climate exposure	Highest cost; premium-priced products	Regulatory standards shape outdoor area quality and enrichment
Cross-cutting Factors	Welfare hinges on ventilation, litter quality, stocking density	Behaviour shaped by enrichment and space	Genotype affects lameness and dermatitis	Economic trade-offs require system optimisation	No system is universally optimal; integration is key

1. **Conventional systems maximise efficiency but present recurring welfarerisks.**

   High stocking densities, low activity levels, and moisture-related litter issues contribute to lameness, contact dermatitis, and behavioural restriction.

2. **Environmental enrichment improves behavioural expression and can enhance leg health and litter quality.** Perches, platforms, straw bales, and barrier structures increase activity and support species-specific behaviours, though impacts vary by enrichment type and implementation.

3. **Outdoor systems promote natural behaviours but require careful management.** Free-range and organic systems encourage foraging and exploration but face challenges related to weather, predation, parasitism, and inconsistent outdoor use.

4. **Genotype–environment matching is critical.** Slower-growing strains are better suited to enriched and outdoor systems, showing improved locomotion, higher outdoor use, and reduced lameness compared with fast-growing broilers.

5. **Welfare improvements often come with economic trade-offs.** Enhanced housing conditions increase consumer acceptance but can elevate production costs, highlighting the need for integrated approaches that balance welfare and profitability.

6. **Future progress requires holistic, sustainability-oriented housing strategies.** Innovations in enrichment, climate control, and outdoor design, combined with regulatory incentives and responsive management, can support both welfare and productivity across diverse production systems.

CONCLUSIONS

The review highlights that each housing system presents unique advantages and challenges. While conventional systems maximize production efficiency, they may compromise animal welfare. Enriched housing systems balance welfare and productivity, thereby promoting better health outcomes for broilers. Free-range and organic systems align with consumer demands for ethical farming but require careful management to mitigate risks related to environmental exposure and predation. Future broiler production must integrate sustainable practices, advanced housing designs, and welfare-focused strategies to meet the growing demand for ethically produced poultry. Regulations and consumer awareness will continue to shape industry standards, emphasizing the need for innovation in housing systems that enhance both productivity and welfare. Ultimately, a holistic approach considering economic, ethical, and environmental factors is necessary for the sustainable advancement of broiler production systems. Despite these insights, several critical research gaps remain that limit the development of fully optimized broiler housing systems. Genotype–environment interactions require deeper investigation. Current evidence indicates that fast-, medium-, and slow-growing strains respond differently to enrichment, stocking density, and outdoor access, yet systematic comparative studies under commercial conditions remain scarce. The long-term economic feasibility of enriched, free-range, and organic systems remains insufficiently quantified. More integrated cost–benefit analyses are needed to determine which welfare improvements are economically sustainable for producers while meeting consumer expectations. Seasonal and climatic constraints on outdoor access, particularly in temperate European regions, are underrepresented in current research. Studies should evaluate how weather patterns, shelter design, and range management influence actual outdoor use, welfare outcomes, and productivity. Many enrichment studies rely on small sample sizes or controlled experimental settings. Large-scale commercial trials are needed to validate the practical relevance, durability, labour requirements, and cost implications of enrichment strategies. Addressing these research priorities will support the development of housing systems that are biologically appropriate for different broiler genotypes, economically viable for producers, and aligned with societal expectations for sustainable and ethical poultry production.

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