

Cage-Free x Climate

The case for compatibility



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Part B2: Broiler Growing Systems, Welfare, Climate Impact

Recommendation: New Broiler Investment

Cage-free floor systems, moderately slower-growing birds at reduced stocking density, with enrichment and a suitable lighting regime. Slower-growing breeds at lower density are not the highest-welfare option available but they capture most of the welfare gain at a moderate climate cost. They also reduce antibiotic use, mortality and leg problems, and help with food safety in hot climates. Feed sourcing affects the climate result more than the choice of housing.

Part B2 of the Cage-free x Climate series. Part A sets out the shared framing, methodology, and cross-cutting findings, and Parts B1 and B3 cover gestating sows and laying hens. The annex, Expanded Source Tables, holds the full evidence tables for the studies cited here.

Key takeaways

- **Conventional fast-growing, high-density broiler production sits at the bottom of the welfare scale on nearly every measure** — gait, leg health, contact dermatitis, behavioural restriction, mortalities — while sitting at the top of narrow climate performance.
- **The primary tension runs through feed:** slower genetics and lower densities raise the feed required per kilogram of output, and feed accounts for more than three-quarters of broiler emissions. But the size of that cost depends above all on feed sourcing, not on the welfare improvement itself.
- **Several welfare changes, including enrichment and lighting, cost nothing in climate terms at all.**
- **For producers in tropical and subtropical Asia, the heating-energy penalty that inflates the cage-free climate cost in temperate studies is largely absent.** The emerging trend toward multi-tier cage systems in several Asian markets runs

in the opposite direction: the welfare evidence against caging is clear, and the limited climate evidence offers no offsetting justification.

In this section

- **Terminology and Scope**
- **1. The Welfare-Climate Question in Broiler Production**
- **2. Key Welfare Determinants in Broiler Systems**
- **3. Main Drivers of Climate Performance in Broiler Systems**
- **4. Welfare and Climate: Alignment, Conflict, Conditionality**
- **5. Methodological Issues**
- **6. Conclusion**

Terminology and Scope

This report uses conventional fast-growing indoor floor systems as the baseline for comparison, and examines higher-welfare alternatives across a spectrum of system change.

- **Conventional fast-growing floor system** — the baseline: an indoor, litter-based system using fast-growing genetics at high stocking density with the shortest grow-out.
- **Lower-density conventional floor system** — the same fast-growing genetics and litter floor, but at reduced stocking density.
- **Moderately slower-growing (BCC-aligned) system** — a floor-based, litter system using moderately slower-growing breeds at lower density, with enrichment and lighting broadly aligned to the Better Chicken Commitment (BCC).
- **Very slow-growing/extensive system** — the slowest-growing breeds at the lowest densities, the most extensive of the floor systems. Slower-growing breeds are already mainstream in Asia — China's native, yellow-feathered chickens were roughly 17–18% of local broiler output in 2024 but gradually replaced by white-feathered, fast-growing broilers.¹
- **Multi-tier caged (colony) system** — stacked-cage systems prevalent in China and emerging in some Asian markets, with a limited and methodologically inconsistent evidence base.

Scope note. This section confines its analysis to on-farm broiler production — chickens raised for meat. The broader broiler system (breeder flocks, hatcheries, feed production and sourcing, veterinary medicines, agricultural inputs, water and land use, and waste management) is acknowledged but not analysed in detail except where it bears directly on the welfare–climate comparison.

Baseline. Throughout this section, the point of comparison is the conventional system: fast-growing breeds raised at high density on a litter floor. In principle, a multi-tier caged or fully slatted system could serve as an even lower welfare baseline, and such systems are increasingly used for broilers across parts of Asia. We have not adopted them as the baseline for two reasons. First, the academic literature on caged broiler production remains limited and methodologically inconsistent — and heavily skewed toward physical-health indicators while omitting behaviour almost entirely. Second,

there is correspondingly little rigorous evidence on the climate performance of these systems, leaving no sound basis for a paired welfare–climate comparison.

That said, the available evidence does not suggest caged systems are benign. A systematic review of 23 studies comparing slatted or caged housing with litter-based floors found that most reported a welfare concern with slatted floors, and **that the supposed advantages of cages — fewer footpad and hock lesions from cleaner flooring — were inconsistent and often absent.** Crucially, none of the empirical studies included a full behavioural assessment, and **not one measured dustbathing or foraging — the very behaviours a cage structurally prevents.**²

An expert survey within the review judged modern cage systems unacceptable on welfare grounds.³ The review concluded against rolling out caged systems, recommending instead that effort go into enriching litter-based barns. We take the same position; caged and slatted systems remove the highly motivated behaviours central to broiler welfare, without delivering a consistent, offsetting health benefit, while noting that more rigorous behavioural and climate assessment of these systems is still needed.

In this report, broiler welfare refers to outcomes experienced by the birds themselves — including whether they can perform highly motivated natural behaviours such as dustbathing, perching, exploratory pecking and wing-flapping, which deliver both mental and physical benefits (disease prevention, thermoregulation, social regulation and stress relief). Welfare outcomes depend on a range of system inputs and hazards including broiler genetics, and on how these are managed in practice.⁴

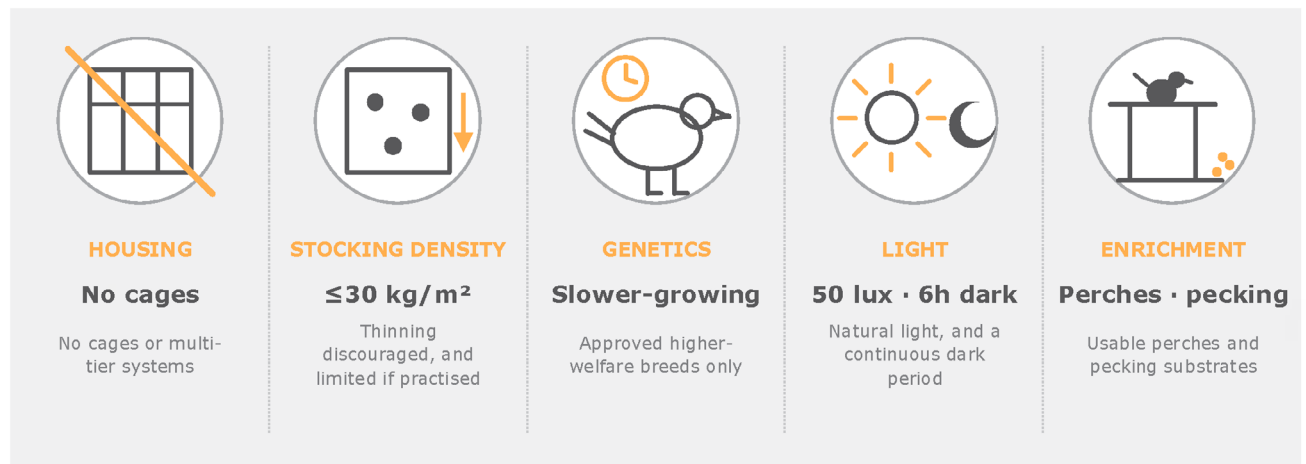
Most civil-society organisations and major independent, science-based welfare certification schemes apply minimum standards broadly aligned with the Better Chicken Commitment (BCC), also known as the European Chicken Commitment.⁵ There are already commercial examples of producers and buyers applying these standards. The Netherlands is a useful real-world reference point: domestic production for domestic consumption has transitioned to the Dutch Retail Broiler standard, which functions commercially across all facets of retail and is broadly similar to the BCC in its minimum welfare requirements.⁶

The main BCC standards are:

- no cages or multi-tier systems.
- maximum stocking density of 30kg/m² or less, with thinning discouraged and limited if practised.
- use of moderately slower-growing or higher-welfare breeds (an approved list is available).
- provision of natural light, a minimum of 50 lux, and a six-hour period of continuous darkness.
- provision of usable perches and pecking substrates, also known as enrichment.

The Better Chicken Commitment

The five minimum standards used as the welfare benchmark in this section



Source: ARE analysis, based on the Better Chicken Commitment.

1. The Welfare-Climate Question in Broiler Production

The global broiler industry raises and slaughters more than 70 billion birds annually — almost half of them in Asia — and comprises approximately 8% of the livestock sector's greenhouse gas emissions, 78% of which come from feed production alone.^{7 8 9}

Welfare pressure on this industry is mounting from multiple directions: the rapid spread of the Better Chicken Commitment among major retailers, growing investor scrutiny of fast-growing genetics and high-density housing, and the prevalence or emergence of multi-tier cage systems in several Asian markets that compound rather than reduce confinement. For a sector producing at this scale, the stakes of getting the welfare-climate relationship wrong in either direction are substantial.

Feed accounts for more than 75% of broiler emissions, and the tension in broiler production runs directly through it. Slower-growing genetics and lower densities improve welfare but raise the feed required per kilogram of output. The size of that cost depends above all on feed sourcing; a slower-growing bird on a low-deforestation diet can carry a lower net climate impact than a fast-growing bird on a high-deforestation one. A 2025 meta-analysis reviewing 46 studies found no statistically significant system-level difference in greenhouse-gas footprint after correcting for methodological variation, suggesting apparent climate penalties between systems may reflect study design rather than welfare standards as such.¹⁰

Several welfare improvements — enrichment and lighting in particular — carry no meaningful climate cost at all, despite linkage to growth, development and activity levels. The operative question for producers is therefore which combination of cage-free system changes — genetics, density, feed sourcing, housing-energy design — produces

the most balanced outcome for this animal.

This section is organised around the production-system inputs that determine both welfare and climate outcomes — caged versus floor housing, stocking density, enrichment, lighting, and genetics and growth rate — rather than around system labels.

- **Section 2** establishes the welfare evidence around these inputs.
- **Section 3** establishes the climate evidence around the main drivers of environmental performance.
- **Section 4** brings the two together, tracing each input through to its welfare and climate consequence before aggregating to a system-level summary.
- **Section 5** sets out the methodological caveats specific to the broiler evidence base, building on the cross-cutting notes in Part A.
- **Section 6** draws the argument together.

Key Welfare Determinants — Broilers

The design and management inputs analysed in this section, and the welfare measures each one drives

2.1 Caged or floor-based systems

Whether birds are housed on litter or in tiered cages

WELFARE MEASURES DRIVEN

Range of movement and behaviour · bone development · leg deformities and standing ability · thermal comfort

2.2 Stocking density

Birds per square metre, and the litter and air quality that follow from it

WELFARE MEASURES DRIVEN

Movement · litter and air quality · gait · footpad dermatitis and hock burn · heat stress

2.3 Environmental enrichment

Pecking substrates, elevated resting places, barriers and covered verandas

WELFARE MEASURES DRIVEN

Foraging and pecking · dustbathing · perching and comfort behaviour · overall activity

2.4 Lighting regimes

Light intensity, and the length of the continuous dark period

WELFARE MEASURES DRIVEN

Natural activity patterns · development · quality of rest

2.5 Genetics and growth rate

How fast the bird is bred to grow, and its breast-muscle balance

WELFARE MEASURES DRIVEN

Walking ability and chronic pain · leg disorders · contact dermatitis · metabolic problems · mortality and culls

Source: ARE analysis.

2. Key Welfare Determinants in Broiler Systems

The welfare differences between broiler systems arise from a defined set of design and management inputs — whether birds are caged or floor-raised, how densely they are stocked, the growth rate and breast muscle balance of the genetics used, and the enrichment and lighting provided. This section is organised around those inputs. The welfare outcomes that follow from them — skeletal development, gait and leg health, contact dermatitis, thermoregulation, behaviour and mortality — are presented under the input that primarily drives them.

2.1 Caged or Floor-Based Systems

A first determinant is whether birds are kept in caged or floor-based systems. Floor-based litter systems allow a greater range of movement and behaviour — walking, foraging, pecking, wing-flapping,

Higher-Welfare Standards Mean Lower Stocking Density

Maximum stocking density for broilers, kg live weight per m².



Lower density improves litter quality, gait and footpad health. The conventional figure is a typical intensive range; standards vary by market.

Source: ARE analysis. The conventional figure is a typical intensive range; standards vary by market.

dustbathing, social interaction and thermoregulation — whereas caged systems impose stronger spatial, social and behavioural restrictions. Caged systems also promote weaker bone development, compounding the skeletal problems generated by fast-growth genetics; colony cages are linked to higher frequencies of leg deformities and reduced standing ability than floor systems, along with claw injuries in slatted or wire systems.^{11 12}

While some studies report better thermal regulation in multi-tier colony cages (with closed systems and ventilation) than in floor systems, an Israeli case study found litter-based systems provided better thermal comfort, with no panting observed in floor-reared birds and more restricted behaviour in cages. As caged birds grow and their body and breast-muscle weight increases, locomotor activity declines through pain, limited space and imbalance, leading to more time spent lying, more litter contact and potentially a more stressful thermal environment they cannot escape or modify.¹³

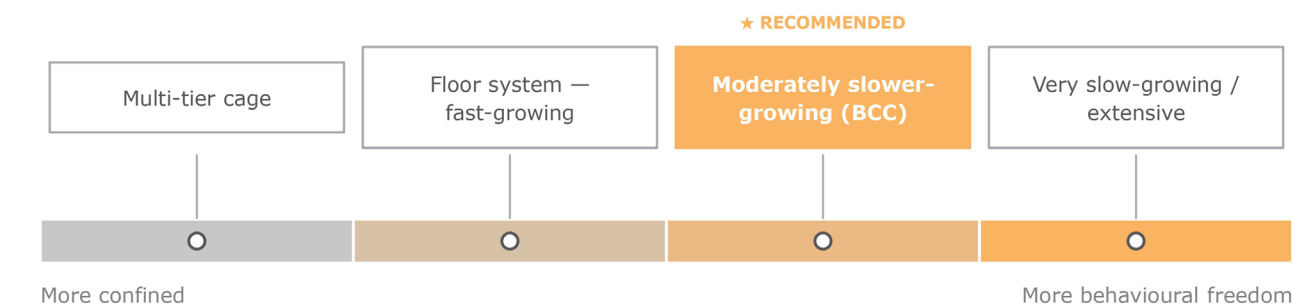
2.2 Stocking Density, Litter Quality, and Heat Stress

Higher stocking density restricts movement, worsens litter and air quality, and increases the risk of poor gait, footpad dermatitis, hock burn, and other contact lesions. Experimental and farm-based studies show that reducing stocking density improves litter quality and several welfare measures in both fast- and slower-growing broilers.¹⁴ Higher density may also worsen heat stress in hotter conditions by reducing airflow and making it harder for birds to dissipate body heat.¹⁵

2.3 Environmental Enrichment

Broilers are motivated to forage, peck, dustbathe, perch and rest comfortably, so systems providing usable litter, space and enrichment support behavioural welfare better than barren environments. A major review concluded that useful enrichments include elevated resting places, barriers, straw bales, covered verandas and outdoor access.¹⁶ Experimental work shows enrichment increases activity in both fast-

Broilers: Growing Systems by Confinement and Welfare



Source: ARE analysis.

and slower-growing broilers, with slower-growing birds often making greater use of it given more balanced skeletal development and no chronic pain.¹⁷ Enrichment can be adapted for Asian contexts provided it is accessible and bio secure — for example, rice-hull-filled sacks.

2.4 Lighting Regimes

Lighting is a smaller but real welfare determinant. Regimes that support natural activity patterns — adequate light intensity (a minimum of 50 lux under the Better Chicken Commitment) and a meaningful continuous dark period of at least six hours — support development, rest and welfare. The standalone evidence base for broiler lighting is more limited than for density or genetics, and lighting is best understood as complementary to those dominant determinants rather than a substitute for them.

2.5 Genetics and Growth Rate

Genetics strongly influence how birds experience the production environment. Fast-growing broilers are associated with chronic pain and poorer walking ability, leg disorders, contact dermatitis, metabolic problems and reduced activity as body weight rises very quickly over a short period (more than three times the growth rate of 50 years ago). Comparative studies show slower-growing broilers to be generally more active, healthier and better able to express positive welfare behaviours.¹⁸ Farm- and pen-based studies report lower mortality, fewer culls, better gait, and lower levels of hock burn and footpad dermatitis even in moderately slower-growing birds.¹⁹

Section 2 establishes the welfare side of the comparison; Section 3 turns to climate.

3. Main Drivers of Climate Performance in Broiler Systems

Feed production dominates the climate impact of broiler systems, typically accounting for more than three-quarters of total emissions. On-farm energy and manure management are smaller, secondary contributors. Housing choice is therefore a secondary driver.

3.1 Feed — Volume, Efficiency, and Sourcing (75–78%)

Feed is the dominant contributor to broiler emissions, usually more than 75%, so climate outcomes are shaped above all by feed volume and composition rather than by housing system. Feed volume matters

because slower growth, poorer feed conversion and longer grow-out increase the feed required per kilogram of output. Composition matters because the proportion of potentially high-impact ingredients — especially soy and soybean meal — can materially change the footprint. Soy-related land-use change, particularly deforestation, can account for more than half of total climate impact in some studies.²⁰ Broiler climate results are therefore highly sensitive to the manner in which soy sourcing and land-use change are accounted for, and this driver is largely independent of housing system.

3.2 On-Farm Energy Consumption (~9%)

On-farm energy use is much less important than feed but remains relevant because it is directly affected by housing design and management. In one cradle-to-farm-gate LCA, on-farm inputs and emissions — largely heating and ventilation — contributed about 9% of total impacts.²¹ In colder regions, heating dominates direct energy input. A Finnish case study found heating demand of 1.3kWh per kg carcass weight against only 0.08kWh per kg for electricity.²² In hotter climates, ventilation and cooling dominate instead: a commercial Arkansas broiler house drew more than 88% of its electricity through ventilation fans, with consumption rising from 43kWh per metric tonne of live weight in winter to 184kWh in summer.²³ Unlike feed, this driver is directly shaped by housing system and local climate.

3.3 Manure Management (~6%)

Manure is a secondary source of total broiler emissions relative to feed but remains significant on-farm, chiefly through nitrous oxide and methane generated during litter accumulation, storage, and handling. In a Brazilian farm-gate LCA, manure management contributed roughly 6% of total GWP; within that, indirect N₂O contributed 61.8%, direct N₂O 19.3% and methane 18.9%, making nitrous oxide the dominant manure-related pathway in that system.²⁴ Manure emissions are not fixed at the point of excretion: they depend on litter moisture, residence time in the house, aeration and downstream handling. A recent farm-scale study found that covering stockpiled broiler litter significantly reduced ammonia, methane and nitrous oxide emissions, showing that post-house handling can materially alter both climate emission and air-pollution outcomes.²⁵

Section 3 establishes the climate side; Section 4 now brings the two together.

4. Welfare and Climate: Alignment, Conflict, and Conditionality

For each input, this section traces the causal chain from the design choice through to both its welfare and its climate consequence, and asks how the two relate — whether they are aligned (a welfare gain at no real climate cost), in conflict (a welfare gain bought at a genuine climate cost), or conditionally aligned (a relationship whose sign and size depend on management, technology or context). It then aggregates these input-level relationships into a net profile for each system type.

Table 2. Welfare and climate at a glance: broiler inputs.

Input	Welfare	Climate	Relationship
Stocking density (lower)	✓	✗	In conflict
Genetics and growth rate (slower)	✓	✗	In conflict
Environmental enrichment and lighting	✓	—	Aligned

Note: ✓ = benefit, ✗ = cost, — = neutral, negligible or unresolved. Symbols show the direction of effect for each input; the Relationship column gives the classification used in the text. Source: ARE analysis

4.1 Input-by-Input Analysis

Stocking density — in conflict. Lower density improves litter quality, gait, footpad dermatitis, hock burn, and thermal comfort (Section 2.2), but increases energy demand for heating, cooling, and ventilation per unit of output. The conflict is real but not fixed in magnitude. It can be mitigated through heat recovery and other housing-energy measures, and lower density may improve productivity under hot and humid conditions, compressing the cost.²⁶ Thailand illustrates the point; its Department of Livestock Development already mandates a relatively low maximum stocking density for cage-free broilers in a warm tropical climate, at 33 kg/m².²⁷ Management and climate context are the principal moderators, which makes lower density relevant not only as a welfare intervention but as a resilience measure in warmer environments.

Genetics and growth rate — in conflict, highly variable magnitude. Slower-growing birds deliver clear welfare gains — better gait, lower contact dermatitis, greater activity and lower mortality (Section 2.5). They also raise total feed demand and lengthen grow-out (around four to five additional days for moderately slower strains, depending on genetics and target weight), increasing climate burden through feed volume and poorer feed conversion.

The magnitude of the conflict depends on three things.

- **Soy sourcing:** a slower-growing bird on a low-LUC diet can carry a lower net climate impact than a fast-growing bird on a high-LUC diet. So, a fast-growing system can still look climate-intensive if its feed mix carries a large land-use-change burden.²⁸
- **Breeder stage efficiency:** the extended broiler growth period penalty can be partly offset upstream, if including breeders in scope, because slower-growing breeder systems may require fewer breeders as they experience lower mortality and longer fertile lifespans.
- **The pace of genetics:** moderately slower and very slow-growing strains differ meaningfully. Moderate strains add roughly four to five days to grow-out, while very slow-growing strains extend it considerably further up to six weeks, delivering a larger welfare gain but a more pronounced climate cost. The conflict is real, but at the moderate end of the range it stays small enough that BCC-aligned genetics remain climate-compatible.

Broilers — Input-by-System Summary

Each cell: how the input plays out in that system · colour = net welfare–climate verdict

	Conventional fast-growing	Moderately slower-growing (BCC)	Very slow-growing
		RECOMMENDED	
Stocking density	Highest density; lowest energy; welfare cost	Lower density; welfare gain; energy cost mitigable	Lowest density; largest gain; energy & feed cost mitigable
Genetics / growth	Fast; poorest leg & gait; best FCR	Slower; clear welfare gain; small, mitigable cost	Very slow; largest gain; largest feed / LUC cost
Enrichment & lighting	Often minimal; climate-neutral	BCC standard; gain; climate-neutral	Extensive; gain; climate-neutral

■ Aligned
 ■ Conditional
 ■ In conflict
 ■ Welfare cost / climate-favourable

Source: ARE analysis of cited LCA and welfare literature.

A Dutch life-cycle assessment covering the whole production chain, from breeder flocks and hatchery to harvest-ready broilers, puts numbers on the moderate end of this range. It compared conventional production with the Dutch Retail Broiler system, the commercial system closest to the Better Chicken Commitment. Dutch Retail Broilers reach slaughter weight in 49 days, about a week longer than a typical 42-day conventional cycle. On the same feed, they emitted about 9% to 16% more greenhouse gases per kilogram of live weight than conventional birds: 9% where soy comes from high land-use-change (deforestation-linked) sources, and 16% where it comes from low land-use-change sources. Soy sourcing has a much larger effect. A Dutch Retail Broiler system fed low land-use-change soy would emit about 56% less than conventional production fed deforestation-linked soy.²⁹

Environmental enrichment and lighting — aligned. Enrichment — pecking substrates, suitably designed perches or platforms, and opportunities for exploratory and comfort behaviour — improves leg and behavioural welfare without materially changing feed demand or extending grow-out.³⁰ Appropriate lighting, including adequate intensity and meaningful dark periods, supports eye and general development, rest, and welfare, while adding little to total emissions. The climate cost of both is therefore negligible. The relationship is aligned: the climate cost does not vary. What does vary is whether the welfare gain materialises, since enrichment must be accessible and biosecure to deliver its benefit, and poorly designed enrichment that birds cannot use confers no welfare gain. These measures are complementary, not substitutive: breed and stocking density remain the dominant welfare determinants, and enrichment and lighting shape activity, space use, and natural behaviour around them.³¹

The moderating role of management. Across all three inputs, management intensity is the variable that sets where a system lands.

It cannot remove the feed cost of slower growth, but it determines the magnitude: litter moisture and ventilation management compress the density penalty, feed sourcing decisions outweigh the genetic penalty, good stockmanship keeps mortality and culling low, and well-designed enrichment delivers the welfare gain it promises while poorly designed enrichment delivers none. Poor management widens every one of these gaps at once. This is why the welfare–climate outcome tracks management quality more closely than it tracks the system label.

4.2 System-Level Summary

Aggregating the input-level relationships gives a net welfare–climate profile for each system. The profiles differ less because any single input behaves differently across systems than because the systems bundle different combinations of inputs.

Conventional fast-growing, high-density floor system. The current baseline sits at the bottom of the welfare scale — poorest gait, leg health, and contact-dermatitis outcomes and the greatest behavioural restriction — while sitting at the top of climate performance through the lowest feed volume, shortest grow-out, and best feed conversion.

It is internally consistent, but consistent in the wrong direction for welfare. Fast-growth genetics also lead to higher cull rates, as birds become unable to walk, assessed in chronic pain or with defects that usually limit basic functions and lead to higher mortalities. There are also further commercial signs of the genetics reaching physical limits, leading to significant losses and direct climate impact, estimated in the US alone at more than USD200m. With the fastest-growing genetics and at the end of the grow-out period, breast muscle myopathies emerge, ranging from visible fat deposition and white striping in the best case to inedible muscular hardening (wooden breast) and carcass condemnation in the worst. These defects have been reported in fast-growth chicken from the US to Europe, Thailand to Australia.

Lower-density conventional floor system. Reducing density on otherwise conventional genetics delivers a modest welfare gain through better litter quality and thermal comfort, at a moderate climate cost from higher energy use per unit of output. This is among the most tractable of the conflicts: heat-recovery and housing-energy measures can largely close the energy gap, and under hot conditions the productivity and welfare advantages of lower density partly offset it.

Moderately slower-growing (BCC-aligned) system. Moving to moderately slower-growing genetics at lower density produces a clearer welfare gain across most indicators, at a moderate and variable climate cost shaped primarily by feed sourcing and soy land-use change. This system also carries a wider set of non-climate benefits that strengthen its case.

- **Compared with conventional fast-growing production, slower-growing broilers are associated with lower antibiotic use** — linking system choice to antimicrobial resistance, not only

welfare — improved robustness, lower mortality, and better leg health with fewer contact-dermatitis issues.

- **Lower-density housing may also offer food-safety advantages in hot climates**, where heat stress increases water intake, disrupts gut microbiota, raises harmful bacteria such as *E. coli* and reduces beneficial *Lactobacillus*; reducing thermal stress therefore supports food safety as well as welfare.
- **Improved skeletal and leg health may further reduce handling, processing and fracture-related losses.**

A large 2024 Dutch study of 113,380 commercial flocks found that systems combining reduced stocking density and moderately slower-growing breeds had fewer antibiotic treatments, lower mortality, and lower footpad-lesion scores than conventional systems.³²

Where climate performance is only equal to or slightly worse than conventional production, these wider gains can materially affect the overall assessment.

Very slow-growing or extensive system. The slowest-growing, lowest-density systems deliver the largest welfare gain — greater activity and fuller use of space and enrichment — but also the largest climate cost where feed volume and land-use change are not managed. The evidence does not support the most extensive model as the universal target for a sustainable transition.

Recommendation

For new broiler investment, the evidence points to one configuration above the others: a cage-free, floor-based system using moderately slower-growing genetics at reduced stocking density. This is not the highest-welfare option — the very-slow-growing extensive model delivers more — but it captures the large majority of the welfare gain while keeping the climate cost moderate and manageable, and it carries a wider set of co-benefits (lower antibiotic use, lower mortality, better leg health, and food-safety advantages in hot climates) that the more extreme options do not improve upon proportionally.

The two conventional systems are ruled out on welfare grounds, and the very-slow-growing model is not recommended as a universal target because its feed and land-use-change burden grows faster than its welfare return. The welfare improvement at the grower stage does not on its own deliver climate compatibility. It depends on being paired with low- or no-deforestation feed sourcing and housing-energy mitigation such as heat exchange where relevant, and may be further supported by breeder-stage gains where these are counted within scope.

5. Methodological Issues

Four methodological issues that apply across all three industries — how to read the comparative figures, the choice of functional unit and system boundary, land-use-change accounting for soy, and geographic transferability to Asian markets — are set out in the Cross-Cutting Methodological Notes in Part A. The points below are specific to the broiler evidence base.

5.1 Full Production Cycle versus Farm-Gate Boundary

Comparisons that omit breeder-flock emissions may misattribute climate differences to the housing or genetic system alone. **Slower-growing breeders may require fewer parent birds per unit of output through lower mortality and longer fertile lifespans, partly offsetting the grow-out feed penalty. Farm-gate-only LCAs should not be read as capturing the full system difference.**

5.2 Cage-System Evidence Base

The welfare and climate evidence base for broiler colony-cage systems is limited and methodologically inconsistent. The welfare–climate comparison in Section 4 is therefore better evidenced for comparisons among floor systems than for cage-versus-floor comparisons and **claims about caged systems should be read with correspondingly lower confidence.** This gap is particularly consequential because the multi-tier cage trend is growing as an Asian-market phenomenon.

6. Broiler Conclusion

Conventional fast-growing, high-density broiler production sits at the bottom of the welfare scale on nearly every measure — gait, leg health, contact dermatitis, behavioural restriction, mortalities — while sitting at the top of narrow climate performance. The challenge of moving away from it is real, but the evidence reviewed in this report does not support the view that welfare and climate objectives are in fundamental opposition.

The primary tension runs through feed: slower genetics and lower densities raise the feed required per kilogram of output, and feed accounts for more than three-quarters of broiler emissions. But the size of that cost depends above all on feed sourcing, not on the welfare improvement itself. Several welfare changes, including enrichment and lighting, cost nothing in climate terms at all.

The most important lever is feed sourcing. Avoiding high-deforestation supply chains and reducing soy dependence can deliver climate gains that dwarf any difference between housing or genetic systems. Moderate-growth genetics capture most of the welfare gain at a containable cost, and the penalty can be partly offset upstream through more efficient breeder systems with lower parent-bird mortality.

Lower stocking density improves welfare and, with heat-recovery and housing-energy measures, need not carry a large energy penalty — a point that matters especially in hot climates, where lower density also reduces heat stress and improves production resilience. Manure and litter management, through moisture control, residence-time reduction, and covered storage, addresses both greenhouse-gas and air-quality outcomes independently of housing system choice.

For producers in tropical and subtropical Asia, the heating-energy penalty that inflates the cage-free climate cost in temperate studies is largely absent. The binding constraints are ventilation and heat-stress management, where lower density is welfare-protective

and climate-compatible simultaneously. The emerging trend toward multi-tier cage systems in several Asian markets runs in the opposite direction: the welfare evidence against caging is clear, and the limited climate evidence offers no offsetting justification.

The right direction for new broiler investment is moderate-growth genetics at lower density, with low-deforestation feed sourcing and active housing-energy management. The welfare and climate costs of building to that standard are manageable — and the evidence reviewed here is substantial enough to support that conclusion in practice.

Endnotes

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