REARING SYSTEMS AND THEIR IMPACT ON PRODUCTIVITY IN QUAIL FARMS: A REVIEW

S.-T. Vlad, G. M. Pîrlea (Gheciu Pîrlea)*, E. A. Moise, D.-M. Grigore, M. L. Maftei, M. Tudorache

University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Faculty of Animal Production Engineering and Management,
Department of Production and Processing Technologies

Abstract

This review explores the relationship between different growing systems and their impact on productivity in quail (Coturnix coturnix japonica) farms. As consumer demand for alternative poultry meat and eggs increases, the need for optimized and welfare-oriented production systems becomes critical. This study analyzes various growing methods such as cage systems, deep litter systems, and free-range setups, highlighting their effects on growth rate, feed conversion ratio, egg production, mortality rate, and animal welfare indicators. Comparative data suggest that intensive systems, particularly multi-tier cages, offer higher productivity in terms of body weight gain and feed efficiency, while alternative systems, such as free-range, show benefits in animal behavior expression and consumer preference. Environmental parameters, stocking density, lighting, and ventilation are also discussed as influencing factors. The findings emphasize the necessity of balancing economic efficiency with ethical farming practices. This review aims to support farmers, researchers, and policy makers in identifying sustainable and productive models suited to various operational goals and regional conditions.

Key words: *quail farming; housing systems; productivity; animal welfare; sustainable production*

INTRODUCTION

The farming of Japanese quail (Coturnix japonica) has experienced significant growth worldwide due to the numerous advantages associated with this species. Quails are characterized by rapid growth rates, small body size, high reproductive potential, short life cycles, and relatively low feed requirements compared to other poultry species [1]. According to the mentioned indicators, animal-derived proteins from different sources (meat, fish, milk, eggs) are of higher quality than those from cereals and legumes, as they contain greater amounts of essential amino acids per gram of protein compared to plant-based proteins [2]. They reach sexual maturity at approximately 5–6 weeks of age and can begin laying eggs very early. A well-managed quail can produce more than 300 eggs per year [3]. A study reported that quail eggs represent 10% of the worldwide table egg market or 1.2 to 1.3 million tons of table eggs each year [4].

Meat consumption has been steadily increasing over the past few decades, with a significant increase reported in developing countries and is expected to double by 2050 [5].

Nutrition plays a crucial role in the development of meat qualities, with a balanced diet contributing to the development of a product with optimal texture and taste. Additionally, stress experienced by the birds during growth and handling can lead to the appearance of

*Corresponding author: pirleam337@gmail.com
The manuscript was received: 24.10.2025
Accepted for publication: 26.11.2025

quality defects, such as abnormal meat pH or changes in color and juiciness [6]. Interest in quail farms is increasing globally, driven both by the demand for eggs considered delicacies with recognized nutritional benefits and by the demand for meat. This growing interest has placed emphasis on improving farming systems and ensuring optimal bird welfare [7].

The housing system (enclosure conditions and management practices) plays a crucial role in the productive performance and health/welfare status of poultry. The primary goal of housing is to offer protection from extreme environmental factors and predators, while also enabling control over feeding and disease prevention [8]. For chickens, for example, studies have shown that the type of production system (battery cages vs. aviaries vs. free-range) significantly influences egg production, body weight, and behavioral patterns. Consequently, intensive cage farming has come under increasing scrutiny from the perspective of animal welfare [9].

A similar situation is observed in quail farming: traditionally, quail eggs have been produced in intensive cage-based systems, while quail meat often comes from barn-type systems with high stocking densities. However, there is a growing interest in developing more animal-friendly rearing alternatives [10]. For instance, in the European Union, the "End the Cage Age" citizens' initiative gathered over 1.4 million signatures between 2018 and 2020, leading the European Commission to propose the gradual phasing out and eventual ban on cage use for several farmed animal species, including quail [11].

This trend toward cage-free farming compels quail producers to understand how different rearing systems affect productivity and what solutions are available to maintain high performance levels while simultaneously ensuring animal welfare [12]. In this context, the present paper reviews the main quail growing systems from intensive battery cages to alternative semi-intensive and extensive (free-range) setups and analyzes their impact on key productivity indicators (body weight, growth rate, feed conversion ratio, egg production, mortality), as well as on quail behavior, welfare status, environmental parameters, and economic implications [13].

This paper aims to provide an in-depth scientific overview of how various quail rearing systems from intensive to extensive affect productivity, animal welfare, and economic outcomes. By examining the influence of housing conditions on key performance indicators, the review seeks to highlight the practical implications of different farming approaches and support informed decision-making among quail producers in the context of evolving welfare standards and sustainability goals.

MATERIAL AND METHOD

This paper is a literature-based review that synthesizes and compares existing research on how different rearing systems affect the productivity of Japanese quails. No original experiments were conducted; instead, data were collected from scientific literature, including peer-reviewed articles, technical reports, and regional studies.

Relevant sources were identified using international databases such as Google Schooler, PubMed, and ResearchGate, as well as academic platforms and resources in Romanian.

Priority was given to studies providing quantitative data and direct comparisons between different rearing systems (e.g., cages, floor-based barns, free-range). Where specific data on quail were unavailable, findings from studies on other poultry species (such as laying hens or broilers) were cautiously extrapolated.

The selected information was qualitatively synthesized and, where available, numerically relevant indicators (e.g., final body weight, FCR, egg production) were extracted and compared.

The results were grouped thematically according to the study's objectives: impact on performance, welfare, environmental factors, and economic outcomes.

The inherent limitations of a review-based methodology such as the heterogeneity of experimental conditions are acknowledged. Conclusions were drawn based on recurring patterns across the literature, and suggestions for further research or application in quail farming practices are included.

RESULTS AND DISCUSSIONS

Quail Rearing Systems: Types and Characteristics

Intensive System (Battery Cages):

This is the most widespread method used in commercial quail egg farms. The birds are kept in standardized cages, typically organized into battery systems with one or more stacked levels. Due to the small size of quails, the stocking density in cages can be relatively high. For example, a cage measuring 150 × 50 cm (0.75 m²) is usually stocked with about 60–70 quails, which corresponds to a density of approximately 80–95 birds per m², depending on the recommended floor space per bird [14].

This high density maximizes space utilization and reduces the cost per animal, which is why around 90% of laying hens in developed countries (and a similar proportion of quails in commercial farms) have traditionally been raised in cages [15]. The intensive system allows for precise control of environmental factors (temperature, ventilation, lighting) and efficient feeding/watering systems. It also facilitates easy egg collection and quick waste removal (via conveyor belts or manure trays beneath the cages), [16].

Individual or small-group cages reduce the risk of birds injuring each other and make it easier to monitor each animal.

However, the extremely limited space and lack of opportunity to move or express natural behaviors lead to welfare concerns such as feather degradation, stress, and stereotypical behaviors (persistent pecking at cage wire, aggression), which can negatively impact long-term productivity [17].

Semi-Intensive System (Indoor Housing with Limited Movement):

In this system, quails are reared on the floor inside a barn or shelter, either on litter (such as straw or wood shavings) or on slatted flooring. Compared to cages, the birds have more room to move, but still no access to the outdoors [18].

This setup corresponds to the shelter system used for other poultry species: birds can roam a shared surface area, though space is still somewhat limited, with densities reaching dozens of birds per m² depending on recommendations, the recommended density is 9 birds/m². Some semi-intensive systems incorporate multi-level aviaries or platforms inside the housing, offering a more complex three-dimensional space [19].

The advantage of this system is that it allows quails to express certain natural behaviors such as scratching in litter, dust bathing if sand is provided, and forming social groups more similar to natural settings. Eggs may be collected manually from nest boxes placed on the floor or in corners, or from special mats [20].

However, overcrowding may still occur if stocking density is pushed too high. Moreover, eggs laid on the floor can become dirty more easily, and disease and parasite control (e.g., coccidiosis, mite infestations) is more challenging than in cages, requiring careful litter management and sanitation. The semi-intensive system is often seen as a compromise between the economic efficiency of the intensive system and the relatively improved welfare offered by free-range methods [20].

System – Free-Range (Outdoor Access):

In this system, quails are raised on the ground with free access to the outdoors and significantly more space. The birds can go outside into a fenced yard or even enjoy broader movement within a mesh-enclosed area. In free-range pro-duction systems, including organic ones, the quality of the pasture, the season, and the amount of time the birds spend outdoors are particularly important factors [21]. An indoor shelter is provided for nighttime or bad weather similar to a coop or shed. This approach emphasizes welfare and natural behavior: quails can scratch the soil, forage for insects, dust bathe to clean their feathers, and benefit from natural light and fresh air [22].

Although domestic quails have lost their migratory instincts, they retain many traits of wild birds they are more active flyers than chickens and tend to take vertical flight when startled as a defense mechanism. In a free-range setting, this can lead to accidents: if the area lacks overhead netting or if the indoor shelter has a low ceiling, birds may injure or kill themselves by flying into the roof or mesh [12].

For this reason, farmers adopting the free-range system for quails typically use covered outdoor enclosures (aviary-style pens) and provide shelter and camouflage within the enclosure artificial shrubs, piles of branches, sandboxes where birds can hide and feel secure. Providing cover reduces panic and flight incidents, allowing quails to remain calmer; it has been observed that when birds feel safe and have hiding spots, they expend less energy on fear-related behaviors and more on weight gain and egg production [23].

The free-range system is favored by small farms or producers targeting niche markets (e.g., organic eggs, “ani-mal-friendly” quail meat).

However, from a production standpoint, this extensive system presents major challenges:

- stocking density is much lower (less than 5–10 birds/m² indoors, plus ample outdoor space per bird), requiring large areas for a given flock size;
- egg production per bird may decrease (laying can slow down or stop seasonally; growth may be slower);
- feed conversion is less efficient (birds expend more energy through movement and partially feed on the environment);
- egg collection becomes harder unlike chickens; quails don’t easily learn to return to shelters or lay eggs in nest boxes; the farmer must search for eggs in the grass and manually ensure all birds return to shelter at night;
- mortality risks are higher due to predators, disease from wild birds, and accidents [24];

Nevertheless, numerous British farms over the last decade have demonstrated the feasibility of a free-range quail system, using large outdoor enclosures with safety netting overhead and heated shelters at night. These systems can obtain “organic” or “free-range” certifications and meet consumer demand for ethically produced animal products [17].

Environmental Parameters (Temperature, Humidity, Ventilation, Light)

The ambient environment in which quail are raised varies significantly across different systems, and these microclimate factors have a direct impact on both welfare and productivity.

Temperature

Quail prefer relatively warm temperatures due to their small body size and large surface area-to-mass ratio, which makes them prone to heat loss. The thermoneutral zone for adult Japanese quail is approximately 21–27°C, with a broader comfort range of 18–30°C (Cambridge University Press, 2017; da Silva et al., 2017). For chicks, brooder temperatures should start at around 35–38°C in the first week and then be reduced by about 5°F (≈2.5°C) each week until reaching ambient levels of about 20–22°C by 4–6 weeks of age [26]. In intensive systems (cages housed indoors), automatic climate control is typically used: heating during winter, cooling/ventilation during summer, and fans to remove ammonia and bring in fresh air. When such equipment functions properly, quail are maintained within their ideal thermal and humidity range (relative humidity around 60–70%). A thermoneutral environment allows birds to conserve energy, which improves feed conversion efficiency [27]. Moreover, forced ventilation helps reduce harmful gas buildup (e.g., ammonia, CO_2) that would otherwise cause respiratory issues and loss of appetite. Ammonia, originating from droppings, can lead to conjunctivitis and corneal lesions, so it's critical to maintain levels below 25 ppm in intensive housing systems [28].

Humidity & Litter Conditions

In floor-based (semi-intensive) systems, modern barns may also include mechanical ventilation, though many still rely on natural airflow via windows and vents. Temperature tends to fluctuate more in large, non-insulated halls especially around the edges of heated zones. If quail are cold, they tend to huddle, which can lead to suffocation; if they're too hot, they spread their wings and drink more water, often at the expense of reduced feed intake. Ensuring even temperature distribution is a challenge typically addressed by strategically placing multiple heat sources and monitoring temperature at bird level [29].

Litter moisture is a critical factor in poultry housing: optimal litter moisture is maintained at around 20–25 %, ideally below 25 %, to prevent microbial proliferation, ammonia production, and litter caking. When moisture rises above 30–40 %, litter becomes sticky and prone to caking, significantly increasing bacterial load and ammonia emissions. Consequently, frequent replacement or top-dressing of bedding is necessary, which raises labor requirements [30,31].

Outdoor (Free-Range) Systems

In free-range systems, environmental conditions are dictated by local climate. Surprisingly, quail can tolerate cold better than expected as long as they are sheltered from wind and can huddle together, they can survive temperatures near 0°C, albeit with increased feed consumption. However, they are very sensitive to moisture and drafts. Rain and cold can quickly kill exposed birds, making proper shelter essential [32].

Typically, free-range systems include insulated, heated shelters used at night and during cold periods, with outdoor access permitted only in favorable weather. In summer, shade and natural ventilation become vital temperatures exceeding 30°C can cause severe heat stress in both quail and chickens. In these systems, birds can self-regulate to some extent choosing cooler spots like shaded areas under bushes but the risk of fatal heatwaves remains if water and shade are insufficient [33].

Lighting

Light intensity and photoperiod are often overlooked but highly influential. In intensive systems, artificial lighting is used. Quail requires 14–16 hours of light per day to maintain optimal egg production. Some farmers use intense lighting believing it stimulates feed intake and boosts productivity. However, studies show that overly bright light (e.g., 250 lux) can actually be harmful quail become agitated, engage in excessive feather pecking, and grow more slowly [34].

Research by Nasr et al. demonstrated that low light levels (≈10 lux, equivalent to dim twilight) improved performance in Japanese quail, resulting in heavier birds, better feather condition, and larger eggs. Based on subsequent studies, a moderate light intensity of about 20–40 lux is recommended for laying quail to promote natural behavior, welfare, and production, along with a dark period to support rest and circadian rhythms [35,36].

Table 1 Comparison of Quail Rearing Systems

Rearing System	Stocking Density	Environmental Control	Productivity	Feed Efficiency	Natural Behavior	Biosecurity & Disease Risk	Labor Requirements	Welfare Level	Main Risks / Drawbacks
Intensive (Battery Cages) [12]	Very high (100+ birds/m²)	Excellent – full temp., ventilation, lighting control	Maximum per area	Very high	Severely restricted	Strong biosecurity; minimal external exposure	Low	Low	Stress, cage wire injuries, feather damage
Semi-Intensive (Indoor Housing) [46, 47]	Moderate (~20–40 birds/m²)	Moderate – natural/forced ventilation	High, slightly below cages	Slightly lower (some waste)	Allows scratching, dust bathing	Moderate risk if hygiene poor; low mortality if density correct	Moderate	Moderate	Overcrowding → pecking, cannibalism
Extensive (Free-Range) [12]	Low (<5–10 birds/m² indoors + large outdoor area)	Low – outdoor climate dependent; heated shelter in winter	Lower per bird; seasonal drops; slower growth	Low (more movement, partial foraging)	Maximum – full natural behaviors	Higher risk from predators, wild birds, disease	High	High	Predators, escapes, egg collection difficulty, weather stress

Nutritional Parameters

The nutrition of domestic Japanese quails (*Coturnix coturnix japonica*), whether reared for meat production or as dual-purpose birds (meat and eggs), must be precisely adapted to the successive growth phases starter, grower, finisher, and the adult (laying/reproduction) stage. Each stage is characterized by specific nutrient requirements, particularly with regard to crude protein (CP) concentration, metabolizable energy (ME), and essential amino acids, which together support optimal growth performance, feed efficiency (FCR), and productive longevity [37].

In general, the starter diet (from hatch until approximately 2–3 weeks of age) is the most nutrient-dense formulation, requiring elevated protein levels of about 24–28% CP, together with a metabolizable energy content of 11.5–12.5 MJ/kg (≈2800–3000 kcal/kg) [38,39]. Several experimental trials confirm the benefit of very high protein supply during the early growth period: Japanese quails perform optimally with 26–27% CP during the first four weeks, achieving superior body weight gains and improved feed conversion ratios. Moreover, starter diets must ensure sufficient inclusion of limiting amino acids, such as lysine (~1.2–1.3%) and methionine (~0.5–0.7%), in order to support protein accretion and muscle deposition. Adequate levels of digestible methionine + cystine are also critical, with requirements estimated at ~0.85% in the starter phase and ~0.77% in the grower phase, to ensure proper feather development and growth performance [40]. In addition, macro-mineral supplementation must be balanced, with calcium and available phosphorus provided at approximately 0.80% Ca and 0.30% available P, respectively, to secure skeletal integrity and bone mineralization [41,42].

During the grower stage (3–6 weeks of age), as quails approach physiological maturity, protein requirements can be moderately reduced while dietary energy remains relatively constant. Standard grower rations usually contain ~20–24% CP and maintain an energy density of 11.5–12.5 MJ/kg ME [43]. Reducing protein concentration after the second or third week of age does not compromise performance provided that essential amino acids and minerals are adequately supplied. In fact, trials have demonstrated that quails fed 20% CP from day 1 to 42 achieved comparable growth rates and feed efficiency indices to those fed diets with higher protein inclusion. Consistently, NRC guidelines recommend ~24% CP during the initial growth phase, followed by a reduction to ~20% CP toward the end of the rearing cycle, while maintaining dietary energy at ~2800–3000 kcal/kg ME (≈12 MJ/kg) to promote lean tissue accretion and prevent excessive lipid deposition [44].

For finisher quails (typically reared until slaughter at ~6–7 weeks, when a distinct finishing phase is applied), rations can be formulated with a moderate protein concentration (~18–20% CP) and an energy density of 2800–3000 kcal/kg ME (~12–13 MJ/kg). These diets sustain final live weight gains while preventing undue carcass fattening, as amino acid requirements progressively decline with reduced growth velocity [45,46]. Empirical evidence indicates that performance is not negatively affected by such protein reductions: in white-feathered quails, a diet containing 20% CP and ~3000 kcal/kg ME during the finishing period yielded growth performance and feed efficiency comparable to those obtained under higher-protein regimens [45]. From a practical perspective, a common feeding program involves administering a single starter/grower ration until 6–8 weeks of age, followed by a switch to a finisher diet when greater slaughter weights are targeted a strategy widely recommended in the management of specialized meat-type quail genotypes, which typically exhibit higher nutrient demands compared with unimproved populations [47].

Final Body Weight and Growth Rate

A key productivity indicator analyzed in relation to the rearing system is the final body weight of quails particularly at slaughter in meat production farms or the adult weight at 6–8 weeks for layer quails and the growth rate during the early weeks of life [48].

Overall, most studies indicate that quails raised in more restrictive (intensive) environments tend to achieve slightly higher body weights compared to those raised on the floor or in more spacious systems. For example, a classic study [49], reported that female layer quails housed in battery cages were significantly heavier than those kept in barn-floor systems or free-range environments.

One possible explanation is that in cages, birds have limited physical activity, preserving energy and converting a larger proportion of feed into body mass (muscle and fat deposits). Additionally, the strictly controlled microclimate in battery systems maintaining a constant optimal temperature around 20–24°C, with no drafts prevents energy expenditure for thermoregulation. By contrast, in open environments, birds consume more calories to stay warm or search for food [50].

Constant access to concentrated feed in cages may stimulate faster growth rates in a shorter time frame. Concrete data support these observations: a study conducted in Egypt showed that at 6 weeks of age (when egg laying typically begins), quails raised in cages already had slightly higher body weights than those raised on the floor. This difference persisted up to 18 weeks, even though both groups continued to gain weight [51].

Another study [52] noted that layer quails raised in cages and fed optimally reached maturity weight and the 50% laying threshold faster compared to floor-raised counterparts.

A study demonstrated that quails raised under low light intensity (≈ 10 lux) had significantly increased slaughter weight rising from approximately 118 g to 132 g indicating that environmental stressors, such as overly bright lighting, may negatively affect optimal weight gain [35]. Growth rate during the early weeks also varies: in one comparative study, caged quails exhibited a higher average daily gain at 3 and 5 weeks of age, while those raised on slatted floors achieved a slightly better gain at 4 weeks. These point-in-time differences may be due to the feeding dynamics at different growth stages for instance, floor-raised chicks may have eaten better initially, but over time the caged group caught up and surpassed them [53].

In contrast, free-range/extensive systems tend to result in lower final weights or at least leaner birds (with less body fat) compared to birds raised in more controlled environments. Birds that run freely or forage for food engage in more physical activity, burning more calories. In addition, variable outdoor temperatures can slow growth if not maintained within optimal ranges [54].

Although direct studies on free-range quails are limited, comparisons can be drawn from chickens: slow-growing meat chickens raised on the ground with outdoor access tend to produce smaller carcasses but higher-quality meat, whereas intensively raised broilers reach much higher weights in a short period [55].

In the case of Japanese quails, which have a relatively low body weight (≈150 g at 4–5 weeks and 180–200 g at 6–8 weeks for females), the absolute differences in growth may appear small, but relative differences can still be meaningful [56, 57]. Studies comparing rearing systems have shown that housing conditions significantly affect body weight and carcass traits, with quails raised in floor pens or cages achieving different growth rates and fat deposition [58]. Anecdotal farmer observations also suggest that free-range quails may reach slightly lower body weights but accumulate less abdominal fat compared to birds raised indoors, although this requires further scientific validation.

Table 2 Final Body Weight and Growth Rate in Quail Rearing Systems

System	Age / Metric/ BW	Value(s) (g)	References
Conventional / cages or tightly controlled	Slaughter (better light)	≈132.5 vs ≈118	[22, 35, 52, 59]
	Week 4 (mixed sex)	133.7	
	Week 8 (mixed sex)	175.5	
Indoor floor (organic ad lib; free access to yard)	Week 4 (mixed sex)	93.5	
	Week 8 (mixed sex)	127.5	
Organic / pasture variants (reduced feed levels)	Week 4	65.8–69.3	
	Week 8	106.2–114.6	
Reference (layers)	Adult female (6–8 wk)	~180–200	

Feed Conversion Ratio (FCR) and Feed Efficiency

Feed Conversion Ratio (FCR) usually expressed as kilograms of feed consumed per kilogram of body weight gain (for young birds) or per mass of eggs produced (for layers) is a key economic indicator in poultry production. In intensive systems, FCR is generally more efficient (i.e., lower), since the birds expend less energy. Studies on quails partially confirm this expectation, though nuances exist [24].

An experiment conducted in Pakistan compared quails raised on three different flooring types: solid floor cages, wire-mesh floor cages, and deep litter systems. It was observed that up to 3 weeks of age, quails on wire mesh had the best feed conversion, consuming less feed per unit of body weight gained. However, by 4 weeks, those raised on litter achieved the best FCR. Over the entire starter period, the differences were not substantial, indicating that factors like flooring type and early feeding behavior can temporarily affect FCR [58].

In a more recent study, [52] found that layer quails raised in cages and fed with high-quality commercial diets showed superior feed efficiency (lower FCR, meaning more eggs per kg of feed) compared to those raised on the floor. Specifically, the group “cages + standardized diet” outperformed the “floor + experimental diet,” highlighting the dual impact of restricted habitat and optimized feed formulation.

Several mechanisms can explain the weaker FCR in floor-based or free-range systems:

- increased movement leads to higher energy expenditure;
- feed losses are common (feed falling into litter or soil, being trampled or scattered);
- social stress may occur if stocking density is too high and competition for feed access increases leading to underfeeding in some birds;

Furthermore, in outdoor systems, quails may also consume natural food sources (seeds, insects), which are not easily accounted for, making precise FCR calculations difficult [60]. Nevertheless, these birds still require formulated feed, and overall feed conversion tends to be lower. Another relevant factor is the efficiency of converting feed into eggs. In chickens, studies show that in cage-free systems (floor or aviary), feed consumption per egg increases by about 5–15% compared to caged systems. This is partly due to more movement and feed wastage. A similar phenomenon is likely in quails: a free-roaming quail eats more to produce the same number of eggs as a calm quail in a cage [61].

Direct studies on FCR for egg production in quails are rare. However, [62] noted that, on average, feed consumption per bird did not differ significantly between cage and floor systems, as both groups had ad libitum access to feed and water. The difference was observed in egg output which was much higher in the floor-raised group (see following section). This indirectly implies a better FCR per egg in the floor system (more eggs for similar feed intake). This outcome is unexpected and contrary to common assumptions, but the authors explained that floor-raised quails benefited from increased comfort (ability to express natural behaviors, reduced stress), which enabled higher egg production without increased feed intake there by improving the biological efficiency of feed use. Traditionally, the cage system offers better FCR due to controlled feeding and limited movement [63].

Table 3 Feed Conversion Ratio (FCR) of Quails by Growth Phase and Rearing System

Rearing System	Starter (0–3 weeks)	Grower (4–5 weeks)	Finisher (6–7 weeks)	References
Cages	3.50	3.89	4.05	[65]
Floor	3.70	4.10	4.28	[65]
Conventional (Cages)	3.10	3.60	3.85	[22]
Organic + Pasture	4.80–6.80	6.20–6.80	6.50–7.00	[22]
Cages, varied protein diets	2.97	3.10	3.24	[66]
Cages (mash/crumble)	2.61	2.80	2.95	[67]

However, if the cage environment causes stress (excessive light, overcrowding), birds may eat below their potential, impairing performance. Conversely, a well-managed floor system that reduces stress and encourages positive behaviors (through the use of appropriate feeders' circular feeders have been shown to encourage more foraging and preening than narrow troughs) can result in healthier and more productive birds, offsetting minor feed losses.

In practice, feed efficiency depends not only on the rearing system, but also on how well that system is managed including factors like stocking density, feeding equipment, and feed formulation [64].

Mortality, Morbidity, and Health Status in Quail

Mortality and morbidity (disease incidence) in quail are key indicators of the efficiency and welfare of a production system. An ideal system should aim to keep mortality as close to zero as possible (excluding scheduled culling) and maintain bird health throughout the entire production cycle. In practice, however, factors such as stocking density and housing conditions can significantly impact the occurrence of diseases, accidental injuries, and mortality rates [68].

Comparative studies offer mixed findings:

- a study reported a higher total mortality rate in cage systems compared to floor pens. Over the course of the study, cumulative mortality in caged groups was significantly higher. This suggests potential issues such as injuries (e.g., birds getting caught in the mesh or being suffocated) or the rapid spread of diseases due to confinement. Additionally, signs like poor feather condition and visible injuries in the caged group pointed to elevated stress levels, which could lead to immunosuppression and increased mortality [62].

- In contrast, it was found that the type of housing system had no significant effect on quail survival [52]. Mortality remained very low and similar in both cage and floor systems over 32 weeks. This suggests that, with proper biosecurity and management, both systems can maintain minimal mortality (often just a few percent or less).

Regarding disease risk, overcrowding is a known contributor to infections such as coccidiosis (caused by *Eimeria*) and ulcerative enteritis (*Clostridium colinum*), particularly in poorly sanitized environments. In cage systems, if the waste removal setup is efficient (i.e., droppings fall onto trays or belts separated from the birds), the risk of coccidiosis can actually be lower than in litter-based systems, where oocysts accumulate. However, in multi-tiered cages where droppings fall onto lower levels, or if trays are not cleaned regularly, infection outbreaks can occur. On floor systems, litter moisture is critical: wet, dirty bedding fosters the growth of pathogens and leads to issues like footpad dermatitis, hock burns, and high ammonia levels that can damage the respiratory system [69]. Trauma is another cause of mortality in quail. These birds are prone to a "spooking" reflex when startled, they may jump and fly upward suddenly. In cages, this can result in fatal head or neck injuries from hitting the mesh ceiling. Similarly, in floor systems with low ceilings or hard surfaces, quail can injure themselves when flying into walls. However, in larger shelters with high ceilings or soft mesh protection, this risk is reduced. Observations show that partially covering the space with soft nets or fabrics can prevent injury from vertical flight. In open free-range systems, the risk of spooking injuries is lower due to the open sky, but birds are at greater risk of escaping or being caught by predators unless the perimeter is properly secured [12].

Aggression and cannibalism can also cause indirect mortality, as injured birds may succumb to secondary infections. High density and poorly structured social groups (e.g., too many males) often result in fights and injuries, especially to females. In small cages, dominant males may attack and even kill other males if forced to share space. Thus, maintaining the optimal male-to-female ratio and separating unused males is crucial. Studies suggest that a 1:3 or 1:4 (male:female) ratio reduces aggression without negatively impacting fertility. Additionally, genetic selection for docile temperament has been proposed: quail lines with lower corticosterone reactivity are more sociable and better tolerate high densities without displaying aggression [70].

Overall, poorly managed intensive systems (overcrowding, lack of hygiene, no enrichment) can result in high mortality rates sometimes up to 100% in extreme cases, such as untreated ulcerative enteritis in overcrowded setups. On the other hand, well-managed systems, whether cage-based or floor-based, can keep mortality under 5% per production cycle. Free-range systems introduce additional external risks (snakes, rodents spreading disease, wild birds as avian flu vectors), but these can be mitigated through proper biosecurity measures (netting, vaccinations, regular veterinary checks) [69].

One disadvantage of alternative systems is the difficulty in identifying sick individuals. In large halls or outdoor areas, a sick bird may go unnoticed, delaying detection of mortality. In cages, a dead bird is immediately visible in its confined space. Nevertheless, research shows that quail health can be effectively maintained in any system if proper measures are in place: reasonable stocking densities, age group separation, stress reduction, strict hygiene, and daily monitoring. Still, cage-free systems require more preventive care due to greater environmental exposure and more complex sanitation, while intensive systems depend on advanced technology (ventilation, waste removal) to prevent housing-related diseases (especially respiratory and infectious ones) [71].

Natural Behavior and Welfare in Quail

The behavior and overall welfare of quail are strongly influenced by the environment in which they are raised. As birds that still retain many of their wild instincts, quail exhibit a range of innate behaviors: scratching and dust-bathing to maintain feather condition and remove parasites, foraging by pecking at the substrate, preening to groom and align feathers, short escape flights when startled, nesting preferences (laying eggs in sheltered spots), and various social interactions including pecking order, male calls, and mating rituals.

The extent to which a production system allows expression of these natural behaviors is a direct indicator of animal welfare and indirectly influences productivity [48].

Cage Systems

Intensive cage systems are the most restrictive in terms of behavioral expression. In metal cages, quail cannot scratch or dig, as there is no substrate this absence is one of the major welfare concerns highlighted by animal protection organizations. Without access to dust baths, feather condition deteriorates, as birds cannot effectively clean their plumage. Studies confirm that in systems lacking dust-bathing opportunities, feather condition worsens feathers become ruffled and worn [10].

This isn’t just an aesthetic issue poor feather condition leads to heat loss, forcing birds to use more energy to maintain body temperature, thereby reducing production efficiency. One study suggests that providing quail with access to dust-bathing materials can improve feather insulation, allowing energy savings to be redirected toward meat and egg production [7].

In cages, birds also cannot fly the height is typically only 25–30 cm, too low for even a basic jump. While this prevents flight-related injuries, it also removes a natural escape response, increasing the risk of panic injuries (crashing into the mesh). Limited space also prevents simple movements like wing stretching or running [19].

Overcrowding in cages such as keeping 5–6 birds in a small 30x30 cm space leads to stress-induced behaviors, including feather pecking and cannibalism. Females in polygamous mixed-sex groups often suffer from over-mating injuries due to repeated mounting in confined spaces, where they cannot escape persistent males. This issue is sometimes addressed by separating sexes with males kept apart and artificial insemination used for hatching eggs or by maintaining small colonies with appropriate male-to-female ratios [72].

Floor-Based (Semi-Intensive) Systems

Floor-based systems allow for significantly more natural behavior. On litter, quail can scratch and dust-bathe if the bedding is dry and fine, they will roll in it much like chickens. Sand trays or designated dust-bathing areas can be provided. Quail also spends time foraging in the substrate, searching for seeds or scraps, even if their main diet is provided in feeders this behavior reflects their natural food-seeking instincts [12].

In larger pens, they can run short distances and perform small jumps (although collisions may still occur if space is limited).

Social interactions unfold more naturally: birds can establish hierarchies (typically through back-pecking) and submissive individuals can withdraw, which helps reduce the severity of conflicts [19].

Although aggression may still occur even in spacious aviaries, increasing space per bird significantly reduces its intensity. Literature reports a minimum stocking density of about 372 cm² per quail (based on studies of bobwhite quail), nearly double the 180–200 cm² per bird previously recommended by FAO for cage systems. Thus, in practice, doubling the space per bird can markedly enhance welfare [12].

Free-Range Systems

Free-range systems offer the highest degree of behavioral freedom. On natural ground and vegetation, quail can explore, scratch, and hide. In the presence of cover such as grass or shrubs, they spend a significant amount of time sheltering behavioral studies show that even domesticated quail spend up to 48% of their time under cover, even when it only occupies 17% of the available area. This behavior is an instinctual predator-avoidance response. Providing cover in free-range setups helps reduce fear and lowers stress levels [73].

Lower psychological stress also results in measurable physiological improvements. For instance, light intensity and the ability to hide affect circulating corticosterone levels a key biomarker of chronic stress in birds. In one study, quail kept in low light (10 lux) with a quiet environment showed a drop in plasma corticosterone from 7.59 ng/ml to 4.40 ng/ml, compared to birds kept under bright light (250 lux).

Lower corticosterone levels indicate improved welfare. Additionally, under pleasant lighting and adequate space, feather pecking among individuals decreased from 5% of observed time to just 1% indicating that behavioral frustrations were reduced [35].

REFERENCES

1. Oke, O. E., Oliyide, K. M., Akosile, O. A., Oni, A. I., Adekunle, E. O., Oyebanji, B. O., Aremu, O. P., Adeoba, I. M., Eletu, T. A., & Daramola, J. O. (2025). Innovations in Quail Welfare: Integrating Environmental Enrichment, Nutrition and Genetic Advances for Improved Health and Productivity. *Veterinary medicine and science*, *11*(4), e70424. https://doi.org/10.1002/vms3.70424
2. Banu Constantin, Vizireanu Camelia, Ianițchi Daniela, Săhleanu Emilian. Living Food-Dead Food. Good Food-Bad Food. București: Editura ASAB; 2011.
3. Nasar, A. (2016). *A survey of Japanese quail (Coturnix japonica) farming: Age at sexual maturity and egg production*. Indian Journal of Animal Research, https://pmc.ncbi.nlm.nih.gov/articles/PMC5057031/
4. Lukanov, H. (2019). Domestic quail (*Coturnix japonica domestica*): Is there such farm animal? *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology, 225,* 108586. https://doi.org/10.1016/j.cbpc.2019.108586
5. Ianiţchi, D., Poşan, P., Maloş, I. G., Nistor, L., Maftei, M. L., Nicolae, C. G., & Hodoşan, C. (2024). *The influence of laying hen rearing systems and maintenance technologies on egg quality parameters: A review. Scientific Papers. Series D. Animal Science*, *67*(1), 215-230. https://mail.spasb.ro/index.php/public_html/article/view/2262/2151
6. Pîrlea, G. M., Stan, E. G., Zinca, A. I., & Nicolae, C. G. (2025). The Influencing Factors of Pheasant Meat Characteristics: A Review. *Bulletin of the University of Agricultural Sciences & Veterinary Medicine Cluj-Napoca. Animal Science & Biotechnologies*, *82*(1).
7. Oke, O. E., Oliyide, K. M., Akosile, O. A., Oni, A. I., Adekunle, E. O., Oyebanji, B. O., Aremu, O. P., Adeoba, I. M., Eletu, T. A., & Daramola, J. O. (2025). Innovations in Quail Welfare: Integrating Environmental Enrichment, Nutrition and Genetic Advances for Improved Health and Productivity. *Veterinary medicine and science*, *11*(4), e70424. https://doi.org/10.1002/vms3.70424

8. Zhao, Z., & Tian, H. (2014). *Effects of housing systems on behavioral activities, welfare and meat quality of fast-growing broilers*. Asian-Australasian Journal of Animal Sciences, *27*(2), 254–260, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4093287/

9. Sherwin, C. M., Richards, G. J., & Nicol, C. J. (2010). Comparison of the welfare of layer hens in four housing systems in the UK. *British Poultry Science, 51*(4), 488–497

10. Nordi, W. M., Yamashiro, K. C. E., Klank, M., Locatelli-Dittrich, R., Morais, R. N., Reghelin, A. I., & Molento, C. F. M. (2012). Quail (Coturnix coturnix japonica) welfare in two confinement systems. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia, 64*(4), 1001–1008. https://doi.org/10.1590/S0102-09352012000400029

11. European Commission. (2021, June 30). *Success for the European Citizens' Initiative on "End the Cage Age"*. EURCAW-Poultry.

12. Jansson, D. S., Lundmark Hedman, F., Yngvesson, J., Keeling, L., & Henriksen, R. (2025). *A critical review on the welfare of Japanese quail in cage-free housing: Current knowledge and future perspectives*. Poultry Science, *104*(8), 105263. https://doi.org/10.1016/j.psj.2025.105263

13. El-Sheikh, T. M., Essa, N. M., Abdel-Kareem, A. A. A., & Elsagheer, M. A. (2016). Evaluation of productive and reproductive performance of Japanese quails in floor pens and conventional cages with different stocking densities. *Egyptian Poultry Science Journal, 36*(3), 669–683.

14. El-Tarabany, M. S. (2016). Impact of cage stocking density on egg laying characteristics and related stress and immunity parameters of Japanese quails. *Animal, 10*(7), 1211–1217. https://doi.org/10.1017/S1751731116000140

15. Hossain, M. A., Mahbub, A. S. M., & Belal, S. A. (2023). *Housing and Dietary Effects on Production Performance, Quality Index, Chemical Composition and Mineral Content of Japanese Quail Eggs* (preprint Heliyon). SSRN. https://ssrn.com/abstract=4480203

16. University of Georgia Extension. (2022, June 1). *Manure drying methods in layer houses*. https://site.extension.uga.edu/poutrytips/files/2022/06/PDF-1.pd

17. The Poultry Site. (2019, July 30). *The welfare of Japanese quail on farms*. The Poultry Site. https://www.thepoultrysite.com/articles/the-welfare-of-japanese-quail-on-farms

18. Nielsen, S. S., Alvarez, J., Bicout, D., & Velarde, A. (2023). Welfare of ducks, geese and quail on farm. *Frontiers in Veterinary Science, 10,* 1060163. https://doi.org/10.3389/fvets.2023.1060163

19. EFSA Panel on Animal Health and Welfare (AHAW). (2023). *Scientific Opinion on the welfare of laying hens on farm*. *EFSA Journal, 21*(6), e07889.

20. Sharma, M. K., & Kim, W. K. (2024). *Coccidiosis in egg-laying hens and potential nutritional strategies to modulate performance, gut health, and immune response*. *Animals, 14*(7), 1015. https://doi.org/10.3390/ani14071015

21. Zinca, A.-I., Lungu, V.-D., Moise, A. E., & Drăgotoiu, D. (2024). The influence of laying hen rearing systems and maintenance technologies on egg quality parameters: A review. *Scientific Papers: Animal Science and Biotechnologies, 57*(1). https://mail.spasb.ro/index.php/public_html/article/view/2262

22. Inci, H., Ozdemir, G., Sogut, B., Sengul, A. Y., Sengul, T., & Taysi, M. R. (2016). Comparison of growth performance and carcass traits of Japanese quails reared in conventional, pasture, and organic conditions. *Revista Brasileira de Zootecnia, 45*(1), 8–15. https://doi.org/10.1590/S1806-92902016000100002

23. Dennis, R. (2022). Protective and stimulatory environmental enrichments in Japanese quail colony. *AWI Quarterly (Animal Welfare Institute),* *https://awionline.org/awi-quarterly/summer-2022/protective-and-stimulatory-environmental-enrichments-japanese-quail*

24. Miao, Z. H., Witter, R., & Christensen, V. (2005). Free-range poultry production - A review. *Asian-Australasian Journal of Animal Sciences, 18*(1), 113–132. https://doi.org/10.5713/ajas.2005.113

25. Meyer Hatchery. (2021). *Coturnix Quail Brooding 101: From Hatch to Outside.* Meyer Hatchery Help Center. https://meyerhatchery.zendesk.com/hc/en-us/articles/4425664324493-Coturnix-Quail-Brooding-101-From-Hatch-to-Outside

26. de Oliveira, E. M., Nascimento, S. T., Mós, J. V. d. N., Roza, L. d. F., Toledo, J. B., & dos Santos, T. C. (2023). *Thermal Conditions of*

Laying Quail Sheds in Brazil. AgriEngineering, 5(4), 2314–2325.
27. Kristensen, H. H., & Wathes, C. M. (2000). *Ammonia and poultry welfare: a review. World's Poultry Science Journal, 56*(3), 235–245.
28. Lay, D. C., Fulton, R. M., Hester, P. Y., Karcher, D. M., Kjaer, J. B., Mench, J. A., Mullens, B. A., Newberry, R. C., Nicol, C. J., O'Sullivan, N. P., & Porter, R. E. (2011). Hen welfare in different housing systems: Cage, aviary, and barn. *Poultry Science, 90*(1), 278–294. https://doi.org/10.3382/ps.2010-00962
29. Gălățanu, D. (n.d.). *Despre creșterea puilor de prepeliță. Gazeta de Agricultură.* https://vet.md/articole/despre-cresterea-puilor-de-prepelita.html
30. Pepper, C. M., & Dunlop, M. W. (2021). Review of litter turning during a grow-out as a management practice to complement effective ventilation. *Poultry Science, 100*(5), 101068. https://doi.org/10.1016/j.psj.2021.101068
31. Mou, C. T. (2025). Evaluation of the effects of maintaining a moderate litter moisture level on ammonia emission and footpad health in broilers. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology, 268,* 109624. https://doi.org/10.1016/j.cbpc.2024.109624
32. Missouri Department of Conservation. (2024). *On the edge: A guide to managing land for bobwhite quail.* https://mdc.mo.gov/sites/default/files/2024-01/On-The-Edge.pdf
33. Göransson, L., et al. (2024). The perks of being an organic chicken Animal welfare science on the key features of organic poultry production. *Frontiers in Animal Science.* https://doi.org/10.3389/fanim.2024.1400384
34. Memon, A., Rajput, N., Naeem, M., Ali, S., Baloch, M. H., & Kaka, A. (2018). The effect of photoperiod and light intensity on egg production of Japanese quails. *Pure and Applied Biology, 7*(4), 1294–1300. https://doi.org/10.19045/bspab.2018.700150
35. Nasr, M. A. F., Mohammed, H., Hassan, R. A., Swelum, A. A., & Saadeldin, I. M. (2019). Does light intensity affect the behavior, welfare, performance, meat quality, amino acid profile, and egg quality of Japanese quails? *Poultry Science, 98*(8), 3093–3102. https://doi.org/10.3382/ps/pez089
36. Shahraki, A. D. (2025). Light intensity and photoperiod effects on performance, behavior, and meat quality in Japanese quail. *Poultry Science and Management, 2*(1), 7. https://doi.org/10.1186/s44364-025-00007-0
37. Ashour, E. A., et al. (2022). Impacts of varying dietary energy and crude protein levels on Japanese quail performance during summer. *Journal of Animal Nutrition*, doi:10.1080/1828051X.2022.2118625
38. Omidiwura, B. R. O., Ayoola, O. T., Afolabi, K. D., & Babatunde, O. O. (2016). Crude protein and energy requirements of Japanese quail (*Coturnix coturnix japonica*) during rearing period. *Poultry Science Journal, 4*(2), 89–97. https://doi.org/10.22069/PSJ.2016.10726
39. Auburn University. (2023). *Feeding game birds: Pheasant, quail, and partridge.* Alabama Cooperative Extension System. https://www.aces.edu/blog/topics/farming/feeding-game-birds-pheasant-quail-and-partridge/
40. Perine, T. P., Silva, R. M., Furlan, A. C., & Murakami, A. E. (2023). Digestible methionine + cystine requirements of Japanese quails during the starter and grower phases. *Revista Brasileira de Zootecnia, 52,* e20220102. https://doi.org/10.37496/rbz5220220102
41. Ahmadi, H., Golian, A., & Shivazad, M. (2025). Calcium requirements for optimal growth, bone quality, and immune response in Japanese quail chicks. *Poultry Science, 104*(1), 102123. https://doi.org/10.1016/j.psj.2024.102123
42. Kamberi, B., Osei, S. A., & Atuahene, C. C. (2007). Calcium and available phosphorus requirements of Japanese quail. In *Proceedings of the 16th European Symposium on Poultry Nutrition* (pp. 314–317). World's Poultry Science Association. Retrieved from https://www.cabi.org/Uploads/animal-science/worlds-poultry-science-association/WPSA-france-2007/44.pdf
43. Yazarloo, M., Sharifi, S. D., Shariatmadari, F., & Salehi, A. (2013). Determination of optimum levels of energy and protein in grower diet of Japanese quail (*Coturnix coturnix japonica*). *Journal of Animal Production, 15*(1), 1–10. https://doi.org/10.22059/jap.2013.36598
44. Mnisi, C. M., & Mlambo, V. (2023). Sorghum, millet and cassava as alternative dietary energy sources for Japanese quail: A review. *Frontiers in Animal Science, 4,* 1066388. https://doi.org/10.3389/fanim.2023.1066388
45. Dowarah, R., & Sethi, A. (2014). Various dietary levels of protein and energy interaction

on growth performance of white-plumage Japanese quails. *Veterinary World, 7*(6), 379–383.
46. Azghadi, M. A., Kermanshahi, H., & Golian, A. (2014). The effect of dietary energy and protein levels on growth performance and antibody responses of offspring of laying Japanese quails. *Iranian Journal of Applied Animal Science, 4*(1), 185–190.
47. University of Georgia Extension. (2024). *Feeding Quail: Starter, Grower, Finisher Program*. Retrieved from *The Poultry Site*, originally based on extension guidance.
48. Dalmau, A., Padilla, L., Varvaró-Porter, A., Xercavins, A., Velarde, A., & Contreras-Jodar, A. (2024). *Animal welfare assessment protocol for quails reared for meat production*. Frontiers in Veterinary Science, 11, 1452109. https://doi.org/10.3389/fvets.2024.1452109
49. Van Loon, D. P. R., Hangalapura, B., De Vries Reilingh, G., Nieuwland, M. G. B., Kemp, B., & Parmentier, H. K. (2004). Effect of three different housing systems on immune responses and body weight of chicken lines divergently selected for antibody responses to sheep red blood cells. *Livestock Production Science, 85*(2–3), 139–150.
50. van Krimpen, M. M., de Jong, I. C., Blokhuis, H. J., & Verstegen, M. W. A. (2011). Interaction effects of ambient temperature, feather cover, and housing system (cage vs. floor) on energy partitioning and performance of laying hens. *Poultry Science, 90*(10), 2211–2218. https://edepot.wur.nl/310457
51. Uçar, Y. C., & Olar, S. A. (2024). Housing systems and performance traits in Japanese quail: A comparative analysis. *Turkish Journal of Agriculture – Food Science and Technology, 12*(8), 1388–1395.
52. Hossain, M. A., Mahbub, A. S. M., & Belal, S. A. (2024). *Housing and dietary effects on production performance, quality index, and chemical composition of Japanese quail eggs*. *Veterinary and Animal Science*, 23, 100340. https://doi.org/10.1016/j.vas.2024.100340
53. Abdallah, N., Angishan, A., Kursun, K., & Baylan, M. *The effect of housing system and strain on growth performance and carcass trait of quails*. Spanish Journal of Agricultural *Research*, **2025**, *23*(1), e21057. https://doi.org/10.5424/sjar/2025231-21057
54. Wang, K. H., Shi, S. R., Dou, T. C., & Sun, H. J. (2009). Effect of a free-range raising system on growth performance, carcass yield, and meat quality of slow-growing chicken. *Poultry Science, 88*(11), 2219–2223.
55. Doğan, S. C., Baylan, M., Bulancak, A., & Ayaşan, T. (2019). Differences in performance, carcass characteristics and meat quality between fast- and slow-growing broiler genotypes. *Progress in Nutrition, 21*(3), 558–565. https://www.mattioli1885journals.com/index.php/progressinnutrition/article/view/7747
56. Minvielle, F. (2004). The future of Japanese quail for research and production. *World's Poultry Science Journal, 60*(4), 500–507. https://doi.org/10.1079/WPS200433
57. Narinc, D., Aksoy, T., & Karaman, E. (2010). Genetic parameters of growth curve parameters and weekly body weights in Japanese quail. *Journal of Animal Science, 88*(7), 2245–2251. https://doi.org/10.2527/jas.2009-2226
58. Angishan, A., Sadeghi, A. A., & Chamani, M. (2025). Effect of housing system on growth performance and carcass traits of Japanese quails (*Coturnix japonica*). *Spanish Journal of Agricultural Research, 23*(1), e06. https://doi.org/10.5424/sjar/2025231-21057
59. Randall, M., & Bolla, G. (2008). *Raising Japanese quail* (Primefact 602, 2nd ed.). NSW Department of Primary Industries. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/145346/Raising-Japanese-quail.pdf
60. El Jeni, R. (2021). An overview of health challenges in alternative poultry production systems. *Animals (Basel), 11*(2), 456. https://doi.org/10.3390/ani11020456
61. Lay, D. C., Fulton, R. M., Hester, P. Y., Karcher, D. M., Kjaer, J. B., Mench, J. A., Mullens, B. A., Newberry, R. C., Nicol, C. J., O'Sullivan, N. P., & Porter, R. E. (2011). Hen welfare in different housing systems: Cage, aviary, and barn. *Poultry Science, 90*(1), 278–294. https://doi.org/10.3382/ps.2010-00962
62. Roshdy, M. (2010). *Effect of housing system (cages versus floor pens) on productive and physiological performance of Japanese quail (Coturnix coturnix japonica).* Egyptian Poultry Science Journal, 30(1), 55–72.
63. Olar, S. A., & Uçar, Y. C. (2024). *Housing systems and performance traits in Japanese quail: A comparative analysis. Turkish Journal of Agriculture – Food Science and Technology, 12*(8), 1388–1395.
64. Yildirim, I., & Taskin, A. (2021). Effects of different feeder types and lighting programs on performance, egg quality, and behavior of

Japanese quails (*Coturnix coturnix japonica*). *Poultry Science, 100*(3), 101019. https://doi.org/10.1016/j.psj.2020.12.005

65. Razee, A., et al. (2016). Performance of Japanese quails (*Coturnix coturnix japonica*) on floor and cage rearing system in Sylhet, Bangladesh. *Iranian Journal of Applied Animal Science*.
66. Mazuba, D. M. F. (2012). *Performance of growing Japanese quails fed on iso-caloric diets of different crude protein levels* (Master's thesis). University of Zambia. UNZA Institutional Repository.
67. Shah, A. M., et al. (2016). Effect of various forms of feed on growth performance of Japanese quail. *Indian Journal of Veterinary & Animal Sciences Research, 50*(4), 23–28.
68. Aro, S. O., Arogbodo, J. O., Ahmed, M. A., & Ademola, O. F. (2021). *Effects of stocking density on the performance characteristics, egg quality and nutrient composition of the eggs of Japanese quails (Coturnix coturnix japonica)*. Journal of Scientific Research in Medical and Biological Sciences, 2(2). https://doi.org/10.47631/jsrmbs.v2i2.248
69. Merck Veterinary Manual Editorial Board. (2025). *Ulcerative enteritis in poultry. Merck Veterinary Manual*.
70. Wechsler, B., & Schmid, I. (1998). *Aggressive pecking by males in breeding groups of Japanese quail (Coturnix japonica).* British Poultry Science, 39(3), 333–339. https://doi.org/10.1080/00071669888863
71. Liebhart, D., & Hess, C. (2023). *Diagnosing infectious diseases in poultry requires a close link between farm observations and laboratory diagnostics. Microorganisms, 2*(2), 20.
72. Choudhary, B. K., & Kumar, S. (2025). *Mortality and pathological conditions in quails. Journal of Novel Research and Innovative Development, 2*(6), 31–48.
73. Schmid, I., & Wechsler, B. (1997). *Behaviour of Japanese quail (Coturnix japonica) kept in semi-natural aviaries. Applied Animal Behaviour Science, 55*(1), 103–113.