Colegio de Postgraduados

Evolving coturniculture: production challenges and market opportunities in alternative quail farming

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ABSTRACT

Objective: Coturniculture refers to the breeding and productive use of *Coturnix japonica*. This bird has emerged as a strategic alternative within non-conventional quail farming, highlighting its biological efficiency, low space requirements, and rapid reproduction rate.

Design/Methodology/Approach: This review explains the integration of the main advances and challenges of coturniculture, focusing on biological characteristics, production systems, feeding management, market dynamics, and agroecological innovation. The productive potential of several production units operating with genetic lines and specific diets or other constraints that limit performance is highlighted.

Results: The quail farming system for this species is adaptable to diverse scales and agroecological conditions. It has been progressively consolidated in Latin America, particularly in Mexico. However, it has limited development, weak technical development, and poor commercial coordination. However, recent studies have documented improvements in production through the incorporation of alternative ingredients (insects, local forage, agro-industrial byproducts) and practices that promote animal welfare. In the public consumption area, coturniculture produces meat and eggs. These products are gaining ground in the gourmet, functional, and sustainable food niches. However, there is a persistent lack of regulations, limited institutional promotion, and limited awareness of public consumption of these products. Current trends in quail feeding should focus on healthy, antibiotic-free production and a circular economy that opens up new possibilities for strengthening the production chain.

Limitations/Implications of the study: Publications on coturniculture are limited. Studies in databases indexed in Scopus and Google Scholar are few. However, the necessary information was collected to understand the landscape of this livestock activity.

Findings/Conclusions: Coturniculture represents a viable option for rural diversification, provided that public policies, applied research, technical training, and marketing schemes are promoted to develop sustainable, profitable systems that integrate culture.

Keywords: Coturniculture, Japanese quail, Production systems, Agroecology.

INTRODUCTION

Coturniculture refers to the intensive farming of quails (*Coturnix* spp.). This production system has gained relevance in recent decades as part of diversification strategies in alternative quail production. It has also established itself as an activity with a low initial cost, a short production cycle, and an important source of animal protein with high biological value (Fagundes *et al.*, 2021). Quail meat and eggs have been positioned for their nutritional quality, palatability, and functional benefits, increasing their demand in specialized and gourmet markets (Vásquez *et al.*, 2019). In developing countries, coturniculture represents a viable option for small and medium-sized producers. Its production requires little space, inexpensive inputs, and is continuous, unlike conventional quail farming (Dib *et al.*, 2022). However, this activity faces structural challenges linked to access to balanced inputs, technologies adapted to the local scale, limitations in sanitary control, and the low professionalization of the sector (Souza *et al.*, 2020).

The productive perspective, genetic aspects, zootechnical management, feeding, and animal welfare are crucial for improving the efficiency and quality of quail products. Recent research has explored sustainable alternatives, such as the inclusion of insects (*e.g.*, *Tenebrio molitor*) or agro-industrial by-products in quail diets, with encouraging results for zootechnical parameters and egg quality (González Muñoz *et al.*, 2023; Morales-de la Peña *et al.*, 2021). On the commercial front, market opportunities in quail farming must be driven by the growing demand for differentiated, healthy, and ethically sourced products. Quail eggs, for example, are valued for their protein profile, iron content, and low allergenicity; while the meat is appreciated for its soft texture and low fat content (Nunes *et al.*, 2020). However, barriers persist regarding production scale, specific regulations, efficient distribution channels, and positioning strategies compared to other poultry products (Fernández-Cruz *et al.*, 2018).

Coturniculture is presented as an emerging quail farming model that requires a comprehensive analysis, taking into account technical and scientific advances and socio-commercial factors that limit or enhance its expansion. Therefore, this review aims to analyze the main production challenges and market opportunities facing coturniculture, with an emphasis on alternative, sustainable, and economically accessible production systems.

History and current status of coturniculture

Coturniculture is the animal husbandry practice focused on the breeding, reproduction, and utilization of quails; it has historical roots in Asian and Mediterranean civilizations. In particular, the Japanese quail (*Coturnix japonica*) has been domesticated for over 2,000 years in China and Japan. This species was primarily raised for its eggs, which are considered

an energy-producing and functional food in traditional medicine (Fagundes *et al.*, 2021). During the 20th century, this species was intensively selected in Asia and subsequently introduced to Europe and America, establishing itself as the genetic basis for most current commercial lines (Dib *et al.*, 2022).

In Latin America, quail farming began to develop with greater emphasis in the final decades of the 20th century, driven by its low investment costs, adaptability to small spaces, and short production times. However, its consolidation has been uneven, while Brazil, Mexico, and Colombia have managed to establish formal production chains in their expansion. In other regions, it remains a marginal activity, linked to self-consumption systems or small market niches (Fernández-Cruz *et al.*, 2018). In the current context, quail farming is in a transitional stage between empiricism and professionalization. It is estimated that more than 1 million tons of quail meat are produced globally per year, with Asia being the main producing continent, followed by Europe and South America (Nunes *et al.*, 2020). In countries like Brazil, quail egg production exceeds 4 billion annually, driven by growing demand from urban consumers (Souza *et al.*, 2020).

The growing demand for functional foods, the search for sustainable animal proteins, and the expansion of gourmet markets have boosted interest in quail products. However, this expansion has also highlighted the challenges inherent to the sector, including the scarcity of certified genetic lines, limited technological development, a lack of public policies, and weak commercial integration (González Muñoz *et al.*, 2023). In Mexico, there are institutional initiatives and successful cases, such as those in Veracruz, Puebla, the State of Mexico, and Jalisco. Production remains small. This production is typical of quail farms, where official figures on quail production are insufficient due to the lack of registration systems for small-scale farms; these farms account for the majority of meat and egg production (El Sabry *et al.*, 2022). Despite these setbacks, coturniculture offers a strategic opportunity to strengthen local food security, diversify the rural economy, and advance more resilient agroecological systems (Global Forest Coalition, 2019).

Biological and productive characteristics of *Coturnix japonica*

The Japanese quail (*Coturnix japonica*) is the most common species in modern coturniculture (Figure 1). Its productive characteristics stand out for its adaptability to diverse rearing conditions and its accelerated growth cycles. This bird exhibits early sexual maturity, reaching egg-laying between 5 and 7 weeks of age, with an annual production of 280-300 eggs per female under optimal management conditions (Fagundes *et al.*, 2021). Its live weight at slaughter varies between 150 and 200 grams in commercial meat lines, with carcass yields ranging between 65% and 75% (El-Sabry *et al.*, 2022).

Coturnix japonica is distinguished by its high feed efficiency, low space requirements, and relative resistance to disease compared to other poultry species. Furthermore, its docile behavior and intensive reproduction facilitate its management in confinement or semi-intensive production systems (Dib *et al.*, 2022). Quail also has a short incubation cycle, ranging from 17 to 18 days, allowing for rapid production cycles and the possibility of establishing continuous production systems with a few weeks' interval (Rodríguez-Almeida *et al.*, 2021). There are different genetic lines selected for specific purposes, such as egg,

meat, or mixed production. Layer lines have lower body weight but a longer and more sustained laying period. Meanwhile, meat lines, such as the Jumbo variety, reach higher live weights and are slaughtered at younger ages (Nunes *et al.*, 2020). The choice of genetic type influences the system's profitability and must be tailored to the producer's objectives and market conditions.

In Mexico, access to specialized genetic lines is still limited. Many producers resort to experimentally bred quails or those from uncertified hatcheries, which leads to problems of inbreeding, loss of vigor, and variability in production. These limitations contrast with those in Brazil, Spain, and Japan, where genetic improvement centers and germplasm banks focus on improving commercial lines (Souza *et al.*, 2020). Production parameters are also closely linked to the environment and management. Factors such as population density, lighting, ventilation, heat stress, and feed quality can modify zootechnical indices. According to Faria Filho *et al.* (2016), high-density conditions without environmental enrichment can affect quail behavior, health, and productivity, thereby increasing the risk of pecking, mortality, and reduced egg production. Quails require balanced diets containing protein (22-24% in early stages), metabolizable energy, calcium and phosphorus, and essential vitamins to maintain optimal performance. Recent studies report the incorporation of alternative ingredients, such as insect meal, agro-industrial waste (fruit pulp, peels, etc.), and nutraceutical additives, to reduce feed costs without compromising product quality (González Muñoz *et al.*, 2023; Morales-de la Peña *et al.*, 2021). Furthermore, animal welfare has become a key component in modern production systems. Research on behavior and ethology in *Coturnix japonica* indicates that providing perches, digging substrates, and visual or tactile panoramas can improve welfare indicators, reduce aggressiveness, and improve physiological and productive parameters (El-Sabry *et al.*, 2022). This increases relevance for consumers, who are increasingly informed and demanding ethical care for animal-origin foods.

Overall, the efficient use of *Coturnix japonica* requires the proper integration of genetics, nutrition, environment, management, and welfare. The design of systems adapted to local conditions, along with technical training for producers and access to specialized inputs, is essential to boosting the performance and sustainability of coturniculture in developing countries.

Production systems in coturniculture

Coturniculture adopts different production systems that vary in technical level, density, management, and commercial orientation. They are generally classified as a) extensive, b) semi-intensive, c) intensive. Each has specific implications for productivity, health standards, and economic profitability (Dib *et al.*, 2022).

a) Extensive system

This system is predominantly artisanal, with feed based on domestic by-products and rustic structures. Although it requires low investment, it presents limitations in yield, uniformity, and animal health due to poor environmental control (Faria Filho *et al.*, 2016).

b) Semi-intensive system (predominant in Mexico)

This system is ideal for rural enterprises and combines tiered cages, balanced feed, artificial lighting, and some basic environmental control (Figure 1). Studies from southeastern Mexico show that these farms can produce between 200 and 2,000 birds at manageable costs, although they face challenges in genetics, financing, and veterinary services (Morales-de la Peña *et al.*, 2021). Studies conducted in Nigeria indicate that 87.6% of producers use intensive systems with deep litter. In comparison, 26.7% combine commercial feed with artisanal rations, which increases health risk without a proportional increase in yield (Saka *et al.*, 2018). In Campeche, for example, integrating forages such as moringa and leucaena into semi-intensive systems has been shown to improve meat and egg production without increasing costs, while also strengthening local sustainability (Aguilar-López and Reyes-Ramos, 2018).

c) Intensive system

This system is based on units with more than 5,000 birds, fully automated management, strict biosecurity, and certified genetic lines. Although it requires a high investment, it offers the greatest technical and economic efficiency (Nunes *et al.*, 2020). Regarding the impact of population density and the environment, studies such as those by Faria Filho *et al.* (2016) and Saka *et al.* (2018) show that high densities without environmental enrichment strategies lead to stress, aggression, pecking, and declines in production parameters; while systems with deep bedding and adequate ventilation reduce these risks and improve feed conversion. Biosecurity and sanitary management must include cleaning and sanitation protocols that help prevent respiratory and digestive diseases. Technologically advanced systems must implement vaccination plans, quarantines, constant monitoring, and rational use of antibiotics (Souza *et al.*, 2020). In Mexico and other countries, the adoption of technologies such as solar energy, mobile incubators, basic automation, and alternative nutrition is increasing in agroecological systems.

Figure 1. Japanese quail (*Coturnix japonica*), semi-intensive system, and egg morphology. (Images provided by the authors).

Feeding and nutrition in coturniculture

Feeding is one of the most determining factors in the productive and economic success of coturniculture, directly influencing growth rate, egg production, feed conversion, and final product quality. Given the short life cycle and accelerated metabolism of *Coturnix japonica*, its nutritional requirements are specific and demanding, particularly for crude protein, metabolizable energy, essential amino acids, minerals, and vitamins (Oliveira *et al*., 2021). During the growth stage, quails require diets with approximately 22-24% protein and between 2,850 and 3,000 kcal/kg of metabolizable energy. During the laying phase, protein can be adjusted to 18-20%, with a high intake of calcium (3-3.5%) and available phosphorus (0.35-0.45%) to ensure adequate shell formation and a stable laying cycle (Sakomura *et al*., 2019). Deficiencies or imbalances in these nutrients can lead to decreased egg production, lower egg weight, weak bones, and low production efficiency. Traditionally, quail feeding has been based on the use of commercially balanced concentrates formulated for hens. However, this practice is suboptimal, as quails have different requirements in terms of energy density, levels of lysine, methionine, and other micronutrients. Recent studies have proposed the use of specific formulations for quails, which show improvements in feed conversion and in the production of eggs and meat with better organoleptic and nutritional characteristics (Costa *et al*., 2020).

Feed costs account for 60-70% of total feed costs in semi-intensive and intensive systems. Some studies have evaluated the inclusion of alternative ingredients such as agro-industrial by-products (fruit pulp, rice husks, cassava flour) and unconventional protein sources, such as insect meal (*Tenebrio molitor*, *Hermetia illucens*) and forage legumes (Ramos-Elorduy *et al*., 2017; González Muñoz *et al*., 2023). These feeding strategies vary, with differences in digestibility, intestinal health, and carcass quality. However, their use must be carefully formulated to avoid adverse effects caused by antinutritional factors or compositional variability. Additionally, functional additives such as probiotics, prebiotics, organic acids, enzymes, and essential oils have been studied to improve digestive efficiency, strengthen the immune system, and reduce the use of growth-promoting antibiotics (Murakami *et al*., 2019). For example, supplementation with oregano and thyme extract has shown positive effects on intestinal integrity, zootechnical parameters, and the lipid profile of quail eggs (Giannenas *et al*., 2018).

Agroecology, or sustainable production, has promoted the use of local forages such as *Moringa oleifera*, *Leucaena leucocephala*, or *Amaranthus hypochondriacus* as natural supplements rich in protein, antioxidants, and carotenoids. Their partial inclusion in quail diets is an efficient strategy that can improve yolk pigmentation, provide functional compounds, and reduce costs in family or small-scale systems (Aguilar-López and Reyes-Ramos, 2018). In summary, a successful feeding strategy in quail farming must consider the nutritional profile, ingredient costs, regional availability, environmental impact, and the quail's productive and physiological responses. Formulating feed to meet specific requirements for *Coturnix japonica*, while incorporating alternative ingredients and functional additives, represents a promising avenue for developing efficient, resilient, and sustainable quail farming systems.

Market and consumption of quail products

Quail farming is a viable alternative within the poultry sector due to its biological efficiency and differentiated product quality. Quail eggs and meat are of interest in organic or ecological markets, which value their high nutritional content, low allergenicity, distinctive flavor, and miniature presentation (Nunes *et al.*, 2020). However, despite these advantages, the commercial development of quail products faces challenges related to production scale, informal sales channels, consumer ignorance, and limited institutional promotion (Fernández-Cruz *et al.*, 2018).

Countries such as China, France, Japan, Brazil, and India account for the largest production of quail eggs and meat, and they have well-structured value chains. Latin America and Brazil are positioned as the main producers and consumers, with more than 4 billion eggs sold annually in supermarkets, municipal markets, and restaurants (Dib *et al.*, 2022). In contrast, in countries such as Mexico, production remains dispersed and small-scale, limiting its competitiveness compared to conventional poultry products. The consumer profile of quail products tends to be linked to middle- to high-income urban sectors that seek gourmet, healthy, functional foods or products associated with traditional medicine. Quail eggs, for example, are frequently purchased for their supposed anti-allergy, digestive, and immune-boosting properties, although many of these properties require further scientific evidence (Santos *et al.*, 2021). Various perception studies indicate a lack of awareness of the product's nutritional value and low availability, which are barriers to mass consumption. A market analysis in Colombia and Peru revealed that 80% of urban consumers recognized quail eggs; 30% purchased them regularly, citing high price, limited availability, and limited access in conventional stores as the main reasons (Torres-Pérez *et al.*, 2020). This suggests a strategic opportunity for educational campaigns, clear labeling, brand differentiation, and strengthening local distribution channels.

In Mexico, quail products are available in regional markets (Puebla, Veracruz, Mexico City, Jalisco) through street markets, agricultural and food fairs, and health food stores, but marketing channels need to be consolidated. Some successful experiences have emerged through direct sales models, producer associations, or e-commerce platforms, enabling these products to reach consumers interested in functional foods of ethical origin or produced under agroecological schemes (Aguilar-López and Reyes-Ramos, 2018). Furthermore, quality standards, labeling, and health regulations for quail products are scarce or poorly defined in many countries, limiting producers' ability to certify their products, access formal markets, or export. This contrasts with countries such as France or Brazil, where differentiated standards and government support programs exist to strengthen quail production and marketing (Fernández-Cruz *et al.*, 2018). Specifically, coturniculture products have significant potential in terms of nutrition, functionality, and niche. Positioning, regulation, and consumer education strategies need improvement. Coordination between small producers, public policies, and value-added initiatives will drive the sustainable expansion of this chain for a more diverse and resilient alternative poultry industry.

Innovation and sustainability trends in coturniculture

Contemporary coturniculture faces the challenge of improving its competitiveness and sustainability without losing its essence as an alternative, accessible, and adaptable production model at the small- and medium-scale level. To this end, various lines of innovation have been identified, including genetic improvement, the use of adapted technologies, agroecological schemes oriented toward circularity, animal welfare, and environmental impact reduction (Souza *et al.*, 2020). One of the main areas of innovation is the development of improved genetic lines that combine resistance, feed efficiency, and production performance. This progress is notable in countries such as Japan, Brazil, and France. In Latin America, there remains a strong dependence on uncertified or poorly characterized lines, which limits long-term improvement (Dib *et al.*, 2022).

Recent projects have proposed germplasm banks and participatory selection as strategies for adapting genotypes to local conditions. Applied technologies have evaluated alternatives such as solar incubators, temperature and humidity sensors for mobile modules, modular cage systems made from recyclable materials, and partial automation of feeding and water supply. These low-cost technologies improve efficiency in semi-intensive systems and reduce heat-stress-related mortality (Aguilar-López and Reyes-Ramos, 2018). Sustainability and circular nutrition through the use of agro-industrial waste are presented as a circular economy model applied to animal production. Byproducts such as banana peels, sugarcane bagasse, cricket flour, and horticultural waste have been used with partial success in quail diets. There are improvements in feed conversion, reduced emissions, and a functional contribution to the nutritional profiles of eggs and meat (González Muñoz *et al.*, 2023; Abiola *et al.*, 2019). Another emerging trend is the integration of coturniculture into diversified agroecological and backyard systems. It promotes food self-sufficiency and reduces dependence on external inputs. This approach, promoted in rural and indigenous communities, proposes synergies among vegetable crops, vermicomposting, native forages, and natural pest control, contributing to local food sovereignty (Altieri *et al.*, 2017). There are also agroecological or antibiotic-free certification schemes geared toward ethical and healthy market niches. In countries like Mexico, there is interest in functional foods with environmental traceability; these innovations position coturniculture as a sustainable, appropriate, and commercially viable protein source, especially in gourmet, organic, or tourism markets (Fernández-Cruz *et al.*, 2018).

Finally, outreach and research are essential for scaling up good practices, developing replicable models, and building collaborative networks. Rural incubator initiatives, participatory social innovation projects, and technical training in agricultural schools have proven to be key to strengthening this production chain in the region (Santos *et al.*, 2021).

CONCLUSION

Quail farming is an emerging production system with high potential to diversify protein supply, strengthen local food security, and boost rural economies through flexible and sustainable production schemes. This review highlights structural limitations in access to specialized genetics, health regulations, and formal marketing. Quail farming offers biological, zootechnical, and commercial advantages that position it as a viable

alternative in non-conventional poultry farming. From a technical perspective, *Coturnix japonica* is an efficient species with high feed conversion efficiency, rapid growth, and adaptability to different management systems, making it suitable for family, semi-intensive, and intensive units. Improvements in diet formulation, use of alternative ingredients, biosecurity, and animal welfare are key factors that improve productivity and competitiveness.

Marketing identifies opportunities in niches linked to functional, ethical, and gourmet products. However, consumption growth is hampered by low product visibility, a lack of regulations, and limited integration between producers, distributors, and consumers. However, successful experiences in Latin America show that coturniculture can be profitable, scalable, and adaptable when combined with agroecological approaches, value-added strategies, and differentiated marketing. Finally, global trends in sustainability, the circular economy, and responsible production open up new perspectives for coturniculture. It is necessary to strengthen the links between science, public policy, producer organizations, and educational systems, promoting a comprehensive transition from empirical models to professionalized, participatory, and inclusive frameworks.

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