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

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Abstract

Turkey farming is a significant sector of the poultry industry, greatly influenced by the rearing systems employed. This review explores the effects of different rearing systems intensive, free-range and extensive, on turkey production performance, including growth parameters, feed conversion efficiency, carcass quality, and meat characteristics. Existing global studies indicate that intensive systems provide the highest productivity but are associated with challenges related to animal welfare and sustainability. Conversely, extensive and organic systems improve animal welfare and meat quality but result in lower production levels and higher costs. The review also examines the role of turkey genotypes, the influence of diet and environmental conditions on performance, and the trends toward adopting sustainable systems, including the use of renewable energy and efficient waste management. Challenges, such as high costs and the need for strict regulations, are highlighted alongside opportunities for improvement through precision technologies and the integration of ecological practices. This review underscores the need for future research to identify best practices that balance productivity, animal welfare, and sustainability in turkey farming.

Key words: *animal welfare, production performance, rearing systems, sustainability, turkeys.*

INTRODUCTION

In recent years, numerous scientific publications have analyzed trends in various livestock sectors (pigs, eggs, dairy cattle:). These analyses are valuable for both market participants and decision-makers.

The present article aims to expand this body of literature by focusing on the turkey meat sector. Meat represents an important source of high quality dietary protein for a large proportion of the global population. Meat consumption is a highly debated topic worldwide, with concerns about its impact on human health, the environment, and animal welfare. Meat is a major source of protein and micronutrients, including iron, zinc, selenium, vitamin D and vitamin B_{12}, in many diets, but overconsumption has been linked to various health issues, including heart disease, stroke, cancer, and diabetes. (Ianitchi et al., 2024; Salter, 2018). The domestication of the turkey began around 1800 BC in southern Mexico and later, around 200 AD, in the southwestern United States (Speller et al., 2010). Since then, turkey domestication has undergone significant transformations. Starting in the 1940s, advancements in genetic selection (including artificial insemination), nutrition, and management practices led to increased productivity and reduced costs for turkey farmers, making turkey meat more accessible to consumers (Lasley et al., 1985; Brant, 1998; Mohan et al., 2018). The FAO's first global data collection in 1961 recorded turkey meat production at 898,000 tons. By 2023, the amount had increased to almost 5.3 million tons. This growth can be attributed to favorable production factors such as the development of the genetic and feed industries, a high degree of integration, and the use of closed housing systems. In addition, consumer preferences have shifted. Turkey meat has a high protein content, is not restricted by religious customs, is part of the Thanksgiving tradition, and can be easily integrated into any diet. The market situation of the turkey meat sector is characterized by high nominal output prices, supported on the demand side by increasing incomes in developing countries, and on the supply side by high production costs, particularly for feed grains, energy, and labor. Turkey meat is versatile, making it a suitable substitute for other types of meat. Its distinctive flavor profile (Herkel et al., 2016) and high nutritional value recommend it as part of a healthy diet, being rich in micronutrients such as selenium, phosphorus, potassium, magnesium, zinc, and iron (Canadian Turkey, 2022). These nutrients have beneficial effects on the human immune and nervous systems. In developed countries, turkey meat is part of everyday gastronomy.

MATERIALS AND METHODS

This paper is a scientific synthesis based on a comparative analysis of specialized literature published over the past two decades, in international scientific data bases, focusing on the impact of turkey rearing systems on productive performance, animal welfare, flock health, environmental sustainability, and economic viability.

The aim of the study was to highlight the differences and convergences between the three main types of rearing systems - intensive, free-range, and extensive (free-range). The sources consulted include scientific articles from international databases such as ScienceDirect, Springer, Wiley Online Library, Scopus, and Google Scholar, as well as best practice guidelines provided by leading organizations in the field (Aviagen Turkeys). The selection criteria for the literature included thematic relevance, methodological rigor, data currency, and applicability to the contemporary livestock context. The extracted data were critically compared and interpreted, with an emphasis on the advantages and limitations of each rearing system, in order to provide integrated and relevant conclusions for farmers, policymakers, and researchers in the poultry sector. This methodological approach enables the formulation of scientifically grounded recommendations regarding turkey farming practices in a sustainable agricultural framework.

This review provides an integrated comparison of rearing systems, focusing not only on productivity but also animal welfare and long-term sustainability a gap not fully explored in previous reviews.

RESULTS AND DISCUSSIONS

Types of rearing systems in turkey production

1. Intensive rearing systems

The intensive rearing system for turkeys represents an industrialized method of raising these birds, characterized by maintaining large flocks in confined spaces under complete technological control of environmental conditions and feeding processes (Marchewka et al., 2013). In practice, most turkeys raised for meat are housed in enclosed buildings, typically without windows, equipped with artificial lighting systems, mechanical ventilation, permanent litter flooring (such as straw or sawdust), and automated feeding and drinking lines (Butterworth, 2019). Compared to the turkey's natural environment, these industrial shelters are poor in stimuli lacking access to the outdoors, with no opportunity for flight or pecking at vegetation and are characterized by high stocking densities (Butterworth, 2019). For example, in an intensive farm in the United States, up to 10,000 birds may be raised in a single building, with a typical density of approximately four birds per square meter (equivalent to about 0.25 m^2 per turkey) (Beaulac, 2018). The facilities used in these systems allow for floor rearing on permanent bedding; in some cases - especially in breeding units - special cages (batteries) adapted for artificial insemination may be used, although floor rearing remains the dominant method in meat production (Chuppava et al., 2018; Grigore et al., 2022). The foundation of the intensive system lies in maximizing production through the use of hybrid birds selected for rapid growth, high stocking densities, complete feeding programs, and strict (nutritional and veterinary) management, which leads to an increased meat yield per unit of area (Erasmus, 2017).

1.1. *Animal welfare*

Intensive systems raise significant ethical and welfare concerns, as they constrain the natural behavior of turkeys and may cause physical or psychological suffering (Marchewka et al., 2013). According to one study, in intensive turkey farms, all three components of welfare physical condition, mental state, and the ability to express natural behavior can be negatively affected by overcrowding, unhygienic conditions, and the absence of natural environmental factors, which can even lead to the development of aggressive behaviors such as cannibalism (Beaulac et al., 2018). In industrial housing, the limited space and lack of stimulation severely restrict natural behaviors birds cannot fly or run, forage for food, or form stable groups over wide areas (Jhetam et al., 2022). High stocking density makes it difficult to avoid aggressive encounters. Similar observations were made in broiler chickens, where reduced stocking densities, compliant with EU animal welfare rules, led to improved production efficiency indices such as the European Production Efficiency Factor and the European Broiler Index (Curea et al., 2023), suggesting a trade-off between welfare-driven stocking practices and productive outcomes across poultry species. Birds may suffer injuries from pecking or collisions, especially if hierarchical or aggressive behaviors develop within large groups (Jhetam et al., 2022). To prevent cannibalism and feather pecking under such conditions, partial beak trimming (debeaking) is commonly practiced in young turkeys a painful procedure banned in many European countries (Roy, 2018). Even so, the lack of space may lead to stereotypic behaviors or chronic stress. Genetic selection for rapid growth has exacerbated welfare issues: modern turkeys reach such high body weights in a short period that they often cannot support their own weight resulting in skeletal deformities, arthritis, and leg pain. Males of heavy breeds can no longer perform natural mating (Lindenwald et al., 2021). Additionally, turkeys raised in intensive systems frequently develop skin and foot lesions due to wet litter caused by accumulated feces and condensation and airborne ammonia. These lesions (footpad dermatitis, breast burns) cause discomfort and pain (Youssef et al., 2011). Moreover, negative behaviors acquired from the inability to move freely or forage for diverse food sources impact the birds' mental state, which can be regarded as a less quantifiable but significant form of welfare impairment (Orihuela et al., 2018). In contrast, in extensive systems (such as free-range or organic systems), turkeys have access to open air and generous space, which improves certain welfare aspects. These birds can walk, peck at grass, and display natural behaviors such as dust bathing. However, there are also risks in such systems (predators, weather extremes, parasites) that can affect welfare if not properly managed.

1.2. *Genetic selection*

Genetic selection forms the foundation of performance in intensive systems. The turkeys used are meat hybrids characterized by extremely rapid growth and high yield in breast muscle. Companies such as Aviagen Turkeys and Hybrid Turkeys supply both parent and commercial lines to farms worldwide (Zampiga et al., 2020). These hybrids are unable to fly and can no longer reproduce naturally and efficiently, which makes artificial insemination necessary in breeder farms. Modern selection has led to accelerated growth (twice as fast as 50 years ago), but also to side effects: increased susceptibility to locomotor and cardiac disorders, as well as infertility in overweight males. For this reason, some recent research is testing slower-growing lines for use in alternative systems, which could offer a compromise between performance and animal welfare (Olschewsky et al., 2021).

1.3. *Productive performance*

The main goal of intensive systems is to maximize productive performance - rapid weight gain, efficient feed conversion, and high meat yield (Shehata & Hafez, 2024). In this regard, intensive systems are extremely efficient: commercial hybrid turkeys (such as the Broad Breasted White line and its derivatives) can exceed 20 kg in approximately 20 weeks under intensive conditions, fully utilizing their genetic potential through optimized nutrition and a constant microclimate favorable to development. The feed conversion ratio (FCR) in modern turkeys is significantly improved compared to traditional populations - approximately 2.5-2.7 kg of feed are required to obtain 1 kg of body weight gain during the first months of life (Wilkanowska, 2017). These performances are difficult to achieve in free-range or extensive systems, where birds expend more energy for movement, thermoregulation, and adaptation to the environment, resulting in slower growth. A recent study showed that by 24 weeks, birds raised in semi-freedom required slightly more feed but achieved similar weights to those raised exclusively indoors; however, after this age, costs increase, and profitability drops if slaughter is delayed (Hassan et al., 2023).

In the intensive system, meat yield is maximized: muscle mass especially the breast is disproportionately developed through genetic selection, resulting in a high proportion of marketable meat per individual. However, product quality is perceived differently: some consumers prefer meat from turkeys raised slowly in free-range systems considered tastier, more textured, and lower in fat while meat from industrial systems is more uniform, higher in calories, and produced at a lower cost (Solaesa et al., 2024a). Thus, the intensive system optimizes quantity but must be carefully managed to avoid compromising quality or bird health, as stress and disease may offset productivity gains.

1.4. *Microclimate control*

Microclimate control is essential in closed housing systems, where temperature, humidity, ventilation, and lighting are fully automated. Turkey poults require an initial temperature of approximately 35-36°C, which is gradually reduced as they grow (Uemura, 2022). Ventilation plays an important role in removing excess moisture, heat, and harmful gases such as ammonia or CO_2, with systems adjusted accordingly based on the season. Optimal humidity levels range between 60-70%; deviations from this range can promote the development of pathogens or negatively affect bird comfort (Panel et al., 2023).

Modern systems include temperature, gas, dust, and humidity sensors connected to digital control panels that automatically regulate internal parameters. Lighting also influences behavior and growth: controlled photoperiods (e.g., 16 hours of light/8 hours of darkness) are used to balance development with rest (Ashabranner, 2023).

1.5. *Nutrition and feeding*

Nutrition and feeding are fully industrialized and based on compound feeds tailored to each physiological stage (starter, grower, finisher). In the first weeks, turkeys require feeds with a high crude protein content (up to 28%), which is gradually reduced to 20-24% later on, while increasing the energy supply. Rations typically include cereals (corn, wheat), soybean meal, synthetic essential amino acids (lysine, methionine), vitamins, minerals, and functional additives (coccidiostats, enzymes, probiotics), (Thesing et al., 2023). Feeding is carried out automatically using spiral or chain systems, and watering is done through automated systems (nipples, cups, adjustable bell drinkers). Monitoring feed intake is essential - any decrease may indicate a health issue. Fresh water should be available at all times, especially since an adult turkey can consume up to 4 liters per day in the finishing phase. Feed quality testing (for mycotoxins, bacteriological hygiene) is commonly used to prevent contamination and nutritional deficiencies (Valenzuela-Lino et al., 2022).

1.6. *Health risks*

Intensive turkey farming systems, due to high density and genetic homogeneity, favor the emergence and rapid spread of infectious diseases, especially respiratory ones (such as those caused by *Mycoplasma gallisepticum* or *E. coli*), particularly under conditions of inadequate ventilation and stress (Irwin et al., 2025). Stressed birds have weakened immunity, requiring frequent prophylactic treatments, including vaccines and coccidiostats. Coccidiosis is a common issue in floor-raised systems, and foot diseases impact not only welfare but also food safety (Self, 2023).

To limit these risks, strict biosecurity is required, including controlled access, thorough disinfection between flocks, and compliance with hygiene protocols. Nevertheless, the risk of outbreaks persists - as demonstrated by the H5N1 avian flu outbreak, which resulted in the culling of over 160,000 turkeys. In extensive systems, disease spread may be slower, but contact with wild birds increases the risk of contamination (Machovcova et al., 2017).

Reducing antibiotic use, in the context of antimicrobial resistance, makes prevention through biosecurity even more critical. In conclusion, the health of flocks in intensive farms depends on continuous monitoring, strict hygiene, and rapid intervention - all of which are essential to prevent major economic losses.

1.7. *Key elements of intensive turkey rearing systems*

Stocking density is one of the most important parameters in intensive livestock management (Erasmus, 2017). Generally, in fattening houses, density varies between 3 and 4 turkeys per square meter, depending on sex and age. According to U.S. standards, it is recommended to allocate 0.23 m^2 per hen and 0.33 m^2 per tones. Excessively high stocking density can compromise ventilation, litter quality, and consequently, the health of the animals. In the European Union, there is no unified legislation, but national guidelines (such as those in Germany) recommend a maximum of approximately 40 kg/m^2 towards the end of the rearing period. In comparison, in extensive systems, birds have access to several square meters each, and the density is significantly lower (<1 $bird/m^2$), while in free-range systems, an intermediate density is maintained (~2 $birds/m^2$ with controlled outdoor access) (Campbell et al., 2017).

1.8. *Biosecurity*

Biosecurity is the backbone of sanitary sustainability in industrial farms. It includes strict measures such as: controlled access, sanitary filters (showers, clean clothing), disinfection of vehicles and equipment, adherence to the “all-in/all-out” principle, controlled disposal of litter and carcasses, as well as sanitary breaks between production cycles. Daily monitoring of flock health and mortality is essential; any irregularity triggers immediate investigation. Additionally, pest control (rodents, wild birds) helps prevent the transmission of major pathogens (e.g., Salmonella, viruses). Personnel education is another key component - employees are trained not to keep birds at home and to follow strict hygiene protocols. Some farms also administer vaccines against Salmonella or use probiotics to reduce food safety risks. Well-implemented biosecurity enables the long-term health of the flock and prevents catastrophic losses (Kovács et al., 2025; Tilli et al., 2022).

2. Free-range rearing systems

Free-range turkey rearing systems represent an intermediate form of poultry farming that combines the advantages of traditional free-range methods with certain modern elements of technology and management. These systems are conceptually and practically situated between the extensive model - characterized by complete freedom of movement and use of natural resources - and the intensive system, which focuses on strict environmental control and productivity maximization (Ali et al., 2019).

According to the Food and Agriculture Organization (FAO), a free-range system involves keeping turkeys in a protected space - typically a shelter covered with a wire mesh aviary - that offers safety and comfort, while also allowing controlled access to the outdoors. At the same time, birds are provided with supplemental feed by the farmer, which distinguishes this system from fully extensive systems, where feeding relies primarily on the natural resources available in the free-range habitat.

2.1. *Animal welfare*

Free-range systems are superior to intensive ones in terms of animal welfare due to the turkeys' access to outdoor areas, natural light, and behavioral stimulation (Madzingira, 2018). Turkeys are able to express natural behaviors such as foraging, exploring the ground, and socializing in a more spacious environment, which reduces stress and harmful behaviors (Aygun et al., 2024). Additionally, footpad health is improved due to exposure to dry, natural soil, and the incidence of lesions is significantly lower (Olschewsky et al., 2021).

However, this system also comes with welfare-related risks: exposure to adverse weather conditions, predators, or overcrowding in poorly managed outdoor runs can negatively impact the birds’ comfort. Furthermore, restrictions imposed during disease outbreaks (such as avian influenza) may temporarily cancel out the benefits of free-range systems, especially for birds accustomed to free movement. Compared to household-level systems, free-range rearing offers better supervision and veterinary care, contributing to overall improved animal welfare (Bashir et al., 2012).

2.2 *Zootechnical productivity*

Free-range systems deliver intermediate performance levels between extensive household-based systems and fully industrial intensive models. Turkeys reared under free-range conditions reach higher weights and demonstrate a better average daily gain compared to those raised in extensive systems, particularly during the first months of life, when the benefits of supplemental feeding and shelter protection are most evident. However, after 25-28 weeks of age, extensively reared turkeys may partially catch up in weight, and the economic efficiency of the free-range system begins to decline progressively (Roy, 2018).

As a result, free-range raised hens can achieve productivity close to that of those in controlled systems, albeit with a more natural feeding regime (Abba et al., 2021). The feed conversion ratio (FCR) is less favorable in free-range systems compared to industrial setups, as turkeys expend more energy for movement and thermoregulation. Consequently, feed consumption per kilogram of meat produced is slightly higher (Çürek et al., 2022). Nevertheless, for farms targeting premium product markets, this disadvantage may be offset by higher selling prices.

2.3. *Space and density*

Flock density in free-range systems is positioned between the values typical of industrial farms and those of traditional household systems. In free-range setups, European standards set a maximum of approximately 25 kg of live weight per square meter inside shelters equivalent to 2-3 turkeys/m², depending on sex and age (Aumaitre & Rosati, 2004). Each adult bird must have access to at least 4 m² of outdoor space. In practice, this translates to flock sizes of several hundred to a few thousand birds per hectare. For instance, densities of up to 4000 females/ha have been reported in free-range regimes approximately 2.5 m² per bird compared to only 1000 females/ha (10 m² per bird) in fully free-range systems (Kaya & Yildirim, 2018). Thus, birds in free-rage systems have significantly more space than those in industrial barns, though less than in household systems, where densities are negligible due to small flock sizes.

2.4. *Shelter and infrastructure*

In terms of infrastructure, free-range systems use simple shelters, often open-fronted, well-ventilated, and equipped with permanent bedding made of straw or wood shavings. These shelters may include perches where turkeys can rest at night. The shelters are directly connected to an enclosed outdoor run, where birds have free access during the day (Fa González et al., 2022). The investment required for such constructions is relatively low less than that needed for fully climate-controlled industrial barns which gives the free-range system the advantage of lower startup capital and reduced labor costs. The shelter's microclimate can be controlled to some extent through natural ventilation, protection from rain, shade in summer, or minimal heating in winter but it does not compare with the precision of the fully automated systems used in intensive farming (Mench, 2017).

2.5. *Feeding*

Feeding turkeys in free-range systems is done mostly with concentrated feed, similar in formulation to that used in intensive systems. These feeds meet the high nutritional demands of turkeys, especially in their early months (Al-Neelain, 2014). However, turkeys can supplement their diet by foraging in the outdoor paddocks, consuming grass, seeds, and insects. In the absence of feed formulated specifically for turkeys, farmers may adapt broiler feed by adding protein. By the age of 5-6 months, a turkey may consume between 20-25 kg of combined feed. When birds have access to abundant vegetation, the consumption of industrial feed can be significantly reduced, offering both economic and ecological advantages.

2.6. *Biosecurity*

Managing biosecurity in free-range turkey farming presents distinct challenges, largely due to the birds' exposure to outdoor conditions. In contrast to intensive production systems, free-range operations allow turkeys to roam in open-air spaces, heightening the risk of interaction with wild birds, rodents, and other potential pathogen carriers (Bergmann et al., 2021). To address these vulnerabilities, farms often implement secure perimeter fencing and protective netting to deter wildlife, along with pasture rotation practices aimed at minimizing the buildup of harmful organisms in the soil (Rufener et al., 2020).

Hygiene protocols in these systems commonly include footbaths at access points to pastures, routine disinfection of mobile units and shelters, and rigorous cleaning procedures for vehicles and equipment (Mulder et al., 2022). Farm personnel are instructed to change clothing and footwear before entering animal areas, and biosecurity training emphasizes the prevention of contamination between indoor and outdoor zones (Van Limbergen et al., 2018). Access to the facilities is strictly controlled, with visitors either prohibited or required to follow stringent decontamination steps prior to entry (Hartcher & Lum, 2020).

Ongoing health surveillance of the flock is vital. The active lifestyle and natural foraging habits of free-range turkeys increase the likelihood of injuries and parasitic infections, making close monitoring crucial. Any unusual mortality or clinical symptoms must trigger immediate diagnostic actions (Kittelsen et al., 2021a). Additionally, due to a higher risk of parasite exposure in outdoor settings, many farms incorporate natural anthelmintics and probiotics into their management programs to support gut health and reduce antibiotic reliance (Kralik et al., 2023).

Vaccination strategies, particularly against *Histomonas meleagridis* the causative agent of blackhead disease are essential in free-range systems, as the organism can persist in natural environments. Proper disposal of litter and carcasses is conducted away from grazing areas to avoid contamination, and downtime between production cycles is maintained to enable environmental sanitation (Van Loo et al., 2022).

Despite the inherent risks, effective biosecurity protocols tailored to the characteristics of free-range production can significantly mitigate disease threats while preserving animal welfare benefits. Ongoing staff education and the application of context-specific strategies are key to safeguarding flock health and ensuring food safety (Manning et al., 2023).

3. Extensive rearing systems

Extensive systems, also known as free-range or backyard farming systems, involve providing turkeys with generous space and constant access to the outdoors, particularly to pastures or paddocks. In Romanian tradition, this type of rearing was commonly practiced in rural households, mainly as a seasonal activity intended for self-consumption (Anna Anandh et al., 2012). From a regulatory perspective, the free-range system is defined by certain minimum criteria, particularly within the European Union. To qualify for the "free-range" label, birds must have continuous access to the outdoors for at least half of their lifespan, on vegetation-covered land, with a controlled density similar to that of the "barn" system (Jones et al., 2007). The minimum required outdoor space is at least 4 m² per bird, and exits from the shelter must total a minimum of 4 meters of opening per 100 m² of building. If the pasture extends more than 150 meters from the shelter, the presence of outdoor shelters and additional water sources is mandatory (at least 4 shelters per hectare), in order to encourage the full use of the available area (Anna Anandh et al., 2012).

3.1. *Animal welfare*

Extensive rearing systems, such as free-range or organic farming, are generally perceived as more welfare-friendly due to their allowance for natural behaviors and increased environmental complexity. Turkeys in these systems benefit from outdoor access, more space, and environmental enrichment, which improve both physical and psychological welfare indicators (Fanatico et al., 2008). Birds are able to engage in instinctive behaviors such as foraging, dust bathing, perching, and exploring, which are critical to their mental health and stress reduction (Blatchford et al., 2013).

Space availability in extensive systems allows turkeys to establish social hierarchies more naturally, reducing aggressive encounters and stress caused by overcrowding. This setup also enables more physical activity, which can prevent health issues commonly seen in intensive systems, such as skeletal deformities, obesity, and joint problems (Sossidou et al., 2011). Nevertheless, physical welfare in extensive systems depends greatly on pasture quality and environmental management - uneven terrain or poorly maintained vegetation can lead to foot injuries and stress from thermal discomfort (Petracci et al., 2010).

Outdoor access also exposes birds to climatic variations and potential predators, which can become significant stressors if not adequately controlled. Shade, shelter, and protective fencing are essential in mitigating these risks and ensuring thermal comfort and safety, particularly during extreme weather or predator activity (Hazel et al., 2020). Moreover, parasite burdens are typically higher in outdoor environments. Without effective parasite monitoring and control strategies (e.g., rotational grazing, natural anthelmintics), turkeys can suffer from infestations that impair both productivity and welfare (Singh et al., 2019).

Behaviorally, birds raised in extensive systems exhibit more species-specific actions, which are widely interpreted as signs of positive welfare. However, variations in environmental complexity, space allocation, and management quality across farms can lead to inconsistencies in welfare outcomes (De Jong et al., 2015). For example, suboptimal pasture design or lack of shelter may cause birds to cluster indoors, thus negating the potential welfare benefits of outdoor systems (Dal Bosco et al., 2016). Additionally, weather extremes and environmental stressors can exacerbate mortality and reduce comfort levels if farms are not properly equipped to offer microclimatic regulation (Sirri et al., 2010).

Feeding strategies in extensive systems also impact welfare. Access to diverse natural foraging material can enhance mental stimulation and gut health, but inconsistent nutrition due to seasonal variability may affect growth and immune response (Kittelsen et al., 2021b). Therefore, a balance between free-access foraging and supplemented, nutritionally balanced feed is necessary for maintaining optimal welfare (Matthews & Hemsworth, 2012). Despite these challenges, many welfare studies conclude that extensive rearing systems, when properly managed, result in better welfare scores across multiple indicators compared to intensive production (Louton et al., 2021).

3.2. *Breed/Genetic Line Selection*

Breeds used in extensive systems should be well-adapted to the environment and moderate growth rates. Traditional (heritage) breeds such as Standard Bronze, Narragansett, or Bourbon Red are valued for their hardiness, although they grow slower and reach lower final weights (Tutkun et al., 2018).

Many farmers use medium-growth hybrids specifically developed for free-range systems. It is recommended to source poults from certified suppliers, vaccinate them in the first days, and possibly engage in natural reproduction when working with traditional breeds (Fiorilla et al., 2023).

3.3. *Productive performance*

In extensive rearing systems - such as free-range and organic turkey production - productive performance tends to be lower compared to intensive farming. This is largely due to the increased energy demands associated with outdoor access, including greater physical activity, thermoregulation, and expression of natural behaviors (Fanatico et al., 2005). Turkeys in these environments must adapt to fluctuating weather conditions and spend more energy on movement, leading to slower growth and higher maintenance requirements than their intensively housed counterparts (Ponte et al., 2008).

Feed conversion ratios (FCR) are generally less efficient in extensive systems. While intensive operations can achieve FCRs as low as 2.5-2.7 kg of feed per 1 kg of weight gain in early growth phases, values above 3.0 are common in extensive settings, depending on factors such as breed and environmental conditions (Castellini et al., 2002). Turkeys raised in these systems are often slower-growing or traditional breeds that are selected for adaptability and hardiness rather than rapid muscle growth, which further impacts performance outcomes (Sirri et al.,

2010). For example, free-range Bronze turkeys typically reach market weights of 10-12 kg over 26-28 weeks, compared to 20 kg in just 20 weeks for intensively raised commercial hybrids (Ponte et al., 2008).
Although growth efficiency is reduced, the meat from extensively reared turkeys often possesses qualities valued by certain consumers. Increased physical activity leads to leaner muscle development, resulting in a firmer texture and more pronounced flavor - traits commonly associated with traditional or premium meat products (Sossidou et al., 2011). However, due to the absence of strong selection for breast muscle hypertrophy, as seen in industrial hybrids, breast yield is typically lower in these birds (Fanatico et al., 2007). This can reduce overall economic return unless offset by access to higher-priced specialty markets.
Seasonality and extended rearing periods also influence the cost-effectiveness of extensive systems. Turkeys are typically slaughtered later, at around 24-28 weeks of age, which increases feed, housing, and labor costs while also exposing birds to a longer period of potential environmental or health challenges (Hassan et al., 2023). Nevertheless, when well-managed and directed toward niche consumer markets, extensive systems can be financially viable. They benefit from consumer interest in welfare, environmental sustainability, and high-quality, naturally produced meat (Solaesa et al., 2024b). In many cases, consumers are willing to pay a premium for turkeys raised in systems perceived as more ethical and traditional.
In summary, while extensive systems may fall short of intensive ones in terms of growth rate and feed efficiency, they provide distinct advantages in terms of perceived meat quality, ethical farming practices, and market differentiation. These attributes make them a valuable alternative for producers targeting specialized or value-added markets (Castellini et al., 2002; Sossidou et al., 2011).

3.4. *Feeding and watering*

In extensive systems, turkey diets come from both foraging and supplemental feed. Turkeys consume grass, insects, and seeds but still require additional protein for proper development. Typically, they are fed twice a day in the morning and evening with cereals mixed with oilseed meals and mineral premixes (Spencer, 2013).
Feed can be offered using conventional feeders or traditional methods (grains scattered on the ground to stimulate natural foraging behavior). It's essential to tailor nutrition to their age: 22-28% protein during the starter phase, 20-22% during the growing phase, and 16-18% during finishing. Fresh water must be continuously available, through portable or automatic drinkers placed both indoors and outdoors, in shaded areas (Salmon, 1984). In hot weather, water temperature should be monitored; in winter, measures must be taken to prevent freezing. Supplements like probiotics or apple cider vinegar can be added to water for prophylactic purposes (Farghly et al., 2018).

3.5. *Housing and infrastructure*

Even though turkeys spend a significant amount of time outdoors, they require safe shelters for nighttime and during adverse weather conditions. It is essential to provide them with well-ventilated, dry, and sufficiently spacious housing, where they can retreat at nightfall. Ideally, perches should be installed inside, as turkeys naturally prefer to roost elevated, a behavior that gives them a sense of security against predators (Stratmann & Ringgenberg, 2023).
The shelter should be equipped with thick bedding (such as straw or wood shavings) to absorb moisture and provide comfort, which must be replaced regularly to maintain hygiene. Pop-holes (access doors) should be generously sized and installed at ground level to encourage the birds' free movement; according to standards, 4 meters of opening are recommended for every 100 m² of shelter (Glatz & Rodda, 2013). Shelters can be fixed or mobile, with a modern trend being the use of "turkey tractors" - lightweight, mobile structures moved daily across pasture, providing constant access to fresh grass while reducing soil contamination. Good practices include positioning shelters on high ground, orienting doors to the south, installing ramps or low thresholds, and equipping shelters with heat lamps for young poults during the critical starting period (Plamondon, 2003).

3.6. ***Fencing and pasture management***

An important component of the extensive system is fencing, which prevents turkey escapes and protects them from predators. Metal or electric mesh fences 1.5-2 meters high are typically used, sometimes with overhead netting to prevent aerial attacks (Glatz & Rodda, 2013). In small farms, partially roofed aviaries can be arranged, while in large pastures, functional landscaping with trees, shrubs, or shade structures provides natural refuges. Pasture rotation is recommended: alternating plots prevents vegetation degradation, reduces parasite pressure, and allows soil regeneration (Glatz & Rodda, 2013).

Another best practice is to avoid raising turkeys on land recently occupied by chickens to prevent Histomonas (blackhead) infestation. Ecological soil treatments, such as lime or tannin-rich plants, can help control parasites (Callait-Cardinal et al., 2010).

3.7. ***Health and biosecurity***

In free-range systems, birds are more exposed to pathogens, making prevention indispensable. Periodic deworming programs (for internal and external parasites), pasture rotation, and avoiding contact with other species (especially chickens) are standard practices (McMullin, 2022). Similar findings were reported in laying hens, where eggs from free-range systems showed improved nutritional quality but also higher microbial contamination compared to conventional systems (Nistor et al., 2015), highlighting the importance of hygiene and biosecurity in extensive poultry production. The impact of storage conditions on the final quality of poultry products, such as eggs, has also been demonstrated - with significantly better preservation of quality indices under low temperature and high humidity conditions (Gavril et al., 2013).

Vaccination is advisable, particularly against Newcastle disease, and biosecurity must be observed: controlled access, clean equipment, and hygienic shelters. Sanitary breaks and thorough disinfection should follow each flock cycle.

Daily monitoring of turkeys is essential: checking their behavior, feed intake, and general condition helps identify problems early. Practices like "finishing" turkeys in the final weeks by feeding grain-rich diets contribute to the quality of the end product (Barnes et al., 2013).

CONCLUSIONS

A comparative analysis of turkey rearing systems clearly reveals that the chosen system profoundly influences productive performance, animal health and welfare, as well as the economic and ecological sustainability of the farm. Intensive systems, focused on maximizing biological and economic efficiency, offer the highest levels of weight gain and carcass yield, supported by specialized breeds and concentrated feeding. However, this productivity often comes at the expense of animal welfare, limiting the expression of natural behaviours and increasing the incidence of pathologies associated with high stocking densities and restricted movement. On the other hand, free-range systems partially balance performance with the birds' ethological needs, providing moderate access to open air and pasture. These systems allow for more harmonious physical development, improving muscle tone and overall health, without significantly compromising productive efficiency. Beyond the technical aspects, free-range systems offer an advantage in terms of positive public perception and alignment with sustainable consumption trends. However, these systems carry higher risks related to predators, environmental diseases, and climatic conditions, requiring careful and seasonally adapted management. Economically, industrial systems offer competitive prices and profitability through volume, while alternative models become viable only if they can market their products at premium prices, targeting consumers willing to pay for quality, ethics, and sustainability. Recent trends show growing demand for turkey meat from alternative systems, and farmers who successfully communicate the advantages of their products be it flavor or ethical provenance can access real market opportunities. Overall, the choice of rearing system should be a carefully weighed compromise between productive efficiency, environmental impact, animal health, and consumer expectations. In the current context, marked by increasing concern for sustainability and animal welfare, free-range and extensive systems seem to offer viable balanced solutions, especially in markets that value these dimensions beyond the final cost of the product.

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