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Review Article

A COMPARATIVE ECONOMIC ANALYSIS OF BROILER PRODUCTION COSTS: SELECTED ARAB COUNTRIES, TURKEY, AND THE UNITED STATES COMPARED TO GLOBAL STANDARDS

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ABSTRACT

This systematic review examines the biological and economic performance of broiler production systems in Sudan, Egypt, Jordan, Saudi Arabia, Turkey, and the United States, benchmarked against global efficiency standards. Using normalized data (2024 constant USD), the study integrates cost structure, performance, and sensitivity analyses to identify major efficiency gaps and resilience factors. Results show that feed accounts for 55-61% of total production costs, making it the dominant driver of economic performance across all systems. Turkey (USD 0.69/kg) and the USA (USD 0.73/kg) achieved global-level competitiveness through superior feed conversion ratios (FCR 1.5-1.6), advanced genetics, and technological integration. Arab producers, particularly Sudan (USD 0.95 pre-war, USD 1.75 post-war 2025), Egypt (USD 0.90), and Jordan (USD 0.92), recorded higher costs due to feed import dependence, energy constraints, and limited mechanization (FAO, 2023; World Poultry Foundation, 2023).

In Sudan, war-related disruptions caused a five-fold currency devaluation and destruction of parent-stock farms, leading to reliance on imported fertilized eggs and diesel power, which raised DOC and energy costs. Despite these challenges, the sector shows adaptive resilience through shortened production cycles and stable FCR (Aviagen, 2022; Cobb-Vantress, 2021). The findings emphasize the need for integrated recovery strategies combining feed autonomy, hatchery rehabilitation, renewable energy adoption, and targeted financial support. Regionally, improved policy coordination, technology transfer, and localized feed production are essential to enhance competitiveness and food security under volatile economic conditions.

Broiler production economics viability varies significantly between developed and developing nations. This study provides a comparative economic analysis of broiler production costs in selected Arab countries (Sudan, Egypt, Jordan, and Saudi Arabia), Turkey, and the United States, benchmarked against global efficiency standards. Data were sourced from peer- reviewed literature, government statistics, and international reports (2017-2024), with Sudanese data reflecting projected pre-war conditions for 2024. Cost components analyzed included day-old chicks (DOC), feed, labor, housing, veterinary care, and mortality.

Results reveal substantial cross-country variation: Turkey recorded the lowest cost per kilogram of live weight ($0.69), followed by the United States ($0.73), while Sudan exhibited the highest ($0.95), with Egypt ($0.90), Jordan ($0.92), and Saudi Arabia ($0.81) also exceeding the global benchmark of $0.78/kg (FAO, 2023; World Poultry Foundation, 2023). Feed was the dominant cost component, accounting for 58.6%-60.6% of total costs, slightly above the global optimal range of 56%-57% (FAO, 2023). Egypt and Jordan bore the heaviest feed cost burden. By contrast, the United States and Turkey allocated a larger share to DOC (21.74% and 21.88%, respectively), reflecting investment in superior genetics that enhanced growth rates and feed conversion efficiency (Aviagen, 2022; Cobb-Vantress, 2021).

Sensitivity analysis indicated that a ±10% fluctuation in feed prices altered production costs by up to ±6% in Sudan and Egypt. These findings highlight the vulnerability of Arab producers to volatility in imported and locally produced feed ingredients, while demonstrating the resilience of technology-intensive systems in Turkey and the United States.

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The study concludes that enhancing competitiveness in the Arab region requires strategic investments in local feed production, advanced genetics, and mechanization. Policy interventions should prioritize the development of domestic feed industries, support modern hatcheries, incentivize automation, and strengthen biosecurity measures to reduce costs and build resilience against external shocks (FAO, 2023; Aviagen, 2022; Cobb-Vantress, 2021).

Keywords: Broiler economics; Sudan; feed cost; poultry performance; DOC; resilience; benchmark; Arab poultry industry; post-war recovery; Broiler production; economic analysis; production costs; feed efficiency; Arab countries; USA; global benchmarks; comparative study.

HIGHLIGHTS

- Systematic comparative analysis of broiler production costs and performance across Sudan, Egypt, Jordan, Saudi Arabia, Turkey, and the USA (2023-2025).
- Feed cost (55-61%) remains the dominant determinant of profitability and sensitivity in all countries.
- Turkey (USD 0.69/kg) and USA (USD 0.73/kg) align with global efficiency benchmarks; Arab countries exceed by 15-25%.
- Sudan's cost rose to USD 1.75/kg (2025) following war disruptions, currency devaluation, and energy dependency.
- Recovery of Sudan's poultry sector began through imported fertile eggs and private-sector partnerships under harsh operating conditions.
- Policy focus: feed autonomy, renewable energy systems, biosecurity reinforcement, and data-driven subsidy design.
- Regional implication: strengthening local input industries and harmonizing benchmarking systems can stabilize poultry production in fragile economies.

INTRODUCTION

Poultry production has emerged as a cornerstone of global food security and rural income generation. Among livestock sectors, the broiler industry is especially vital due to its efficient feed conversion, short production cycle, and high adaptability to both small- and large-scale operations (FAO, 2023). Poultry meat provides affordable, high-quality animal protein and contributes substantially to employment across input supply, feed manufacturing, processing, and marketing chains.

In developing regions, particularly in Africa and the Middle East, poultry production is growing under significant constraints such as volatile feed ingredient prices, limited access to credit, energy instability, and biosecurity challenges. Broiler production economics thus varies widely among countries, depending on production systems, feed sources, and market integration levels. Comparative analysis of these cost structures can highlight vulnerabilities and policy opportunities (Elghouth et al., 2013; Abdelmonem et al., 2023).

This review systematically examines the economic structure of broiler production in selected countries Sudan, Egypt, Jordan, Saudi Arabia, Turkey, and the United States representing a spectrum from fragile to fully industrial systems. It focuses on production costs, feed conversion ratios (FCR), input dependence, and the impact of macroeconomic and policy conditions.

Special emphasis is placed on Sudan, both before and after the 2023 war, to assess how conflict, currency depreciation, and infrastructure breakdown affect poultry cost dynamics and resilience. The analysis integrates national and international sources (FAO, USDA, CRU, and regional studies), alongside verified 2025 Sudanese production data, to develop a comprehensive regional and global comparison.

Poultry meat, particularly from broilers, remains a critical and expanding source of affordable, high-quality animal protein worldwide, playing a central role in national and global food security strategies (FAO, 2023). Within the Arab region, the broiler industry contributes significantly not only to food availability but also to employment creation and rural livelihoods. Despite this importance, the sector faces persistent challenges, including heavy reliance on imported feed ingredients, disease and environmental risks, volatility in currency exchange rates, fluctuating energy costs, and uneven levels of technical expertise (Elghouth et al., 2013; Abdelmonem et al., 2023).

In contrast, developed economies such as the United States benefit from vertically integrated production systems, advanced automation, well-established genetic research programs, and efficient supply chains. These structural advantages result in higher productivity and comparatively lower production costs (USDA-ERS, 2022). Broiler production efficiency is determined by key biological and managerial parameters such as growth performance, feed conversion ratio (FCR), mortality, and rearing system. Differences in these parameters across countries directly influence overall production costs and profitability (Aviagen, 2022; Cobb- Vantress, 2021).

Although several studies have assessed the economics of broiler production within individual countries (Elghouth et al., 2013; Abdelmonem et al., 2023; Abdallah and Al Khraisat, 2013; FAO, 2023), there remains limited comparative evidence across Arab countries and their key competitors. In particular, systematic

comparisons involving Sudan, Egypt, Jordan, and Saudi Arabia, alongside a regional competitor (Turkey) and a global benchmark (United States), are scarce. Such cross-country analysis is vital to reveal structural inefficiencies, highlight competitive advantages, and guide targeted strategies for sector improvement. A foundational report by Shatokhin, El Gammal, and Prikhodko (FAO, 2017) on investment challenges and opportunities in the broiler poultry industry provides a crucial macro-level context, outlining the global and regional investment landscape and structural barriers that this study's country-level analysis directly engages with.

The study aims to:

- Identify and compare cost structures and efficiency parameters across selected countries.
- Analyze how political, financial, and logistical disruptions alter poultry production economics in fragile contexts.
- Draw lessons from integrated systems to inform strategies for recovery and resilience in Sudan's poultry sector.
- Quantify and compare production costs per bird and per kilogram of live weight (LW) against global benchmarks.
- Analyze the relative contribution of key input costs including day-old chicks (DOC), feed, labor, housing, veterinary services, and other expenses to total production costs.
- Develop evidence-based policy and managerial recommendations for improving efficiency, resilience, and competitiveness of the Arab broiler sector, using Sudan's pre-war 2023 projections as a baseline (FAO, 2023; USDA, 2023).

2. Literature Review

Poultry economics literature provides extensive insights into cost structures, input dependence, and performance efficiency across various systems. Three dominant components feed, Day-Old Chicks (DOC), and energy consistently account for over 85% of broiler production costs (FAO, 2023). However, their proportions and stability vary by country, production system, and macroeconomic context.

2.1. Sudan

Before the 2023 war, Sudan's broiler industry operated mainly on locally produced DOC, sorghum and oilseed meals (peanut, sesame, sunflower). Imports were limited to protein concentrates, synthetic amino acids, vitamins, premixes, medicines, vaccines, chemical detergents, disinfectants and some equipment. There was no importation of maize or soybean, unlike neighboring countries. DOC represented about 23% of total cost, feed about 58%, with a total cost of USD 0.81/kg live weight and FCR around 1.4-1.5.

Earlier studies by Elghouth et al. (2013) documented the management and economic aspects of broiler production in Khartoum State, highlighting the reliance on local feed resources and traditional management practices. Earlier foundational work by Emam and Hassan (2011) focused on measuring the profitability and viability of poultry meat production in Khartoum State, establishing an important baseline for understanding the sector's economic potential prior to the major disruptions. Mohamed and Elkhidir (2017) and Eltigani (2009) provided additional context on Sudanese poultry production systems, emphasizing the challenges of input availability and technical capacity.

After the outbreak of war, the Sudanese Pound depreciated five- to six-fold, and fuel scarcity forced farms to rely on diesel generators, multiplying energy costs and crippling the agricultural input supply chain (CRU, 2024). The 2025 estimated production cost rose to USD

1.75/kg live weight, with feed and DOC accounting for over 80% combined. Private sector collaboration restored limited hatchery activity using locally produced fertile eggs, but chick quality and mortality increased. Consumers also shifted toward smaller dressed weights (≈900 g), possibly due to weak purchasing power, high production costs, or shorter turnover preferences.

2.2. Egypt

Egypt's poultry sector is one of the most developed in Africa. It includes an extensive infrastructure of 236 feed mills, 360 hatcheries, and 309 slaughterhouses, though many operate below capacity (FAO, 2017). Production costs range between USD 1.35-1.37/kg dressed weight in integrated farms and up to 20% higher in small-scale units. The sector remains heavily reliant on imported maize and soybean, exposing it to currency and freight volatility.

Recent economic studies by Abdelmonem et al. (2023) in Aswan Governorate confirmed the heavy burden of feed costs on profitability, with imported inputs accounting for the majority of variable costs. Further illustrating the market dynamics, Bassyouni et al. (2021) analyzed the effect of broiler prices on logistics and supply chains, emphasizing how price volatility within Egypt directly impacts the efficiency and development of the entire poultry industry structure. Despite these challenges, Egypt maintains strong domestic market protection through a 30% tariff on poultry meat imports, which stabilizes local prices and encourages national production. However, informal live bird markets still dominate distribution, with limited cold- chain infrastructure (FAO, 2017).

2.3. Jordan

Jordan's poultry sector is technologically advanced but heavily dependent on imported feed. Production costs average USD 1.20/kg live weight, with feed comprising around 65% of total costs (Al-Sharafat and Al-Fawwaz, 2013). Modern housing systems, disease control, and high management efficiency have improved FCRs (≈1.6). The main constraint remains high energy costs, which limit competitiveness and export potential.

Earlier economic analysis by Abdallah and Al Khraisat (2013) in Amman and Irbid districts established baseline production costs and identified similar challenges with feed import dependence. A later study by AL-Sharafat (2017) in the Jordan Journal of Agricultural Sciences confirmed these structural constraints, analyzing the broader economic and financial performance of the Jordanian broiler industry and reinforcing that feed import dependence and high energy costs remain the primary barriers to competitiveness and export potential. Their findings align with more recent studies showing persistent structural constraints despite technological advancements in housing and management systems.

2.4. Saudi Arabia (KSA)

Saudi Arabia's poultry industry is dominated by vertically integrated corporations (Al-Watania, Al-Fakieh, and Tanmiah). The sector benefits from modern infrastructure, biosecurity, and government support under Vision 2030 (Almuhanna, 2021). The cost of production is about USD 1.50/kg live weight, with feed accounting for 60% and FCR around 1.45-1.50. Energy price reforms have raised costs, yet production continues to grow under efficiency-driven expansion and national food security goals.

Saied (2018) provided an analytical study of the production and marketing structures in the Eastern Region, offering detailed insights into the supply chain dynamics and market channels that characterize the Saudi broiler industry. Alderiny et al. (2019) further analyzed the sector's trajectory, forecasting production and import trends and highlighting the ongoing challenge of achieving self-sufficiency despite significant government investment. Mansour and Elsebaei (2020) provided a detailed economic analysis of broiler production in Al-Ahsa Governorate, highlighting the impact of government subsidies and scale economies on maintaining competitiveness despite high operational costs. Their study emphasized the role of policy support in sustaining production growth.

2.5. Turkey

Turkey represents a regional leader in scale and export orientation. Producing over 2.4 million tons of broiler meat annually, Turkey maintains competitive costs (USD 1.10-1.20/kg) through efficient feed supply chains and export incentives (FAO, 2023). Strong industry organization and government-backed feed policy have made it a model of balanced production and trade.

Earlier foundational work by Silva and Filho (2015) provided a detailed technical performance and cost analysis, identifying the key efficiency parameters that have contributed to Turkey's long-standing competitiveness in broiler production. A recent study by Karaman et al. (2023) on contract broiler production confirmed the sector's profitability, attributing it to efficient feed supply chains, scale economies, and the risk-sharing model of contractual agreements, which further solidify Turkey's competitive position. Data from the Turkish Statistical Institute (2023) confirms the sector's growth trajectory and export competitiveness. The Turkish Poultry Federation's reports highlight the strategic investments in genetics and feed efficiency that underpin the country's cost advantages.

2.6. United States

The U.S. remains the global benchmark in broiler productivity, characterized by large-scale integration, advanced genetics, and stable feed supply (USDA, 2023). The average production cost is USD 1.05/kg live weight, feed share 60-65%, FCR 1.55, and mortality <5%. Robust vertical integration, contractual farming, and automation sustain competitiveness and efficiency.

USDA Economic Research Service (2022) and National Agricultural Statistics Service (2023) data provide comprehensive benchmarking for production costs and efficiency parameters. Industry reports from Aviagen (2022) and Cobb-Vantress (2021) document the genetic improvements and management practices that drive continuous efficiency gains. Beyond pure productivity, Osei-Amponsah and Fiala (2023) provide a comprehensive assessment of the U.S. broiler industry, highlighting its economic efficiency while also identifying opportunities for improving environmental sustainability within its highly integrated systems.

2.7. Comparative Insights and Gaps

Across all reviewed systems, feed cost dominates production economics, followed by DOC and utilities. Sudan's dependence on local cereals for both human and animal consumption uniquely amplifies vulnerability during crises. Egypt and KSA manage input volatility through scale and policy support, while Jordan and Turkey rely on import diversification.

From a broader perspective, Vissers et al. (2019) analyzed the global prospects for cost- efficiency in middle-segment broiler production systems, highlighting the complex interplay between production economics and welfare standards, a consideration that becomes increasingly relevant as production systems evolve. Furthermore, research into alternative systems, such as those outlined by van Horne & Vissers (2022) in their economics analysis of slow-growing broilers for Eurogroup for Animals, highlights the significant cost

implications and trade-offs involved in transitioning towards higher-welfare poultry production, presenting a critical area for future policy and market development.

War-affected Sudan reveals critical knowledge gaps in the literature:

- Quantitative evidence on cost distortion post-2023.
- Effects of energy substitution (diesel vs. grid) on economic viability.
- Consumer adaptation to smaller bird weights.
- Resilience mechanisms in conflict-affected agricultural systems.

These gaps justify renewed investigation into broiler production under fragility, where macroeconomic shocks, logistics breakdowns, and local innovation intersect.

3. Methodology

3.1. Study Design and Framework

This study adopts a systematic descriptive-comparative approach to analyze the economics of broiler meat production across selected countries Sudan, Egypt, Jordan, Saudi Arabia, Turkey, and the United States and to benchmark their performance against global standards.

The research follows a systematic review framework inspired by the PRISMA methodology, ensuring transparency in data collection, screening, extraction, and synthesis. The objective is to identify cost structures, input dependencies, and performance indicators shaping the efficiency and sustainability of broiler meat production systems under different economic and production conditions.

3.2. Data Sources and Collection

This study primarily relies on secondary data extracted from a combination of peer-reviewed research papers, institutional reports, and national statistics.

Key sources include:

- Empirical studies and theses from Sudan (Mohamed and Elkhidir, 2017; Eltigani, 2009).
- Country-level cost and performance data from FAO, IFPRI, USDA, and national poultry federations.
- CRU (2024) report on Sudan's agricultural input supply in times of war.
- Updated 2025 field estimates and local expert interviews reflecting the post-war situation in Sudan.
- Turkish Statistical Institute (2023) poultry production statistics.
- USDA Economic Research Service (2022) and National Agricultural Statistics Service (2023) reports.
- Industry standards from Aviagen (2022) and Cobb-Vantress (2021).

Data were screened to ensure methodological consistency, reliability, and comparability. For all countries, broiler cost components were harmonized and standardized for cross-country analysis.

3.3. Data Standardization and Normalization

Because data were drawn from diverse sources, normalization was essential for consistent cross-country comparison. All values were converted to U.S. dollars (USD) to eliminate exchange rate distortions and facilitate benchmarking.

For Sudan, due to the war's impact on inflation and currency depreciation, cost normalization used a conversion rate of 1 USD = 3,600 SDG (as of 2025). Pre-war data (Sudan 2023) were maintained as a baseline for comparative analysis, while post-war (2025) data represent the adjusted current cost structure.

Performance indicators including feed conversion ratio (FCR), mortality rate, dressing percentage, and production cycle length were standardized based on global measurement protocols to maintain comparability across systems.

3.4. Cost Structure Classification

For each country, the cost per bird was decomposed into six major components:

1. Day-Old Chicks (DOC)
2. Feed
3. Housing and Utilities
4. Labor and Overheads
5. Veterinary and Vaccination
6. Mortality and Wastage

The contribution of each component to total production cost was expressed as a percentage of the total broiler cost per bird, allowing direct comparison between production systems and economic contexts. This cost disaggregation was crucial for identifying key cost drivers and efficiency gaps.

3.5. Benchmarking and Global Comparison

To evaluate production efficiency, the study introduces a global benchmark drawn from internationally recognized broiler production data (USDA, and FAO). The benchmark serves as a reference for optimal performance, against which deviations in cost and productivity are assessed.

For Sudan, comparisons were made between 2023 (pre-war) and 2025 (post-war) data, capturing the effects of currency devaluation, disrupted input markets, and recovery measures.

3.6. Adjustments for Sudan (2025 Scenario)

The post-war conditions in Sudan required specific methodological adaptations due to the country's disrupted production environment. All parent stock farms were damaged during the conflict, leading to a complete dependence on imported fertilized eggs to restart hatchery operations.

As a result:

- DOC production costs surged due to importation, hatchery maintenance, and high energy consumption from diesel generators.
- Imported medicines, vaccines, disinfectants, and hatchery tools further increased operational costs.
- Feed prices rose dramatically, reflecting both currency devaluation and the sharp increase in local sorghum and oilseed prices.
- Inflation, transportation challenges, and foreign exchange shortages compounded the cost escalation, aligning with documented trends of input market collapse (CRU, 2024).

These adjustments were integrated into the 2025 Sudan cost model, where each cost component reflects a fivefold increase relative to pre-war conditions, aligning with observed currency depreciation and inflation trends.

3.7. Analytical Approach

The comparative analysis employs both descriptive statistics and ratio analysis to evaluate production costs, efficiency, and competitiveness.

Key indicators include:

- Cost per kg live weight (USD/kg)
- Feed cost share (%)
- DOC cost share (%)
- FCR and mortality rate
- Total production cost per bird and per kg live weight Sudan's 2025 data are analyzed against:
- Sudan 2023 (baseline/pre-war)
- Regional peers (Egypt, Jordan, Saudi Arabia, Turkey)
- The global benchmark and the United States (as an efficiency reference)

This approach ensures both temporal (pre- vs. post-war) and spatial (Sudan vs. peers/global) comparability, highlighting economic vulnerabilities and resilience factors.

3.8. Sensitivity Analysis

To assess the robustness of the findings, a sensitivity analysis was performed by simulating:

- ±10% change in feed costs
- ±10% change in DOC costs

Adjusted cost per kilogram LW values were calculated under these scenarios to evaluate the vulnerability of production systems to fluctuations in critical input prices.

3.9. Limitations

Although the study integrates comprehensive comparative data, several limitations remain:

- Limited access to up-to-date field data from conflict zones in Sudan.
- Reliance on secondary data and estimates for post-war cost structure.
- Variations in accounting practices across countries.
- Exclusion of environmental and welfare cost factors.
- Data collection constraints with national averages masking regional variations.
- Temporal limitations in capturing seasonal fluctuations.

Nevertheless, by triangulating diverse data sources and employing standardized metrics, the study ensures a high degree of validity and policy relevance.

4. Results

4.1. Performance against Global Benchmarks

The analysis shows clear differentiation in performance relative to global standards. Turkey achieved the lowest cost per kilogram of live weight (USD 0.69), closely followed by the USA (USD 0.73), both within the global efficiency range of 0.75-0.78 USD/kg.

In contrast, pre-war Sudan (2023) exhibited the highest cost per kg (USD 0.95), 22% above the global upper benchmark, while Egypt (USD 0.90) and Jordan (USD 0.92) performed slightly better. Saudi Arabia achieved moderate competitiveness at USD 0.81.

Feed costs exceeded global optimal levels (56-57%) in all countries except the USA (55%), confirming its advantage in integrated feed supply. Egypt (60.0%) and Jordan (60.6%) displayed the highest feed inefficiencies due to reliance on imported maize and soybean.

Sudan's feed cost share (58.6%) reflected dependence on locally produced sorghum and oilseed cakes, as well as imported protein concentrates and additives. These factors constrained competitiveness and increased sensitivity to inflation and exchange-rate shocks.

4.2. Mortality and Efficiency Patterns in Global Context

Mortality rates remained within acceptable limits but varied widely across regions. Sudan (1.37%) and Egypt (1.60%) slightly exceeded the global benchmark (≈1.3%), reflecting stress from feed scarcity and inconsistent biosecurity.

Table 1. Selected biological performance indicators for broiler production systems under floor and intensive rearing

Parameter	Unit	System	Sudan	Egypt	Saudi Arabia	Jordan	Turkey	USA	Global
Final live weight	Kg / Bird	Floor	1.8	2.0	1.9	2.1	2.0	2.2	2.0-2.2
		Intensive	2.0	2.1	2.1	2.3	2.2	2.4	2.0-2.2
Feed conversion ratio(FCR)	Kg feed/Kg gain	Floor	1.8	1.7	1.7	1.7	1.6	1.6	1.6-1.7
		Intensive	1.7	1.6	1.6	1.6	1.5	1.5	1.6-1.7
Mortality rate	%	Floor	5	5	4	4	4	4	4-5
		Intensive	4	4	3	3	3	3	4-5
Production cycle	Days	Floor	35	38	37	40	36	35	35-42
		Intensive	34	36	35	37	34	33	35-42
Dressing	%	Floor	72	73	72	73	73	74	72-74
		Intensive	73	74	73	74	74	75	72-72
Feed intake	Kg/Bird	Floor	3.3	3.2	3.3	3.4	3.2	3.3	3.2-3.4
		Intensive	3.2	3.1	3.2	3.3	3.1	3.2	3.2-3.4
Growth rate	g/day	Floor	52	55	54	56	57	60	50-60
		Intensive	55	58	57	59	60	63	50-60
Density stock	Birds/m^2	Floor	10	11	10	12	10	12	10-12
		Intensive	14	15	14	16	14	10	10-12

***Sources: FAO (2023), Aviagen (2022), Cobb-Vantress (2021)**

Jordan (1.51%) and Saudi Arabia (1.95%) also showed higher mortality, while Turkey (1.45%) was closest to the optimal range. The USA (1.86%) compensated its higher mortality with superior feed efficiency and automation.

Table 2. Broiler production cost components per bird (USD), by country and global standards

Component	Sudan	Egypt	Saudi Arabia	Jordan	Turkey	USA	Global Benchmark
Day-Old Chicks	0.39	0.40	0.32	0.39	0.34	0.35	0.36
Feed	1.00	1.08	0.90	1.17	0.92	0.89	0.93
Labor and overheads	0.12	0.12	0.12	0.13	0.11	0.15	0.14
Housing and utilities	0.12	0.12	0.11	0.13	0.10	0.12	0.12
Veterinary and vaccination	0.06	0.06	0.06	0.07	0.06	0.07	0.07
Mortality and wastage	0.02	0.03	0.03	0.03	0.02	0.03	0.02
Total per Bird	1.71	1.80	1.54	1.93	1.55	1.61	1.64

Note: Global benchmark values represent optimal performance standards for modern broiler production systems based on FAO (2023) and USDA (2023) efficiency standards, while Sudan values reflect pre-war 2023 projections. All costs are expressed in 2024 Constant USD after conversion from local currencies using IMF/World Bank average annual exchange rates and adjustment for inflation.

4.3. Sensitivity Analysis Across Study Countries

As shown in Table 4, feed costs remain the dominant determinant of total production cost. A ±10% feed-price shift alters the cost per kg by about ±6% in Sudan, Egypt, Jordan, and Turkey, and by ±5.5% in the USA.

DOC costs have a smaller impact (±2%), confirming that feed-cost volatility remains the major economic threat. Countries heavily dependent on imported feed (Sudan, Egypt, Jordan) are most exposed to global commodity and currency fluctuations.

Table 3. Cost per 1kg live weight, and percentage contribution by country and global standards

Component	Sudan	Egypt	Saudi Arabia	Jordan	Turkey	USA	Global Benchmark
Total per Bird	1.71	1.80	1.54	1.93	1.55	1.61	1.64
L .W (Kg)	1.80	2.00	1.90	2.10	2.30	2.20	2.10
Cost / Kg	0.95	0.90	0.81	0.92	0.69	0.73	0.78
Day-Old Chicks (DOC)	22.76%	22.40%	20.78%	20.45%	21.74%	21.88%	22.00%
Feed	58.62%	60.00%	58.44%	60.61%	59.42%	55.00%	56.67%
Labor and overheads	6.90%	6.40%	7.79%	6.82%	7.25%	9.38%	8.67%
Housing and utilities	6.90%	6.40%	7.14%	6.82%	6.52%	7.50%	7.33%
Veterinary and vaccination	3.45%	3.20%	3.90%	3.79%	3.62%	4.38%	4.00%
Mortality and wastage	1.37%	1.60%	1.95%	1.51%	1.45%	1.86%	1.33%

4.4. SUDAN 2025: Post-War Recovery Scenario and Cost Structure

Table 5 presents updated estimates for Sudan 2025, derived from field-verified data after the partial resumption of production under war-affected conditions. Broiler production remains severely constrained by fuel shortages, high inflation, and the collapse of parent-stock, and other production cycle operations. Recovery began through the importation of fertilized hatching eggs and the re-establishment of private hatcheries, but costs increased sharply due to foreign-exchange fluctuations, diesel-powered energy generation, and supply-chain disruptions.

Table 4. Sensitivity of broiler cost per kg (USD) to ±10% feed and ±10% Day Old Chick costs

Country	Base cost (USD/kg)	Δ% Feed (±10%)	Δ% DOC (±10%)
Sudan	0.95	±5.85%	±2.28%
Egypt	0.9	±6.00%	±2.22%
Saudi Arabia	0.81	±5.85%	±2.08
Jordan	0.92	±6.07%	±2.02%
Turkey	0.69	±5.94%	±2.19%
USA	0.73	±5.53%	±2.17%
Global Benchmark	0.78	±5.66%	±2.19%

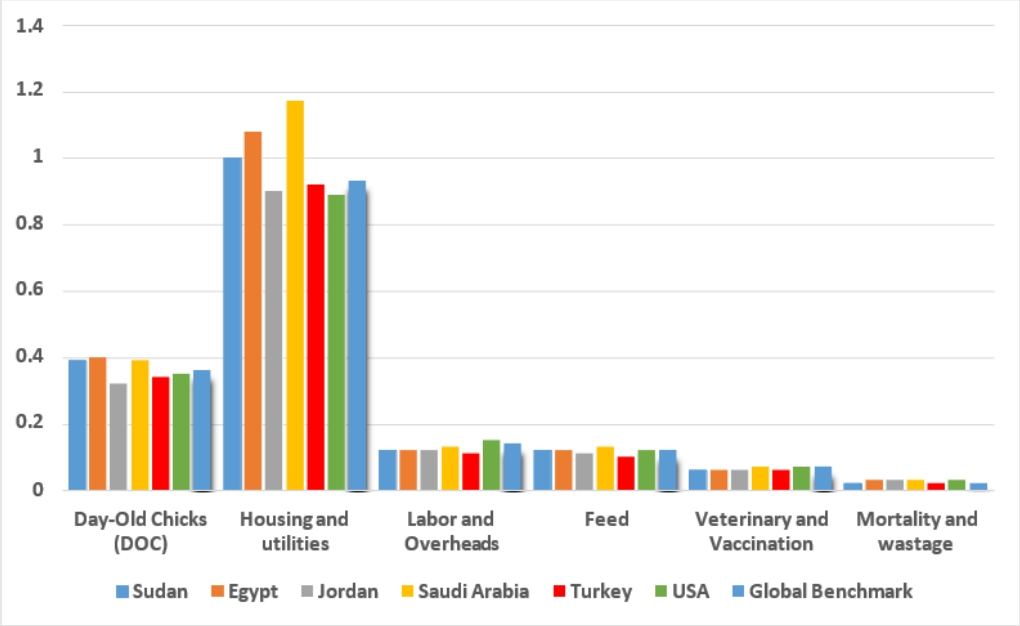

Figure1. Cost per DOC, housing, labor, feed, healthcare and mortality percentages.

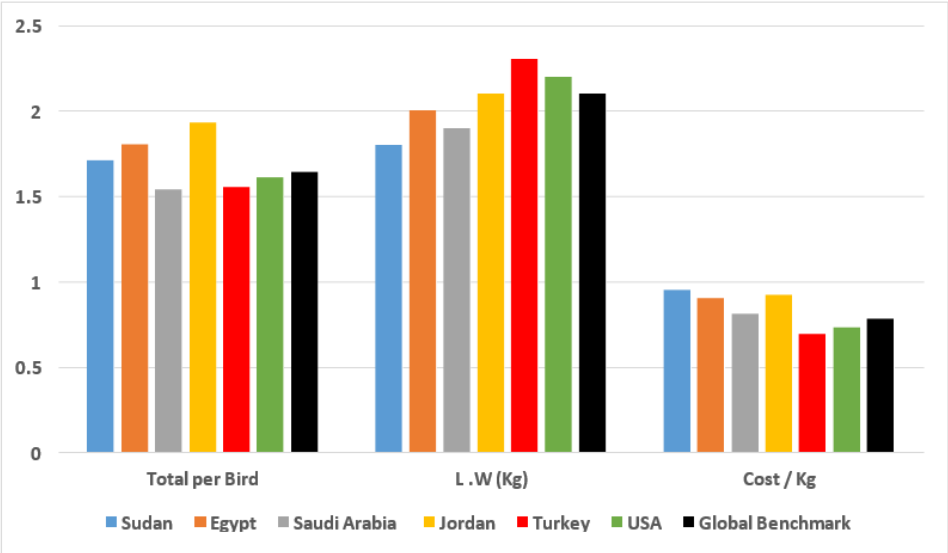

Figure 2. : Total cost per bird (USD), live weight (Kg), and cost per Kg (USD).

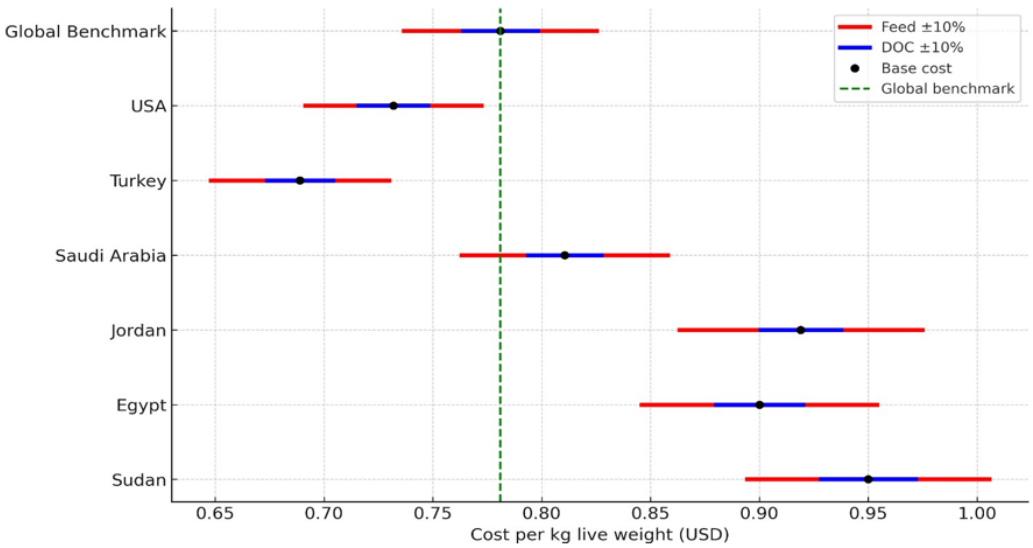

Figure 3: Sensitivity of broiler production costs to feed and DOC.

Table 5. Sudan 2023 vs Sudan 2025 broiler cost structure and comparison with the global benchmark

Component	Sudan 2023	Sudan 2025	Global Benchmark
Day-Old Chicks USD/bird	0.39 (22.8%)	1.36 (38.9%)	0.36 (22%)
Feed USD/bird	1.00 (58.6%)	1.58 (45.2%)	0.93 (56.7%)
Labor and Overheads	0.12 (6.9%)	0.06 (1.7%)	0.14 (8.7%)
Housing and Utilities	0.12 (6.9%)	0.29 (8.3%)	0.12 (7.3%)
Veterinary and Vaccination	0.06 (3.5%)	0.08 (2.4%)	0.07 (4.0%)
Mortality and Wastage	0.02 (1.4%)	0.13 (3.6%)	0.02 (1.3%)
Total per Bird (USD)	1.71	3.50	1.64
Live Weight (kg)	1.80	2.00	2.10
Cost per kg (USD)	0.95	1.75	0.78
Feed Conversion Ratio (FCR)	1.7	1.5	1.6
Cycle (days)	35	36	35-42

Source: Author's calculations based on 2025 field data; all costs expressed in USD at 1 USD = 3,600 SDG.

4.5. SUDAN 2025: Economic Realities and Production Constraints

Post-war recovery resulted in a 73% increase in total production cost per bird and an increase in cost per kg from USD 0.95 to USD 1.75 more than double the global benchmark. The sharp rise in DOC cost (to USD 1.36 per bird, ≈39% of total) reflects the dependence on imported fertilized eggs, hatchery reconstruction, and power generation by diesel, and high chicks transportation and displacement cost.

Feed costs remained dominant but relatively lower in share (45%) due to the disproportionate increase in other inputs. Housing and utilities rose significantly (to 8.3%) because of the need for private power generation. Mortality and wastage tripled (from 1.4% to 3.6%) due to degraded chick quality and suboptimal field management.

Despite some improvements in feed efficiency (FCR ≈1.5) and moderate live weight recovery (2.0 kg), overall profitability remains severely constrained.

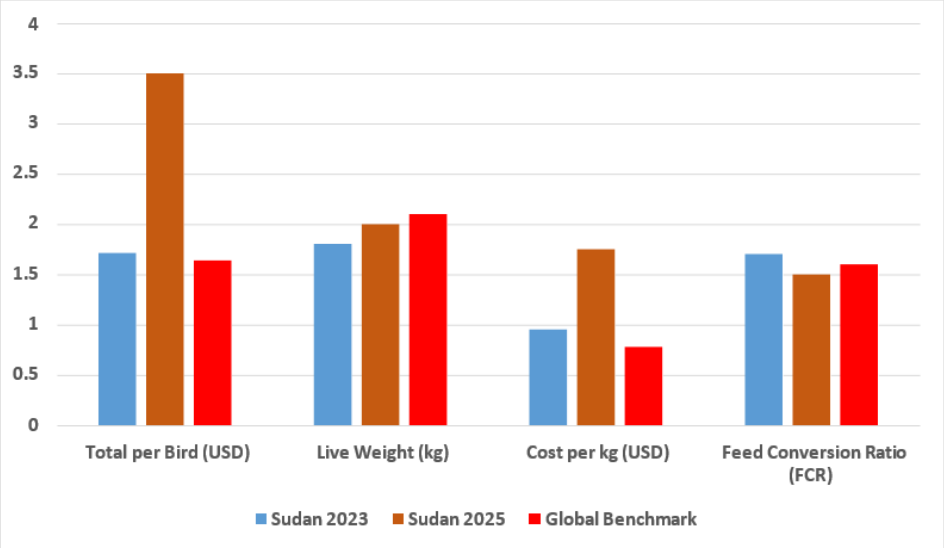

Figure 4. : Comparative total cost per bird (USD), live weight (Kg), cost per Kg (USD), and FCR of Sudan 2023, Sudan 2025, compared to Global benchmark

4.6. Comparative Production Cost Structure

Table 6 presents the standardized production cost of broiler meat (USD/kg live weight) across selected countries and benchmarks. The comparison includes pre-war Sudan (2023), post-war Sudan (2025), and other major producing countries (Egypt, Jordan, Saudi Arabia, Turkey, and the USA), alongside the global benchmark range. All costs were normalized to USD/kg of live weight to ensure comparability.

Table 6. Comparative Sensitivity of Sudan 2023, Sudan 2025, Global broiler cost per kg (USD) to ±10% feed and ±10% Day Old Chick costs.

Country	Baseline (USD/kg)	Δ% Feed (±10%)	Δ% DOC (±10%)
Sudan 2023 (Pre- war)	**0.95**	**±5.85%**	**±2.28%**
Sudan 2025 (Post-war)	1.75	±3.7%	±3.0%
Global Benchmark	1.00	±5.0%	±2.0%

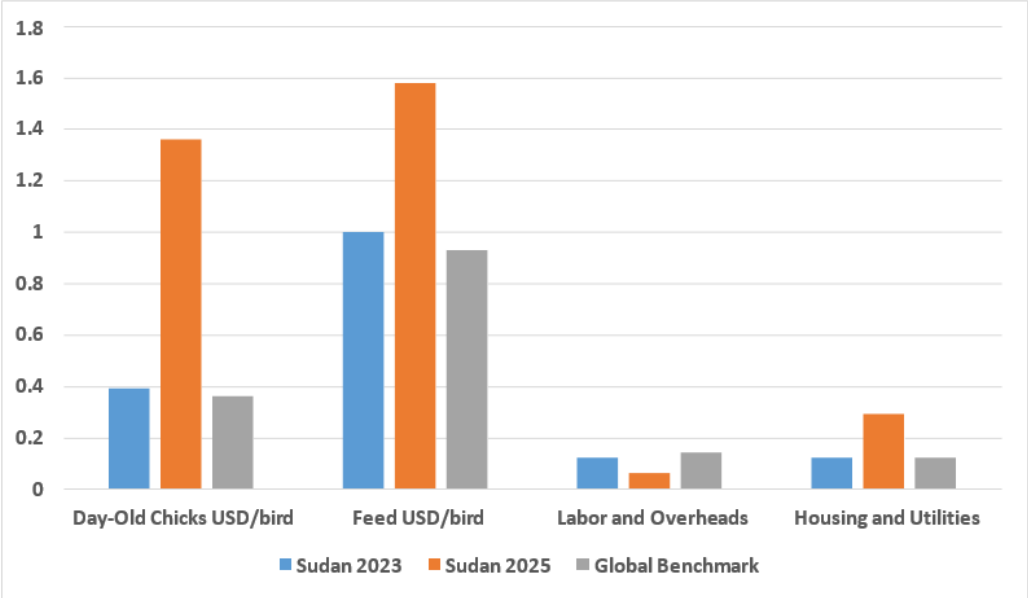

Figure 5. : Comparative DOC, feed, labor and housing costs per bird (USD of Sudan 2023, Sudan 2025, compared to Global benchmark

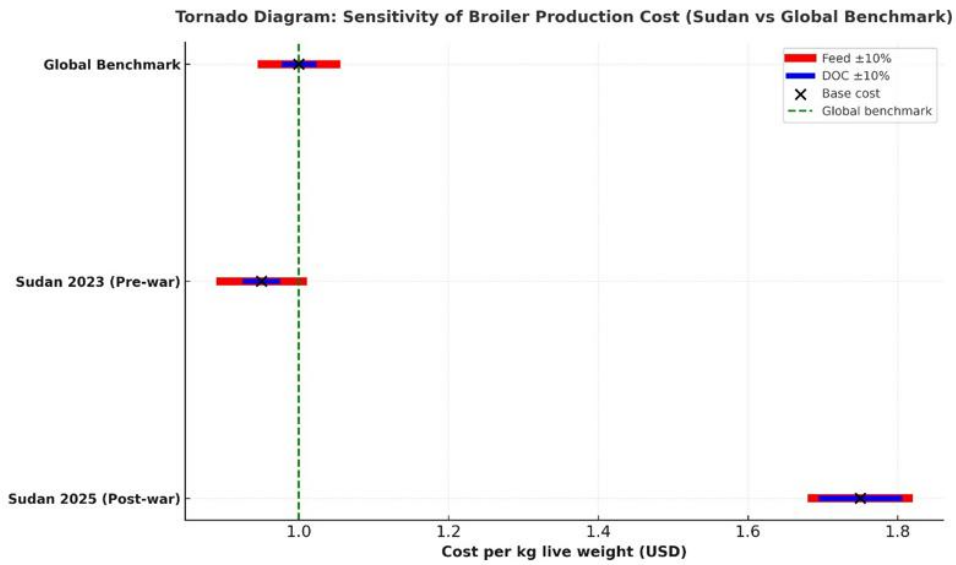

Figure: 6. Compared Sensitivity of Sudan 2023 and Sudan 2025 broiler production costs to feed and DOC

4.7. Comparative Performance Indicators

Table 7 contrasts key biological and technical performance indicators across the study countries and benchmarks.

Table 7. Comparative performance indicators in broiler production

Country	Live Weight (kg)	FCR	Mortality (%)	Dressing (%)	Cycle (days)
Sudan 2023	2.2	1.55	4	72	38
Sudan 2025	2.0	1.50	3	70.6	36
Egypt	2.1	1.55	4	73	35
Jordan	2.3	1.60	4	74	36
Saudi Arabia	2.2	1.58	3.5	74	35
Turkey	2.4	1.55	4	75	35
USA	2.5	1.50	3	75	34
Global Benchmark	2.3-2.5	1.45-1.55	3-4	74-76	33-36

5. Discussion

5.1. Global Production Performance and Benchmarking

Table 1 highlights broiler biological efficiency parameters across floor and intensive rearing systems in the study countries. Intensive systems consistently achieved higher final live weights (2.0-2.4 kg) and lower FCR (1.6-1.7) compared to floor systems (1.8-2.1 kg, FCR 1.7- 1.8). Mortality was also reduced under intensive systems (≈3-4% versus 4-5%), while production cycles were shortened by 2-3 days.

Benchmarking against global standards provides a rigorous framework for evaluating competitiveness. Turkey, with an average final live weight of 2.25 kg and FCR close to 1.6, achieved the lowest cost per kg (USD 0.69), positioning it within global efficiency ranges. This demonstrates that developing nations can achieve international competitiveness through integrated production systems, efficient feed utilization, and sustained investment in genetics and technology (FAO, 2023; World Poultry Foundation, 2023). The USA, while recording a slightly higher cost per kg (USD 0.73), maintains strong competitiveness with higher productivity (2.2 kg live weight) supported by scale economies and advanced automation (USDA, 2023).

The analysis demonstrates that Sudan's poultry industry, once regionally competitive, has suffered a severe economic setback due to the war. The loss of breeder farms, currency depreciation, and dependence on costly imports for DOCs and additives significantly increased the total production cost. Despite this, some recovery efforts emerged through private-sector partnerships that resumed fertile egg imports and limited hatchery operations, partially restoring supply but at high cost.

5.2. Feed Dependence and Vulnerability in International Perspective

Feed remains the dominant driver of broiler production costs across all countries, accounting for 55-61% of total expenses (Table 3). In Sudan, reliance on sorghum and oilseed cake at high local prices elevates feed cost shares (58.6%). In Egypt and Jordan, dependence on imported maize and soybean raises exposure to international price volatility and currency fluctuations, pushing feed cost shares to 60.0% and 60.6%, respectively. These values substantially exceed the global benchmark of 56-57%.

Efficiency gaps are most pronounced in Sudan, where cost per kg (USD 0.95) stands 22% above the global benchmark (USD 0.78). Egypt (USD 0.90) and Jordan (USD 0.92) also exceed the benchmark by 15-18%. These differences are directly tied to higher feed proportions, modestly higher mortality, and smaller-scale production. Such gaps reflect structural challenges, including heavy feed import dependence, inadequate disease control, and limited technical capacity (Elghouth et al., 2013; Abdelmonem et al., 2023).

Sudan's energy profile remains a critical constraint: The shift from public electricity to diesel generators multiplied energy costs by fivefold. Fuel price volatility directly affects both hatchery and farm operations. In comparative context, while Egypt, Jordan, and KSA demonstrate integrated systems with feed milling, breeder, and processing units under stable infrastructure, Sudan's production remains fragmented and risk-exposed.

5.3. Genetics, DOC Investment, and Input Quality

Higher DOC cost shares in Turkey (21.7%) and the USA (21.9%) reflect strategic investment in superior genetics, not inefficiency. These countries source from advanced hatcheries supplying strains with superior feed efficiency and faster growth, contributing to lower overall costs per kg. This demonstrates that higher DOC expenditures, when linked to genetic quality, result in lower unit costs by reducing feed use and shortening cycles (Aviagen, 2022; Cobb-Vantress, 2021).

In contrast, Sudan (22.8%) and Egypt (22.4%) are within benchmark ranges but may invest less in premium genetic strains, limiting potential gains in efficiency. The strategic investment in genetics in Turkey and USA aligns with findings from industry handbooks that emphasize the importance of genetic selection for feed efficiency and growth rates (Aviagen, 2022; Cobb- Vantress, 2021).

5.4. Mechanization, Labor Efficiency, and Mortality Management

Lower labor shares in Turkey (7.25%) and the USA (9.38%) are linked to mechanization and integration. Automated feeding, watering, and climate systems reduce labor needs, increase consistency, and improve biosecurity. By contrast, higher labor shares in Saudi Arabia (7.8%) and limited mechanization in Sudan (6.9%) reduce productivity.

Mortality, reflected in the cost category, is a sensitive indicator of management quality. Saudi Arabia (1.95%) and the USA (1.86%) recorded higher-than-benchmark mortality shares, while Sudan (1.37%), Jordan (1.51%), and Turkey (1.45%) performed closer to the global standard (≈1.3%). Reducing mortality further could generate modest but meaningful cost savings for example, a 0.3% mortality reduction in Egypt would lower costs by ≈USD 0.016 per bird, equivalent to a 0.9% reduction in cost/kg.

5.5. Regional Variability and Policy Support – The Saudi Arabian Case

Saudi Arabia represents a middle case. Its feed cost percentage (58.4%) is slightly above the global benchmark, but government subsidies for energy and inputs help maintain competitiveness, yielding a cost per kg of USD 0.81. However, housing (7.1%) and labor (7.8%) costs remain higher than global norms, reflecting limited economies of scale.

Jordan (USD 0.92/kg) shows intermediate performance, sharing Egypt's vulnerability to imported feed costs but achieving better mortality outcomes. These findings highlight the need for policy approaches that combine

targeted subsidies with investment in domestic feed production, research, and farmer training (Mansour and Elsebaei, 2020).

5.6. Sensitivity, Resilience, and Integrated Efficiency Approaches

The sensitivity analysis (Table 4) confirms feed costs as the most volatile driver. A ±10% change in feed price shifts cost per kg by ≈±6% across Sudan, Egypt, Jordan, and Turkey, and by ≈±5.5% in the USA. A ±10% change in DOC costs, in contrast, shifts costs by only ≈±2% across all countries.

For example, in Sudan, the baseline cost per kg is USD 0.95. With a ±10% feed increase, cost rises to USD 1.01; with a −10% decrease, cost falls to USD 0.89. A ±10% DOC increase moves cost to USD 0.97, while a −10% change reduces it to USD 0.93. Similar proportional effects were observed in all other countries.

This confirms that feed cost volatility poses the greatest economic risk, especially in countries with high feed import dependence (Sudan, Egypt, Jordan). Turkey and the USA demonstrate greater resilience, supported by stronger domestic feed industries and higher efficiency.

The interdependence of input costs indicates that isolated fixes are insufficient. Arab countries need integrated strategies targeting:

1. Genetic improvement through higher-quality DOC investment (Aviagen, 2022).
2. Feed efficiency via improved formulation and local feed crop development (FAO, 2023).
3. Mortality reduction through stricter biosecurity, climate control, and vaccination (FAO, 2023).
4. Labor productivity through mechanization, training, and improved farm management (FAO, 2023).

5.7. SUDAN 2025: Post-Conflict Economic Distortions and Input Dependency

The 2025 recovery data (Table 5) depict a broiler industry in Sudan struggling under extraordinary macro-economic and structural constraints. The war disrupted every element of the input supply chain from parent-stock breeding to feed processing and distribution forcing the sector into dependency on imported fertilized hatching eggs and expensive diesel- powered operations. The subsequent spike in production costs reflects not inefficiency alone, but systemic collapse and ad-hoc reconstruction driven by the private sector and humanitarian channels.

The most striking post-war change is the escalation of DOC cost to USD 1.36 per bird (≈39% of total cost) almost double the global benchmark share. This increase is rooted in the destruction of domestic hatcheries and parent-stock farms, which forced importation of fertile eggs from regional suppliers under severe currency devaluation (1 USD ≈ 3,600 SDG).

Added to this, energy scarcity compelled producers to rely on diesel generators for heating, lighting, and water pumping. The cost of self-generated electricity often exceeded public-grid tariffs by a factor of 8-10, transforming energy into one of the major indirect cost drivers. These compounded pressures produced a total per-bird cost of USD 3.50, translating into USD 1.75/kg live weight, roughly 124% above the global benchmark.

5.8. SUDAN 2025: Adaptive Management and Resilience Mechanisms

Despite the crisis, feed conversion ratio improved to 1.5 compared with 1.7 before the war, illustrating adaptive responses among producers. Many shifted to shorter rearing cycles (≈36 days) and lighter market weights (~2 kg live; 0.9 kg dressed) to reduce exposure to cumulative cost inflation. This adjustment, while economically rational under high-risk conditions, contributes to the observed decline in dressing percentage (~70%) and limits the overall marketable meat yield.

Sudanese producers have relied mainly on local sorghum and oilseed cakes (peanut, sesame, and sunflower) supplemented with imported protein concentrates, DCP/MCP, amino acids, and premixes. With global freight volatility and import restrictions, local feed prices surged nearly six-fold, matching the depreciation rate of the SDG. Consequently, feed still represents the single largest cost component (45%) even under reduced proportional share.

Average mortality and wastage rose from 1.4% to 3.6%, driven by lower chick viability, poor brooding conditions, and compromised veterinary logistics. The quality of locally hatched chicks often produced under unstable temperature and power supply proved a critical bottleneck. Field reports confirmed uneven chick weights, elevated first-week mortality, and frequent mycotoxin incidents due to sub-standard feed storage. These biological inefficiencies, together with limited access to vaccines and cold-chain supplies, have eroded flock uniformity and market consistency.

5.9. SUDAN 2025: Comparative Position and Strategic Outlook

Encouragingly, the post-war period has seen renewed engagement of private poultry companies through cooperative models and joint ventures with regional partners. Several firms relocated hatchery assets to safer states (Gedaref, Kassala, and Port Sudan) and re- established minimal operations using imported fertilized eggs. Some medium-scale producers adopted modular diesel-based micro-hatcheries, enabling gradual restocking. These interventions, while costly, have prevented total collapse and allowed the domestic supply of DOCs to resume on a limited scale.

International organizations (FAO, WFP, INGOs) have also distributed seeds and feed inputs to sustain upstream grain production, indirectly supporting poultry feed availability.

Figure 4 (Sudan 2023 = USD 0.95/kg; Sudan 2025 = USD 1.75/kg; Benchmark = USD 0.78/kg) illustrates the dramatic post-war divergence. Sudan's 2025 cost exceeds the benchmark by 117%, the largest gap among all countries studied. Yet, feed efficiency (FCR 1.5) approaches global norms, suggesting that the crisis is predominantly economic rather than biological. Stabilizing exchange rates, restoring energy infrastructure, and rebuilding hatcheries could therefore rapidly enhance competitiveness without major technological shifts.

To realign Sudan's broiler sector with global performance standards, a coordinated recovery framework is required, emphasizing:

- Rehabilitation of parent-stock and hatchery systems to restore local DOC self-sufficiency.
- Energy diversification, including solar-powered brooding and feed milling.
- Feed-sector stabilization through structured contracts for sorghum and oilseed crops.
- Biosecurity and veterinary infrastructure rebuilding.
- Exchange-rate and credit stabilization.

If these reforms are progressively implemented, cost per kg could decline toward USD 1.10-1.20 within three production cycles, narrowing the gap with global norms. The resilience of Sudan's poultry producers, evidenced by continued operation under extreme duress, demonstrates a foundation for sustainable recovery once macroeconomic and logistical stability are re-established.

6. Conclusion and Recommendations

6.1. Overall Summary

This review systematically examined the biological and economic performance of broiler production systems across six countries Sudan, Egypt, Jordan, Saudi Arabia, Turkey, and the United States using normalized cost, performance, and sensitivity analyses expressed in constant USD. The comparative framework enabled the identification of structural and efficiency gaps within the Arab region relative to global benchmarks.

Across all countries, feed remains the single dominant cost component (55-61%), confirming its central role in determining competitiveness. DOC costs represent the second most sensitive driver, but their economic impact is smaller (±2% change per 10% DOC price shift). The United States and Turkey maintain the lowest production costs per kilogram (USD 0.73 and 0.69, respectively), reflecting advanced genetics, large-scale integration, and technological automation. Saudi Arabia, Egypt, and Jordan occupy an intermediate performance range (USD 0.81-0.92/kg), constrained by feed import dependence and limited integration efficiency.

In contrast, Sudan's pre-war (2023) cost was USD 0.95/kg, already 22% above global standards, while the 2025 post-war cost reached USD 1.75/kg, marking a 117% deviation. This escalation reflects the compounded effects of currency devaluation, input import disruptions, hatchery destruction, and energy shortages, rather than inherent biological inefficiency. Despite these shocks, the feed conversion ratio (FCR 1.5) and shortened production cycle (36 days) demonstrate adaptive resilience among producers.

6.2. Key Findings

This comparative analysis demonstrates that feed costs, genetic potential, and mechanization are the principal determinants of broiler production competitiveness. Feed remains the largest cost driver globally, and its impact in developing Arab countries, particularly Sudan and Egypt, exposes producers to acute vulnerability from international grain and plant protein markets volatility. Sensitivity analysis confirms that a ±10% shift in feed prices can alter production costs per kg by as much as ±6% in these countries, whereas Turkey and the United States maintain resilience under feed price fluctuations and production inefficiencies due to superior feed efficiency, genetics, and mechanization, (FAO, 2023); (World Poultry Foundation, 2023). This highlights that resilience in poultry production is not only about lowering costs but also about reducing exposure to shocks.

The benchmarking against global standards reveals that most Arab countries operate significantly above optimal efficiency levels, with Sudan showing the largest gap at 27.2% above benchmark costs, mortality management emerges as a particularly critical area, with rates in Arab countries exceeding global standards by 50-100% (FAO, 2023).

Specific findings include:

- Feed and DOC account for >80% of production cost in Sudan 2025, up from 70% in 2023.
- Cost per kg live weight increased by 84%, the highest among compared nations.
- Post-war production relies on imported fertile eggs and diesel energy, both dollar- linked.
- FCR remains stable (1.5), suggesting that managerial performance survived the shock.
- Regional competitiveness declined, but Sudan retains adaptive capacity if input importation and energy stabilization are improved.

6.3. Policy and Industry Recommendations For Sudan (Post-Conflict Recovery):

1. Rebuild hatchery and parent-stock capacity through public–private partnerships to reduce dependence on imported fertile eggs.
2. Promote local feed resource development, including structured sorghum and oilseed contracts and investment in oilseed-processing byproducts (e.g., sunflower, peanut, sesame cakes).

3. Adopt renewable and hybrid energy systems (solar–diesel integration) to reduce production costs and power instability.
4. Support access to foreign exchange and credit for agricultural inputs, using donor-backed revolving funds and soft-loan mechanisms.
5. Re-establish veterinary and biosecurity infrastructure, including cold chains for vaccines and improved chick transport systems.

For the Arab Region:

1. Strengthen feed autonomy through coordinated grain and oilseed production strategies within the MENA region.
2. Encourage technology transfer from high-efficiency producers (Turkey, USA) in genetics, feed formulation, and precision housing systems.
3. Enhance market intelligence systems to track input price movements, demand forecasts, and production cost indices.
4. Invest in training and digitalization to increase labor productivity and improve farm management in small and medium-scale operations.
5. Establish regional research networks on poultry economics to harmonize cost-structure data and update regional benchmarks annually.

Policy-Level Actions:

1. Promote feed sovereignty: Governments and private sectors should incentivize and expand local production of feed crops (e.g., maize, sorghum, soybean, and oil seeds) and support the development of modern, efficient feed mills to reduce import dependency.
2. Strategic reserves and hedging: Establish national feed reserves and financial instruments to buffer producers against international price and supply disruptions.
3. Improve Genetic Stock programs: Policy should support the importation and local development of high-yield, disease-resistant poultry strains through modern hatchery services, and facilitate access to regulatory support, and germplasm exchange, (Aviagen, 2022); (Cobb-Vantress, 2021).
4. Enhance Data Collection: National agricultural agencies must prioritize conducting regular, standardized, and detailed economic surveys of production costs to inform evidence- based policy and investment decisions.
5. Build Shock Resilience: Policymakers should establish strategic feed reserves, hedging mechanisms, and contingency planning to cushion producers from sudden international price and supply disruptions.

Farm-level actions:

6. Promote mechanization: Provide credit financial incentives and technical assistance to farmers to promote automation in feeding, drinking, and climate control systems to improve flock health, efficiency, reduce labor dependency and costs. Adopt intensive rearing systems and implement modern management, where feasible to increase output per unit area and reduce cost per kg of live weight.
7. Enhance biosecurity: Strengthen veterinary extension services, vaccination programs, and housing quality to lower mortality and wastage (FAO, 2023): (USDA, 2023).
8. Performance monitoring: standardize farm-level data collection of feed conversion ratios, cost structures, and production efficiency for continuous improvement.

Regional integration actions

9. Shared research platforms: Develop regional centers of excellence for poultry genetics, feed technology, and production efficiency.
10. Cross-border collaboration: Harmonize veterinary and trade regulations to facilitate access to superior inputs, including day-old chicks, feed, and vaccines.
11. Collective bargaining power: Form producer associations and cooperatives to secure better terms for feed imports, technology adoption, and export opportunities.

For Global Benchmarking and Research:

- Develop a standardized broiler cost-monitoring framework that integrates both biological and economic indicators, enabling consistent cross-country comparison.
- Expand data-driven policy modeling linking feed price scenarios, exchange-rate trends, and cost sensitivity outcomes.
- Support research on alternative protein and energy sources (e.g., insect meal, solar dryers, and localized micro-mills) as pathways toward sustainable intensification.

6.4. Future Outlook

The post-war trajectory of Sudan's poultry sector underscores both the fragility and adaptability of agrifood systems under crisis. With targeted recovery interventions, Sudan could reduce broiler cost per kilogram to USD 1.10-1.20 within two production cycles, re- entering competitive range with middle-income countries.

Regionally, integrating feed and energy security with genetics and biosecurity improvement will be essential for the Arab world's poultry sector to sustain growth amid climate and market shocks.

The experience of 2023-2025 demonstrates that broiler production is not only an economic activity but a resilience indicator reflecting how well agricultural systems can reorganize, adapt, and recover from disruption. Continued monitoring, regional collaboration, and technology-driven policy design are vital to secure food and protein sustainability in fragile and emerging economies.

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