



Efficiency of urban broiler farming and its contribution to household food security

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Abstract

This study investigates the Efficiency of Urban Broiler Farming and its contribution to household Food Security. The research is motivated by the growing importance of urban livestock production in enhancing food security and income diversification in rapidly urbanizing regions of Sub-Saharan Africa. Primary data were collected from 270 urban broiler farming households through structured questionnaires, field observation, and production record analysis. The stochastic frontier model was employed to estimate technical efficiency scores and identify determinants of inefficiency, while the Cost-of-Calorie method was used to determine household food security status based on the recommended dietary intake benchmark of 2260 kcal per person per day. A Probit model further examined the socioeconomic drivers of food insecurity among farming households. The results reveal a mean technical efficiency score of 0.72, indicating a 28 percent efficiency gap attributed largely to managerial, institutional, and input-related constraints rather than technological limitations. The frequency distribution shows that only 14.1 percent of farmers operate near the production frontier, while a significant proportion remain in the moderate efficiency category. Determinants of inefficiency analysis indicates that education, farming experience, extension access, and credit availability significantly reduce production inefficiency. The household food security analysis reveals that 38.1 percent of broiler farming households remain food insecure despite active participation in commercial poultry production, highlighting a commercialization–nutrition paradox. Operational audit findings identify faulty ventilation systems, feed protein deficits, and intermediary-dominated marketing channels as critical structural bottlenecks limiting productivity and profitability. Sensitivity risk assessment further demonstrates the sector's vulnerability to feed price shocks, disease outbreaks, and regulatory pressures. The study contributes to empirical literature by integrating efficiency analysis, food security assessment, and operational diagnostics within a single urban livestock framework. The findings provide policy-relevant evidence for improving productivity, strengthening value chains, and enhancing urban food system resilience in Northern Nigeria and similar developing economy contexts.

Keywords: Urban broiler farming, technical efficiency, household food security, stochastic frontier analysis, Nigeria

Introduction

Urban livestock production has increasingly emerged as a critical livelihood and food security strategy in developing countries, particularly within rapidly expanding urban and peri-urban environments. In Sub-Saharan Africa, urban poultry production plays a dual role in providing animal protein and generating income for households facing rising food prices, unemployment, and urban poverty. Nigeria, being the largest poultry producer in West Africa, relies heavily on small and medium-scale broiler enterprises to meet the growing demand for affordable animal protein. However, the sector continues to face structural inefficiencies, high input costs, infrastructural deficits, and market distortions that constrain productivity and profitability.

Katsina State, located in Northern Nigeria, represents a unique case of emerging urban broiler production systems operating under resource-constrained and climate-stressed environments. Despite increasing urban demand for poultry meat, many producers operate below the production frontier due to managerial inefficiencies, poor housing infrastructure, feed quality variability, and weak institutional support systems. Existing literature has emphasized that technical efficiency gaps in poultry production systems are often driven by input misallocation, inadequate extension services, and limited access to credit (Adene and Oguntade, 2006; FAO, 2019) ^[1, 4]. Similarly,

heat stress, poor ventilation, and inconsistent feed composition have been identified as major productivity constraints in tropical poultry systems (Lara and Rostagno, 2013) ^[6].

Furthermore, while commercialization of poultry farming is expected to enhance household income and food access, empirical evidence suggests that increased market participation does not automatically translate into improved food security outcomes. This paradox is particularly evident in urban farming households where rising production costs, price volatility, and intermediary exploitation erode farm profitability and household welfare (World Bank, 2017; IFPRI, 2010) ^[5, 8]. Consequently, there is a growing need for integrated research that simultaneously examines production efficiency, operational risks, and household food security within urban livestock systems.

This study addresses this gap by applying a multi-model analytical framework combining Stochastic Frontier Analysis (SFA), Probit regression, Cost-of-Calorie food security assessment, and operational audit diagnostics to evaluate the performance of urban broiler farmers in Katsina State.

Methodology and Econometric Models

1. Stochastic Frontier Production Model (SFA)

The stochastic frontier production function was specified using the Cobb–Douglas functional form:

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + V_i - U_i$$

$$\ln(Y_i) = \beta_0 + \beta_1 \ln(X_{1i}) + \beta_2 \ln(X_{2i}) + \beta_3 \ln(X_{3i}) + \beta_4 \ln(X_{4i}) + V_i - U_i$$

Where

- Y_i = Broiler output
- X₁ = Feed quantity
- X₂ = Labor input
- X₃ = Day-old chicks
- X₄ = Veterinary and management inputs
- V_i = Random error term
- U_i = Technical inefficiency term

Technical Efficiency

$$TE_i = e^{-U_i}$$

2. Inefficiency Effects Model

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + W_i$$

Where Z₁ = Education, Z₂ = Experience, Z₃ = Extension access, Z₄ = Credit access.

3. Probit Model for Food Security

$$FS_i^* = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \epsilon_i$$

FS = 1 if food secure, FS = 0 if food insecure.

4. Cost-of-Calorie Approach

Food Security Line (Z) = 2260 kcal per person per day. Households with intake ≥ Z are food secure; otherwise food insecure.

Results and Discussion

The stochastic frontier analysis indicates a mean technical efficiency of 0.72, implying a 28 percent output gap attributable primarily to managerial and institutional inefficiencies rather than technological constraints. This aligns with poultry efficiency studies in developing economies where efficiency levels commonly range between 0.60 and 0.80 due to infrastructural and institutional limitations (Adene and Oguntade, 2006; FAO, 2019) [1, 4].

The inefficiency model shows that education, farming experience, extension access, and credit significantly reduce

production inefficiency, confirming the critical role of human capital, institutional support, and financial access in improving productivity. These findings are consistent with Battese and Coelli (1995) [2], who emphasized the importance of socioeconomic variables in explaining technical inefficiency.

Operational audit results reveal that 45 percent of controlled-environment units have faulty ventilation, leading to 12–15 percent mortality during peak dry seasons. Broilers are highly susceptible to heat stress due to limited thermoregulatory capacity, which reduces feed intake, growth rate, and immune response (Lara and Rostagno, 2013; FAO, 2013) [3, 6].

Feed analysis further identified a 20 percent crude protein deficit in budget-tier feeds used by 30 percent of farmers. Given that feed constitutes 60–75 percent of total production costs in Nigeria, nutrient imbalance significantly affects feed conversion ratio and growth performance (Adene and Oguntade, 2006; FAO, 2019) [1, 4].

Household food security analysis shows that 38.1 percent of broiler farming households remain food insecure despite market participation, reinforcing the commercialization–nutrition paradox documented in small-scale agricultural systems (World Bank, 2017; IFPRI, 2010) [5, 8].

Market analysis indicates that although proximity to urban markets saves approximately ₦150 per bird in logistics costs, intermediary dominance captures up to 40 percent of retail margins, significantly eroding farmer profitability. This reflects value chain inefficiencies and weak bargaining power commonly reported in West African livestock markets (Liverpool-Tasie and Winter-Nelson, 2012) [7].

Table 1: Frequency Distribution of Technical Efficiency Scores (N = 270)

Efficiency Decile	Frequency	Percentage (%)
0.91 – 1.00	38	14.1
0.81 – 0.90	62	23.0
0.71 – 0.80	95	35.2
0.61 – 0.70	45	16.6
< 0.60	30	11.1

Table 2: Determinants of Production Inefficiency (SFA Model)

Variable	Coefficient	T-Ratio	Significance
Education	-0.452	-3.21	***
Experience	-0.128	-2.15	**
Extension Access	-0.684	-4.89	***
Credit Access	-0.312	-2.45	**

Table 3: Food Security Status of Farming Households

Status	Headcount	Percentage (%)	Avg. Intake (kcal)
Food Secure	167	61.9	2450
Food Insecure	103	38.1	1840
Total/Mean	270	100.0	2145

Table 4: Risk Sensitivity and Impact Matrix

Scenario	Impact	Risk Level
20% Feed Price Increase	Food insecurity rises (38%–54%)	Critical
5% Disease Mortality	Net profit decreases by 18%	High
Urban Zoning Tax	22% farm non-viability	Moderate

Table 5: Policy Implementation Matrix

Action Item	Responsibility	Timeline	KPI
Solar Housing Retrofit	Ministry of Agriculture	< 6 Months	TE: 0.72 → 0.85
Micro-Credit for Women	Bank of Industry	Immediate	+15% Food Security Index
Urban Feed Subsidy	State Government	Seasonal	-20% Input Cost

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