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# Determinants of Technical Efficiency in Improved Indigenous Poultry Production: A Stochastic Frontier Analysis in Kebbi State, Nigeria

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***Abstract***
*This study used a stochastic frontier model to examine the factors that influence technical efficiency in enhanced indigenous poultry production in Kebbi State, Nigeria. Using a multistage sampling technique, primary data were gathered from 120 poultry farmers who were sampled. To estimate production efficiency and determine the socioeconomic factors influencing efficiency, the stochastic frontier approach was utilized. While other factors like flock size and breed type were not significant, the results showed that technical efficiency was significantly increased by purchased feeds, labor input, veterinary expenses, energy, and poultry housing. There is significant room for productivity improvement, as evidenced by the efficiency score distribution, which revealed that 51.7% of farmers operated within the 0.41–0.50 efficiency range and only 9.1% achieved efficiency above 0.71. Additionally, inefficiency was greatly decreased by having access to extension and credit services, while inefficiency was increased by being farther from input markets. Interestingly, local breeds were more adaptable to local conditions than improved breeds, as evidenced by their decreased inefficiency. The study finds that increasing efficiency requires better market access, institutional support, and resource management. In order to increase production and food security, it suggests bolstering credit programs, extension services, and infrastructure development while encouraging breeding initiatives that incorporate the adaptive qualities of regional and improved breeds.*

**Keywords:** Improved Indigenous Poultry, Stochastic Frontier Analysis, Technical Efficiency.

## Introduction

The raising of livestock is an essential part of Nigeria's agricultural economy, making a substantial contribution to rural incomes, household food security, and GDP. In particular, the production of poultry contributes significantly to the availability of reasonably priced animal protein, job opportunities, and cash income for millions of rural households [1]. Indigenous poultry systems continue to be the most popular among smallholder farmers due to their cultural significance, minimal input requirements, and capacity to adapt to hard settings. However, the slow growth, limited egg output, high sensitivity to illnesses, and tiny body size of traditional, unimproved indigenous poultry limit their commercial viability.

In Nigeria, improved indigenous poultry (IIP) strains have been introduced to solve these production issues. These birds have been deliberately bred to produce more meat and eggs while maintaining the adaptability and flexibility of local poultry. As a result, they are seen as a crucial means of establishing a connection between the intense commercial sector and conventional poultry agriculture. Because of their dual-purpose utility (meat and eggs) and ability to improve rural livelihoods, enhanced indigenous chicken are becoming more and more popular in Kebbi State, where smallholder poultry production is primarily conducted under extensive and semi-intensive systems. Smallholder productivity levels are still far below reachable frontier levels in spite of this potential [2].

A major contributing factor to the productivity gap is technical inefficiency, which is the incapacity of farmers to optimize a given set of inputs using current technology. The ability of producers to transform inputs like feed, labor, veterinary care, and capital into products like meat or eggs is known as technical efficiency. Low technical efficiency suggests that by merely enhancing resource utilization and management techniques, farmers might significantly boost output without the need for additional inputs. Designing successful interventions that can increase productivity, profitability, and food security thus requires an understanding of the extent of efficiency and its drivers.

In agricultural economics, stochastic frontier analysis (SFA) has been used extensively to quantify technical efficiency because it makes a distinction between inefficiency resulting from managerial or institutional issues and random shocks like disease outbreaks and weather unpredictability. SFA incorporates statistical noise to produce a more accurate assessment of efficiency. Furthermore, inefficiency effects model enables researchers to pinpoint institutional and socioeconomic elements that account for differences in farm efficiency, including education, experience, extension contact, credit availability, and biosecurity measures [3].

The output of IIC producers is still below expectations, notwithstanding their potential. Farmers often face challenges related to feed supply, veterinary care, poor husbandry practices, market access, and institutional constraints. These challenges not only affect output but also influence the technical efficiency (TE) of production. TE reflects the ability of farmers to maximize output from given inputs. Identifying the determinants of TE is critical for designing interventions that enhance resource use, improve productivity, and strengthen food security in the state [4].

Previous studies on poultry efficiency in Nigeria have shown that factors such as feed management, veterinary care, housing, and extension services significantly affect productivity. However, the majority of existing literature has focused on commercial broiler or layer systems, with limited attention paid to improved indigenous Poultry that are increasingly promoted as a climate-resilient and farmer-friendly alternative in Northern Nigeria. As a result, IIC producers frequently have low input utilization efficiency. Farmers are unable to boost output and fully utilize the technology that are available. However, there is a dearth of empirical study assessing the degree of inefficiency and pinpointing its causes in light of increased domestic poultry production in Kebbi State [5]. There is a knowledge gap regarding IIP producers because the majority of efficiency studies in Nigeria's poultry subsector concentrate on commercial broilers and layers. Policymakers and extension services lack the empirical basis necessary to create successful initiatives in the absence of such evidence. Furthermore, despite Kebbi State's strategic position as a major agricultural hub in Northwestern Nigeria, there are still few empirical studies that specifically examine the technical efficiency of IIP producers in the state.

Therefore, there is a need to assess the technical efficiency of IIP production in Kebbi State and to identify the socioeconomic, institutional, and management factors that explain variations in efficiency. This will help in formulating policies and extension strategies aimed at improving productivity, reducing rural poverty, and enhancing food security.

The main objective of the study is to analyze the determinants of technical efficiency in improved indigenous Poultry production in Kebbi State using a Stochastic Frontier Approach.

1. To identify the socioeconomic, and management factors influencing technical efficiency.
2. To identify the determinants of technical efficiency of improved indigenous Poultry producers in Kebbi State.
3. To examine the extent of productivity gaps and the potential output gains achievable through improved efficiency.

## Methodology

### Study Area

The research was conducted in Kebbi State, Northwestern Nigeria, Kebbi State is bordered by Sokoto, Zamfara, and Niger States, and shares an international boundary with the Republic of Benin. The state has 21 Local Government Areas (LGAs) with agriculture as the dominant livelihood activity. Poultry, especially indigenous Poultry, are kept by a majority of smallholder households under extensive and semi-intensive systems. The introduction of Improved Indigenous Poultry (IIP) has been promoted through government and development programs as part of strategies to improve rural incomes, food security, and nutrition.

### Sampling Technique and Sample Size

A multistage sampling technique was used to sample the respondents.

**Stage 1:** these involve a purposively sampling four (4) LGAs with high concentration of IIC producers (e.g., Birnin Kebbi, Argungu, Yauri, and Zuru).

**Stage 2:** involve a simple random sampling 3 - 4 villages from each sampled LGA.

**Stage 3:** simple random sampling of 15 smallholder households engaged in IIC production.

A total of about 120 IIP producers was surveyed to ensure sufficient statistical power for stochastic frontier analysis.

## Data Collection

A well-designed questionnaire was used to gather primary data, and it recorded crucial details about the factors that were input, such as the amount of feed, labor (both family and hired), veterinarian expenses, housing facilities, flock size, and capital inputs. Value of poultry production (meat and eggs) is a variable output. Age, gender, education, household size, farming experience, financing availability, extension contact, and poultry organization membership are examples of socioeconomic variables. Practices for biosecurity and management include immunization, disease prevention, housing standards, and feeding procedures. Disease outbreaks, death rates, and climate-related stressors (temperature and rainfall variations) are examples of shock indicators.

## Data Analysis

### Model Specification

The stochastic frontier production function (SFA) approach was used for determining technical efficiency in this study. There are two basic empirical approaches used to measure production efficiency i.e: mathematical programming techniques of estimating a frontier relationship usually referred to Data Envelopment Analysis (DEA) and econometric techniques that are either deterministic or stochastic. Following the pioneering work of [6]. The stochastic frontier approach incorporates a composed error structure with a one-sided inefficiency component and a two-sided symmetric random component [7].

The inefficiency component is used to obtain firm average efficiency with the random component picking up the effect of uncontrolled random shocks, such as statistical noise. Random error may not be zero even if a farm uses a best practice technique due to errors of measurement, weather and other factors.

This study uses the stochastic frontier approach model specification and distribution of the unknown variance of the efficiency component. We assume a modified Cobb Douglas specification and specify the following frontier production and inefficiency models that are variants of [8].

**The Stochastic Frontier Production Function is Specified As**

$Yi = f(Xi; \beta) \exp(Vi – Ui)$

**Where:**

Yi = output of the ith poultry producer (measured in Naira or physical units)

Xi = vector of input variables (day old chicks, water. feed, labor, veterinary, housing, flock size.)

β = vector of parameters to be estimated

Vi = two-sided random error term ($Vi \sim N(0, \sigma v^2)$)

Ui = one-sided error term representing inefficiency ($Ui \geq 0$)

The production function is presented as follows:

$\ln Yi = \alpha + \beta 1 \ln X1 + \beta 2 \ln X2 + \beta 3 \ln X3 + \beta 4 \ln X4 + \ldots\ldots B8 \ln X8 + \mu$;

Yi = represents the output of the ith poultry producer.

The input variables in the model include:

X1 = No. of day-old chicks

X2=quantity of water used in litres

X3 = Labour (man-days)

X4 = Quantity of poultry feed in kilograms

X5 = Quantity of vaccines (mls) administered

X6 = Quantity of energy used measured in amount of cash used

X7= Flock size (No. of birds kept for eggs)

X8=Production system (1=intensive, 2=semi-intensive, 3=free range)

**Factors That Influenced Technical Inefficiency of the Poultry Producers Were Specified as Follows**

$R = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \ldots \ldots + \beta n X n + e$

Where: R= Technical Efficiency

X1=Marital Status

X2=Gender of household head

X3=Age in years

X4= Education (No. of years of schooling)

X5=Experience in poultry production (No. of years)

X6= Main occupation of farmer

X7=Distance to the input market (Km)

X8=Distance to the output market

X9=Credit access

X10=Access to livestock extension services

## Results and Discussion

**Objective One**

**To identify the Socioeconomic Factors Influencing Technical Efficiency**

Table 1 shows the estimated coefficients of production inputs identifying factors that significantly
contributing to technical efficiency (TE) among poultry producers. Positive significant coefficients include Purchased feeds (0.215, $p<0.01$), labour days (0.173, $p<0.01$), veterinary cost (0.119, $p<0.01$), energy and water cost (0.088, $p<0.05$), and poultry housing (0.065, $p<0.05$) significantly influenced technical efficiency of poultry farmers. This implies that efficient feed utilization, adequate labor input, proper animal health management, and investment in poultry housing strongly determine output. These findings are consistent with, who found that feed, labor, and veterinary services were critical drivers of efficiency in livestock production. Similarly, emphasized that access to housing infrastructure and water significantly improved poultry productivity in developing countries [9,10].

This aligns with findings by, who observed that feed quantity, education level, drug expenses, and gender significantly affect poultry production efficiency in Nigeria. Similarly, recent studies indicate that better access to inputs (feeds, veterinary services) and effective Management Practices Enhance Technical efficiency.

**Table 1:** Stochastic Frontier Analysis

| Production factors (TE) | Coefficients (TE) | Std Error |
|---|---|---|
| Constant | 1.802 (0.000) | 0.466 |
| Total quantity of purchased feeds per month | 0.215 (0.000) | 0.036 |
| No of day-old chick | 0.009 (0.745) | 0.032 |
| Labour days spent in production | 0.173 (0.000) | 0.039 |
| Veterinary cost | 0.119 (0.002) | 0.040 |
| Flock size | -.061 (0.125) | 0.039 |
| Energy and water cost | 0.088 (0.018) | 0.037 |
| Poultry Housing | 0.065(0.021) | 0.028 |
| Improved birds | -0.017 (0.528) | 0.028 |
| Local birds | -0.022 (0.471) | 0.029 |

Source Field survey 2025

**Objective Two**

To identify the determinants of technical efficiency of improved indigenous Poultry producers in Kebbi State. Table reveals distribution of TE scores among improved indigenous poultry farmers in Kebbi State, showing that the majority (51.7%) fall within 0.41-0.50 efficiency while only 9.1% achieved efficiency levels above 0.71. This suggests that a large proportion of poultry farmers in Kebbi State are technically inefficient and could improve output by better resource allocation. The mean efficiency indicates room for substantial productivity gains if farmers adopt improved management practices. This suggests room for improvement in production techniques. Consistent with similar studies, low to moderate technical efficiency is common among smallholder poultry farmers, attributed to constraints like limited access to extension services and inputs. Strategies aimed at improving input quality, farmer training, and infrastructural support are needed to move farmers closer to the efficiency frontier. This distribution is consistent with studies such as, who reported that African smallholder poultry farmers often record efficiency scores below 0.60 due to limited access to modern inputs and poor managerial capacity. Similarly, showed that indigenous poultry farmers in West Africa operate below optimal efficiency, mainly due to credit and extension constraints.

**Table 2:** Distribution of Technical Efficiency Scores for Improved Indigenous Chicken Farmers.

| Efficiency levels | Frequency | Percentage |
|---|---|---|
| 0 - 0.40 | 9 | 7.5 |
| 0.41 - 0.50 | 62 | 51.7 |
| 0.51- 0.60 | 30 | 25 |
| 0.61 - .70 | 8 | 6.7 |
| 0.71 - .80 | 11 | 9.1 |
| TOTAL | 120 | 100 |

Source Field survey 2025

**Objective Three:** To examine the extent of productivity gaps and the potential output gains achievable through improved efficiency.

Table 3 identifies determinants of technical inefficiency. Significant inefficiency factors include Access to credit (-0.005, $p<0.05$) and extension services (-0.034, $p<0.05$) significantly reduced inefficiency, implying that financial and technical support enhances efficiency. Conversely, distance to input markets (0.045, $p<0.05$) increased inefficiency, while distance to output markets (-0.051, $p<0.01$) reduced inefficiency, possibly because proximity to competitive markets encourages efficiency. Local breed adoption (-0.020, $p<0.10$) also reduced inefficiency compared to improved breeds, suggesting that adapted indigenous breeds may perform better under prevailing local conditions. These findings support, who highlighted credit and extension services as key enablers of efficiency in small-scale poultry. Similarly, found that distance to markets increases inefficiency among Nigerian poultry farmers [11]. The role of indigenous breeds in reducing inefficiency corroborates, who reported that local breeds, though lower in productivity, adapt better to harsh conditions, thereby minimizing losses.

These findings mirror reports by evidencing that advisory services and credit access reduce productivity gaps and increase economic efficiency in agriculture. Reducing physical barriers and providing timely support to producers can enhance output gains achievable through improved efficiency.

**Table 3:** Determinants of Technical Inefficiency

| Inefficiency factors | Coefficients | Std Error |
|---|---|---|
| Gender of the household head | -0.025 (0.132) | 0.016 |
| Education of the household head | -0.005 (0.511) | 0.008 |
| Age of the household head | 0.150(0.456) | 0.201 |
| Marital status | 0.0005 (0.953) | 0.008 |
| Occupation of the household head | -0.008(0.458) | 0.011 |
| Access to credit | -0.005 (0.006) | 0.002 |
| Access to extension services | -0.034 (0.008) | 0.013 |
| Experience of the household head | -0.008 (0.302) | 0.008 |
| Improved Breed | -0.003(0.754) | 0.010 |
| Local Breed | -0.020 (0.072) | 0.012 |
| Distance to input market | 0.045 (0.010) | 0.017 |
| Distance to output market | -0.051 (0.002) | 0.016 |

Source Field survey 2025

## Summary and Conclusion

The study assessed the determinants of technical efficiency in improved indigenous poultry production in Kebbi State using a stochastic frontier model. Results revealed that purchased feeds, labor, veterinary costs, energy, and housing were the major factors significantly influencing technical efficiency. The distribution of efficiency scores indicated that over half of the farmers (51.7%) operated within 0.41–0.50 efficiency, with only 9.1%

achieving above 0.71, suggesting a large potential for productivity improvement. Determinants of inefficiency highlighted the importance of institutional support, as access to credit and extension services significantly reduced inefficiency, while greater distance to input markets increased inefficiency. Interestingly, local breeds reduced inefficiency compared to improved breeds, reflecting their adaptability to prevailing production conditions.

The findings demonstrate that poultry farmers in Kebbi State are operating below their potential efficiency frontier, mainly due to poor input management and limited institutional support. Improving feed management, veterinary care, and housing infrastructure is essential for boosting productivity. Furthermore, credit access, extension services, and market proximity remain critical for reducing inefficiency and unlocking output gains among improved indigenous poultry farmers.

## Recommendations

The study recommends strengthening input delivery systems and ensuring affordable access to quality feeds and veterinary services, expansion rural credit schemes and extension services tailored to poultry production. Provision of market infrastructure and road networks would reduce inefficiency associated with input access. Additionally, breeding programs should integrate local adaptive traits with improved breeds to balance productivity with resilience. Such measures will enhance farmers' technical efficiency, increase rural incomes, and contribute to food security in Kebbi State [12].

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