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RESEARCH

# Impact of Vertical and Horizontal Expansion on Employment Generation in the Egyptian Broiler Sector

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## Abstract

The Egyptian broiler sector constitutes a central component of national food security, yet the socio-economic consequences of its various expansion strategies remain inadequately quantified. This study investigates the differential impacts of vertical and horizontal expansion on employment generation, investment returns, and wage outcomes within the sector. Utilizing time-series data spanning 2000 to 2024, the analysis applies growth rate calculations alongside independent samples t-tests to assess the effectiveness of these expansion approaches. The results demonstrate that both vertical and horizontal expansion significantly enhance productive capacity and stimulate job creation. Horizontal expansion, on average, generates approximately 0.46 thousand additional jobs per year, accompanied by potential investment returns of EGP 5.93 million. In contrast, vertical expansion contributes around 0.34 thousand jobs annually, with associated investment returns of EGP 4.36 million. Despite these positive outcomes in productivity and employment, the analysis reveals that neither expansion model produces a statistically significant increase in aggregate wage levels. This finding showed a notable decoupling between sectoral productivity gains and labor compensation, suggesting that employment growth does not necessarily translate into improved worker earnings. These insights provide critical quantitative evidence for policymakers and sector stakeholders, emphasizing the importance of adopting integrated policy frameworks that not only promote production expansion but also incorporate labor market interventions.

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**Statement of Sustainability:** The present work supports sustainability by analyzing pathways for optimizing a key food production sector. By quantifying the employment and economic returns of different expansion strategies, this research provides evidence-based guidance for policies that enhance food security (SDG 2) and promote decent work and economic growth (SDG 8). The findings encourage efficient resource use and highlight the need for equitable benefit-sharing, contributing to poverty reduction (SDG 1) and fostering responsible consumption and production patterns (SDG 12) within a vital agricultural industry.

## 1. Introduction

The global agricultural sector stands at the forefront of ensuring food security for a growing world population, with poultry production playing an increasingly pivotal role in providing affordable and accessible protein (FAO, 2018). Strategies for enhancing agricultural output are broadly categorized into vertical expansion, which focuses on intensifying production within existing units, and horizontal expansion, which involves increasing the number of productive units. The choice between these strategies carries significant implications not only for production volumes but also for socio-economic outcomes such as employment and income distribution, particularly in developing nations (Hazell and Wood, 2008). While the economic benefits of agricultural growth are widely acknowledged, the mechanisms through which this growth translates into improved livelihoods for farm workers remain a complex and often under-examined area of research. This is particularly true in sectors characterized by informal labor markets and fluctuating production cycles, where productivity gains do not automatically lead to proportional increases in wages or job security (Davis and Lopez-Carr, 2010).

In Egypt, the broiler sector represents a cornerstone of the nation's food security apparatus and a significant contributor to the agricultural economy. Its strategic importance cannot be overstated, providing a buffer against food

inflation and contributing to rural livelihoods. The sector has successfully achieved self-sufficiency in white meat, a critical accomplishment for national stability. Recent data from 2024 underscores its scale, with national production reaching approximately 2.08 million tons against a domestic consumption of 1.47 million tons, yielding a surplus of 0.61 million tons. Economically, its contribution is substantial; the value of poultry meat production was estimated at EGP 242.46 billion, accounting for 71.36% of the total value of the poultry industry and nearly 40% of the total value of all animal production nationwide (Ministry of Agriculture and Land Reclamation, 2024). This economic weight signifies its potential as a major driver of rural employment and economic development, particularly in the context of rapid population growth and the need for sustainable job creation.

Despite these impressive figures, the sector is chronically hampered by its inability to operate at its full productive capacity, creating a significant and persistent gap between potential and actual output. This underutilization is not merely a production shortfall but translates directly into substantial foregone economic and social opportunities. In 2024, for instance, an estimated 297.24 million chickens represented untapped productive potential, which equates to a loss of approximately 0.297 thousand potential jobs, EGP 3.86 million in investment returns, and EGP 11.19 million in unrealized agricultural wages for that year alone (Ministry of Agriculture and Land Reclamation, 2024). This inefficiency stems from persistent economic constraints, including limited access to investment capital for modernization, fluctuating feed costs, cyclical disease outbreaks, and inadequate technological adoption, which collectively hinder the sector's ability to expand sustainably in response to Egypt's demographic growth.

A review of the existing literature on Egypt's poultry industry reveals a predominant focus on production economics, farm-level profitability, and the efficiency of resource use. Studies by El-Qadi (2020) and El-Naggar (2016) provided valuable insights into the optimal use of resources in animal production projects and the efficiency of poultry farms, respectively. Similarly, Abdel Salam et al. (2019) focused on the economics of production and marketing at a regional level. While these studies are crucial, they often stop short of connecting macro-level expansion strategies with national-level employment and wage outcomes. Other significant data sources, such as the statistical bulletins from CAPMAS (2000-2024), offer rich descriptive statistics but do not employ empirical models to test the relationships between growth and its socio-economic consequences. Consequently, a significant research gap persists. There is a notable lack of detailed empirical studies that quantitatively differentiate between vertical and horizontal expansion and measure their respective impacts on employment, wages, and investment returns within the Egyptian context. Without such a nuanced analysis, policies aimed at stimulating growth may inadvertently prioritize production gains without effectively translating them into sustainable employment or improved worker welfare, thereby missing key opportunities to align agricultural development with the Sustainable Development Goals (SDGs).

This study, therefore, aims to fill this gap by empirically investigating the differential impacts of horizontal and vertical expansion strategies on the Egyptian broiler sector. The central research question is: Do horizontal and vertical expansion significantly affect labor supply, investment returns, and wage levels within the sector? To address this, the study pursues two primary objectives: first, to assess the current productive status and quantify the magnitude of underutilized capacity by analyzing the gaps between potential and actual production over 25 years; and second, to model the potential for generating employment and economic returns through both expansion strategies, using time-series data from 2000 to 2024 to provide a robust empirical basis for policy recommendations.

## 2. Materials and Methods

This study employs a quantitative approach, integrating descriptive and inferential statistical analysis to investigate the impact of different expansion strategies on the Egyptian broiler sector. The methodology is structured to define the conceptual framework, detail the data sources, and outline the analytical models used to measure the effects.

### 2.1. Study Area and Data Sources

The study focuses on the broiler sector at the national level in Egypt. It is based on secondary time-series data spanning 25 years from 2000 to 2024. The data were meticulously compiled from a variety of official publications, primarily the annual *Poultry Wealth Statistics Bulletin* and the *Agricultural Income Bulletin* issued by the Economic Affairs Sector of the Egyptian Ministry of Agriculture and Land Reclamation. Additional demographic and consumption data were sourced from the *Annual Statistical Book* published by the Central Agency for Public Mobilization and Statistics (CAPMAS). This combination of sources provided the necessary longitudinal data on key variables, including total and

actual productive capacity (in millions of chickens), average annual agricultural worker wages, and national per capita consumption of poultry meat.

## 2.2. Theoretical and Conceptual Framework

The study's analytical framework is grounded in agricultural development theory, which distinguishes between two primary strategies for increasing agricultural output (Fayek, 2006). These concepts were operationalized for the broiler sector, and their potential socio-economic impacts were calculated using standard technical coefficients derived from established literature on the Egyptian agricultural sector, specifically from a foundational symposium on job creation in agriculture (Mansour and Shenishen, 1998).

### *2.2.1. Vertical Expansion*

Vertical expansion is defined as the intensification of resource utilization, particularly labor, within existing poultry production units. The objective is to enhance operational efficiency and close the gap between the actual productive capacity and the total potential capacity of the current infrastructure. The "surplus" or "wasted" capacity due to vertical underutilization was calculated as the difference between the total possible output (representing full utilization of existing farms) and the actual output for each year. This metric represents production, and by extension, the economic value lost due to operational inefficiencies.

### *2.2.2. Horizontal Expansion*

Horizontal expansion is defined as an increase in the number of broiler production units to meet rising market demand. This involves expanding the sector's agricultural resource base. For this study, the potential productive capacity for horizontal expansion was calculated based on the capacity needed to meet the recommended global average per capita consumption (approximately 17 kg/person/year), adjusted for Egypt's population and actual consumption rate for each year. The "surplus" or "wasted" capacity due to a lack of horizontal expansion was the difference between this calculated potential and the actual productive capacity. This metric represents the opportunity cost of not expanding the sector's physical base to meet food security targets.

### *2.2.3. Calculation of Socio-Economic Indicators*

The socio-economic impacts of the "surplus" capacity under both scenarios were quantified as follows:

- **Employment Opportunities:** Calculated based on the established technical coefficient that one sustainable job opportunity is created for every one thousand chickens in the surplus capacity.
- **Investment Return:** Calculated using a standard investment equivalent of EGP 13,000 for each potential job opportunity identified in the surplus capacity.
- **Wages:** Calculated by multiplying the number of potential employment opportunities by the average annual wage for an agricultural worker in the given year, providing an estimate of the total wage volume lost.

## 2.3. Analytical Models

The study utilized two primary statistical methods to analyze the data and test the research hypotheses. This dual approach allows for an examination of both long-term trends and the statistical significance of observed differences.

### *2.3.1. Growth Rate Model*

To estimate the annual rate of change for all variables (e.g., actual capacity, potential capacity) and their associated gaps over the 25 years, a semi-logarithmic growth rate model was employed. The parameters of the model were estimated using the Ordinary Least Squares (OLS) method, chosen for its robustness in time-series analysis. This model is well-suited for economic data that exhibits non-constant rates of change and is represented by the equation (Greene, 2020):

$$Ln(Yt) = a + b(t)$$

Where *Yt* is the value of the variable at time *t*, *Ln* is the natural logarithm, *a* is the intercept, *t* is the time variable, and the coefficient *b* represents the continuous growth rate. The annual percentage growth rate is derived from this coefficient, allowing for a standardized comparison of trends across different variables.

#### *2.3.2. Hypothesis Testing*

An Independent Samples t-test was used to compare the meaning of the key indicators under the "potential capacity" scenarios (both vertical and horizontal) versus the "actual capacity" scenario. The fundamental hypothesis tested was whether the difference between the means of potential and actual outcomes was statistically different from zero. This test determines if the observed gaps in average values of productive capacity, employment, investment returns, and wages are statistically significant or merely attributable to random variation within the data series. Levene's Test for equality of variances was first checked to confirm the homogeneity of variances, a key assumption for the t-test, ensuring the validity of the results (Greene, 2020).

## 3. Results and Discussion

This section presents a detailed analysis of the empirical findings. It begins with an in-depth examination of the vertical expansion scenario, followed by a parallel analysis of horizontal expansion. The section concludes with a comparative synthesis that integrates the outcomes from both models to draw broader policy implications.

### 3.1. Impact of Vertical Expansion: Intensifying Existing Capacity

The strategy of vertical expansion focuses on optimizing existing resources to close the gap between potential and actual production. This approach is critical for enhancing efficiency and sustainability without requiring new land or capital-intensive infrastructure.

#### *3.1.1. Trends in Productive Capacity and Economic Indicators*

The time-series data, as detailed in Table 1, reveal a sector in a state of continuous growth over the 25 years. The total potential productive capacity, representing full utilization of existing farms, averaged 1,000.18 million chickens annually, ranging from a low of 699.04 million in 2010 to a high of 1,730.65 million in 2022. In parallel, the actual productive capacity averaged 664.47 million, ranging from 382.59 million in 2008 to 1,433 million in 2021. This indicates a substantial and persistent efficiency gap averaging over 33%. The growth rate analysis presented in Table 2 provides a more nuanced picture. It shows that the actual productive capacity grew at a statistically significant annual rate of 4.0%, which notably outpaced the 2.4% annual growth in total potential capacity. This important finding suggests that the sector has been making gradual progress in improving its operational efficiency, likely driven by incremental technological adoption or improved farm management practices over the last two decades. The socio-economic indicators associated with this actual capacity also showed strong growth, with employment, investment returns, and wages growing at annual rates of 4.0%, 4.0%, and a remarkable 16.4% respectively. However, despite this positive relative trend, the absolute gap between what is currently produced and what could be produced with existing infrastructure remains the central challenge that vertical expansion aims to address. This gap is not static; its fluctuation over time reflects the sector's vulnerability to market shocks, disease outbreaks (such as Avian Influenza in the mid-2000s), and policy changes, highlighting the need for strategies that build resilience and promote consistent operational excellence.

Table 1. Estimation of employment, investment, and wages from vertical expansion (2000-2024).

| Years | Agricultural worker annual average wage (thousand pounds) | Total productive capacity (vertical expansion) | | | | Actual productive capacity | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | productive capacity that achieved vertical expansion (million chickens) | Employment opportunities generated by vertical expansion * (thousand employment opportunities) | Investment return generated by vertical expansion ** (million pounds) | Wages generated by vertical expansion*** (million pounds) | Productive capacity (million chickens) | Employment opportunities * (thousand employment opportunities) | Investment return** (million pounds) | Wages*** (million pounds) |
| 2000 | 2.86 | 831.47 | 0.83 | 10.80 | 2.38 | 445.69 | 0.45 | 5.80 | 1.28 |
| 2001 | 2.97 | 838.35 | 0.84 | 10.89 | 2.49 | 454.75 | 0.46 | 5.92 | 1.35 |
| 2002 | 3.11 | 857.38 | 0.86 | 11.14 | 2.67 | 628.14 | 0.63 | 8.16 | 1.95 |
| 2003 | 3.12 | 897.42 | 0.90 | 11.66 | 2.80 | 564.12 | 0.56 | 7.33 | 1.76 |
| 2004 | 8.22 | 922.92 | 0.92 | 12.00 | 7.59 | 505.5 | 0.51 | 6.58 | 4.16 |
| 2005 | 8.68 | 776.29 | 0.78 | 10.09 | 6.74 | 491.23 | 0.49 | 6.38 | 4.26 |
| 2006 | 9.14 | 972.04 | 0.97 | 12.64 | 8.88 | 462.34 | 0.46 | 6.01 | 4.22 |
| 2007 | 7.93 | 1008.43 | 1.01 | 13.10 | 7.99 | 440.15 | 0.44 | 5.72 | 3.49 |

Table 1. Continued...

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2008 | 8.63 | 763.92 | 0.76 | 9.93 | 6.59 | 382.59 | 0.38 | 4.98 | 3.31 |
| 2009 | 11.75 | 803.15 | 0.80 | 10.44 | 9.44 | 408.28 | 0.41 | 5.30 | 4.79 |
| 2010 | 14.54 | 699.04 | 0.70 | 9.09 | 10.16 | 443.16 | 0.44 | 5.76 | 6.44 |
| 2011 | 14.50 | 743.05 | 0.74 | 9.66 | 10.77 | 479.83 | 0.48 | 6.24 | 6.96 |
| 2012 | 18.23 | 828.33 | 0.83 | 10.76 | 15.09 | 512.98 | 0.51 | 6.67 | 9.35 |
| 2013 | 21.56 | 814.64 | 0.82 | 10.60 | 17.57 | 544.7 | 0.55 | 7.09 | 11.75 |
| 2014 | 22.16 | 864.34 | 0.86 | 11.23 | 19.15 | 577.82 | 0.58 | 7.51 | 12.81 |
| 2015 | 26.16 | 892.64 | 0.89 | 11.61 | 23.36 | 589.00 | 0.59 | 7.66 | 15.41 |
| 2016 | 27.81 | 898.82 | 0.90 | 11.69 | 25.00 | 576.96 | 0.58 | 7.50 | 16.05 |
| 2017 | 50.40 | 939.40 | 0.94 | 12.21 | 47.33 | 595.24 | 0.60 | 7.74 | 29.99 |
| 2018 | 53.86 | 940.45 | 0.94 | 12.22 | 50.63 | 600.44 | 0.60 | 7.80 | 32.32 |
| 2019 | 63.36 | 908.84 | 0.91 | 11.82 | 57.59 | 594.46 | 0.59 | 7.72 | 37.64 |
| 2020 | 49.06 | 908.38 | 0.91 | 11.80 | 44.55 | 622.96 | 0.62 | 8.10 | 30.56 |
| 2021 | 33.22 | 1722.35 | 1.72 | 22.39 | 57.20 | 1433.00 | 1.43 | 18.63 | 47.60 |
| 2022 | 37.30 | 1730.65 | 1.73 | 22.50 | 64.57 | 1432.81 | 1.43 | 18.63 | 53.45 |
| 2023 | 37.01 | 1719.32 | 1.72 | 22.35 | 63.62 | 1400.00 | 1.40 | 18.20 | 51.81 |
| 2024 | 37.68 | 1722.87 | 1.72 | 22.40 | 64.92 | 1425.63 | 1.43 | 18.54 | 53.73 |
| Average | 22.93 | 1000.18 | 1.00 | 13.00 | 25.16 | 664.47 | 0.66 | 8.64 | 17.86 |
| Min | 2.86 | 699.04 | 0.7 | 9.09 | 2.38 | 382.59 | 0.38 | 4.98 | 1.28 |
| Max | 63.36 | 1730.65 | 1.73 | 22.5 | 64.92 | 1433 | 1.43 | 18.63 | 53.73 |

Employment opportunities were estimated using technical coefficients, with one job opportunity allocated for every 1,000 chickens (Mansour and Shenishen, 1998). The investment return was calculated as the investment equivalent per job opportunity, estimated at 13,000 Egyptian pounds (Mansour and Shenishen, 1998). Wage size was determined by multiplying the estimated number of employment opportunities by the average worker wage. The data were obtained from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector (Poultry Wealth Statistics Bulletin, 2000–2024) and the Central Agency for Public Mobilization and Statistics (Annual Statistical Book, 2000–2024).

Table 2. Growth function estimation for vertical expansion indicators (2000–2024).

| Statement | | Equation | Mean | Determination Adjusted Coefficient ($R^2$) | (F) Value | Annual Rate Change (%) |
|---|---|---|---|---|---|---|
| Total productive capacity (vertical expansion) | Employment opportunities generated by vertical expansion (thousand employment opportunities) | Ln Yi= 6.553 + 0.024 $x_t$ (74.05)** (4.096)** | 1000.18 | 0.397 | 16.781** | 2.4 |
| | Employment opportunities generated by vertical expansion (thousand employment opportunities) | Ln Yi= -0.355 + 0.024$x_t$ (-4.044)** (4.093)** | 1 | 0.396 | 16.75** | 2.4 |
| | Investment return generated by vertical expansion (million pounds) | Ln Yi= 2.209 + 0.024 $x_t$ (25.18)** (4.102)** | 13 | 0.397 | 16.82** | 2.4 |
| | Wages generated by vertical expansion (million pounds) | Ln Yi= 0.789 + 0.148 $x_t$ (8.11)** (22.64)** | 25.16 | 0.955 | 512.88** | 14.8 |
| Actual productive capacity | Productive capacity (million chickens) | Ln Yi= 5.882 + 0.040 $x_t$ (50.98)** (5.199)** | 664.47 | 0.520 | 27.02** | 4 |
| | Employment opportunities (thousand employment opportunities) | Ln Yi= -1.023 + 0.040$x_t$ (-8.084)** (5.16)** | 0.66 | 0.516 | 26.63** | 4 |
| | Investment return (million pounds) | Ln Yi= 1.539 + 0.040 $x_t$ (13.34)** (5.195)** | 8.64 | 0.520 | 26.99** | 4 |
| | Wages (million pounds) | Ln Yi= 0.118 + 0.164 $x_t$ (1.334)** (27.56)** | 17.86 | 0.969 | 759.73** | 16.4 |

The variable lny^ represents the logarithmic values of productive capacity, available employment opportunities, return on investment, and wages in Egypt. The variable Xt denotes the time factor, with i=1,2,...,25. The adjusted $R^2$ indicates the adjusted statistical coefficient of determination, while FFF refers to the calculated F-value. The numbers in parentheses shown below the regression coefficients represent the calculated t-values. Statistical significance is denoted as follows: ** indicates significance at the 0.01 level, * indicates significance at the 0.05 level, and *n.s.* Denotes a lack of significance at either level (0.05 or 0.01).

### *3.1.2. The Economic Cost of the Vertical Capacity Gap*

The core of the vertical expansion analysis lies in quantifying the persistent gap between potential and performance. As detailed in Table 3, this "surplus" or "wasted" capacity fluctuated significantly, reaching its widest point in 2007 at 568.28 million chickens and its narrowest in 2002 at 229.24 million chickens. On average, the sector operated with an untapped productive capacity of 335.71 million chickens annually. This figure represents a substantial loss of economic

value and social opportunity. When translated into socio-economic terms, this underutilization equates to an average annual loss of approximately 0.34 thousand jobs and EGP 4.36 million in potential investment returns. The growth function analysis for this gap (Table 4) reveals a very slow and statistically marginal annual decrease of just 0.9% for productive capacity, employment, and investment returns. This sluggish pace of improvement suggests that, at the current rate, achieving full capacity utilization remains a distant goal, posing a significant challenge to meeting Egypt's food security needs efficiently and sustainably.

Perhaps the most alarming finding from this analysis is the divergent trend observed in the agricultural wage gap. While the production and employment gaps showed marginal, albeit slow, improvement, the gap between potential and actual wages widened at a substantial and statistically significant annual rate of 11.4% ($p < 0.01$). This indicates a clear decoupling of productivity and labor compensation. The implication is that even as farms gradually become more efficient and create a higher potential for value, the financial gains are not being proportionally passed on to the workers in the form of higher aggregate wages. The wage gap itself showed high volatility, ranging from a mere EGP 0.72 million in 2002 to a peak of EGP 19.95 million in 2019. This phenomenon, where productivity gains outpace wage growth, is a common challenge in many agricultural systems and points to structural issues within the labor market, such as a high prevalence of informal employment, a lack of collective bargaining power for workers, and wage-setting mechanisms that are not tied to productivity (Davis and Lopez-Carr, 2010). It suggests that simply improving farm efficiency will not, by itself, resolve issues of low agricultural wages.

Table 3. Vertical expansion impact on gaps in employment, investment, and wages (2000-2024).

| Years | Surplus productive capacity resulting from vertical expansion (million chickens)* | Surplus Employment opportunities resulting from vertical expansion (thousand Employment opportunities)** | Surplus investment resulting from vertical expansion (million pounds)*** | Change in wages resulting from vertical expansion (million pounds)**** |
|---|---|---|---|---|
| 2000 | 385.78 | 0.385 | 5.00 | 1.10 |
| 2001 | 383.60 | 0.383 | 4.97 | 1.14 |
| 2002 | 229.24 | 0.229 | 2.98 | 0.72 |
| 2003 | 333.30 | 0.333 | 4.33 | 1.04 |
| 2004 | 417.42 | 0.417 | 5.42 | 3.43 |
| 2005 | 285.06 | 0.285 | 3.71 | 2.48 |
| 2006 | 509.70 | 0.510 | 6.63 | 4.66 |
| 2007 | 568.28 | 0.568 | 7.38 | 4.50 |
| 2008 | 381.33 | 0.381 | 4.95 | 3.28 |
| 2009 | 394.87 | 0.395 | 5.14 | 4.65 |
| 2010 | 255.88 | 0.256 | 3.33 | 3.72 |
| 2011 | 263.22 | 0.263 | 3.42 | 3.81 |
| 2012 | 315.35 | 0.315 | 4.09 | 5.74 |
| 2013 | 269.94 | 0.270 | 3.51 | 5.82 |
| 2014 | 286.52 | 0.286 | 3.72 | 6.34 |
| 2015 | 303.64 | 0.304 | 3.95 | 7.95 |
| 2016 | 321.86 | 0.322 | 4.19 | 8.95 |
| 2017 | 344.16 | 0.344 | 4.47 | 17.34 |
| 2018 | 340.01 | 0.340 | 4.42 | 18.31 |
| 2019 | 314.38 | 0.315 | 4.10 | 19.95 |
| 2020 | 285.42 | 0.285 | 3.70 | 13.99 |
| 2021 | 289.35 | 0.289 | 3.76 | 9.60 |
| 2022 | 297.84 | 0.298 | 3.87 | 11.12 |
| 2023 | 319.32 | 0.319 | 4.15 | 11.81 |
| 2024 | 297.24 | 0.297 | 3.86 | 11.19 |
| Average | 335.71 | 0.34 | 4.36 | 7.31 |
| Min | 229.24 | 0.229 | 2.98 | 0.72 |
| Max | 568.28 | 0.568 | 7.38 | 19.95 |

The table indicators are defined as follows: (*) Surplus productive capacity resulting from vertical expansion, calculated as the difference between total productive capacity and actual productive capacity; (**) Surplus employment opportunities resulting from vertical expansion, calculated as the difference between the employment opportunities available for total productive capacity and those available for actual productive capacity; (***) Surplus investment resulting from vertical expansion, calculated as the difference between the volumes of investment in employment opportunities for total productive capacity and for actual productive capacity; and (****) Change in wages resulting from vertical expansion, calculated as the difference between the volumes of wages for employment opportunities for total productive capacity and for actual productive capacity. Data sources include the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, *Poultry Wealth Statistics Bulletin* (2000–2024), and the Central Agency for Public Mobilization and Statistics, *Annual Statistics Book* (2000–2024).

Table 4. Growth function estimation for the impact of vertical expansion (2000–2024).

| | Statement | Equation | Mean | Determination Adjusted Coefficient ($R^2$) | (F) Value | Annual Rate Change (%) |
|---|---|---|---|---|---|---|
| Effect of vertical expansion | Surplus productive capacity resulting from vertical expansion (million chickens) | Ln Yi= 5.917 - 0.009 xt (71.42)** (1.69-) | 335.71 | 0.073 | 2.887** | 0.9 |
| | Surplus Employment opportunities resulting from vertical expansion (thousand Employment opportunities) | Ln Yi= -0.992 - 0.009 xt (-11.96)** (1.69-) | 0.34 | 0.072 | 2.862* | 0.9 |
| | Surplus investment resulting from vertical expansion (million pounds) | Ln Yi= 1.573 - 0.009 xt (19.006)** (1.69-) | 4.36 | 0.072 | 2.863* | 0.9 |
| | Change in wages resulting from vertical expansion (million pounds) | Ln Yi= 0.154+ 0.114 xt (0.904) (9.98) ** | 7.31 | 0.804 | 99.611** | 11.4 |

The table notes are defined as follows: Ln ŷi represents the logarithmic values of productive capacity, employment opportunities, investment return, and wages in Egypt. Xt denotes the time factor, with i ranging from 1 to 25. Adjusted $R^2$ indicates the adjusted coefficient of determination, and F refers to the calculated F value. Numbers in parentheses below the regression coefficients correspond to the calculated t values. Statistical significance is denoted as (** ) for 0.01, (*) for 0.05, and n.s for not significant at either 0.05 or 0.01 levels. The Annual Rate of Change (%) represents the yearly growth or decline in the dependent variable, calculated as the value of the regression coefficient multiplied by 100 (Source: Table 3).

### *3.1.3. Statistical Significance of Vertical Expansion Impacts*

To validate the robustness of these observations, an Independent Samples t-test was conducted (Table 5). Levene's Test for equality of variances confirmed the assumption of homogeneity (F-values were not significant), validating the use of the t-test. The results confirm that the observed average gaps in productive capacity (mean difference = 335.71 million birds), employment opportunities (mean difference = 0.34 thousand jobs), and investment returns (mean difference = EGP 4.36 million) are not due to random chance but are highly statistically significant (p = 0.001). This provides strong empirical evidence that policies aimed at improving operational efficiency can yield substantial and predictable gains in production and job creation. In stark contrast, the t-test for the difference in wage volume, with a mean difference of EGP 7.30 million, was not statistically significant (p = 0.220). This is a critical result, as it statistically validates the observation made from the growth rate analysis: the benefits of intensification, while creating potential for more work and higher returns, stop short of the workforce and fail to translate into meaningful aggregate wage improvements. The system appears capable of generating more value, but is structured in a way that this value does not flow to labor, a finding with profound policy implications.

Table 5. T-test Analysis of the impact of vertical expansion (2000-2024).

| Statement | Equal variances assumed | | Equal variances not assumed | | | |
|---|---|---|---|---|---|---|
| | (F) Value | (F) Significant | Means Difference | (T) Value | DF | (T) Significant |
| Productive capacity (Million Chickens) | .0025 | .0875n.s | 335.71 | 3.52 | 48 | .0001** |
| Employment Opportunities (Thousand Employment Opportunities) | 0.028 | .0871n.s | 0.340 | 3.52 | 48 | .0001** |
| Investment Return (Million Pounds) | 0.024 | .0874n.s | 4.36 | 3.51 | 48 | .0001** |
| Wages (Million Pounds) | 2.402 | .0128n.s | 7.30 | 1.24 | 48 | 0.220n.s |

Where: n.s: not significant at any significance level (0.05, 0.01); (**): Significant at a significance level of (0.01), (Source: calculated from Table 1).

## 3.2. Impact of Horizontal Expansion: Expanding the Productive Base

The horizontal expansion strategy considers the potential for growth by increasing the number of production units to meet national food security goals, specifically the recommended per capita consumption of white meat. This model reflects the impact of new investments and the expansion of the sector's physical footprint.

### *3.2.1. Potential for Growth and Associated Economic Indicators*

The potential productive capacity under a horizontal expansion model, as detailed in Table 6, averaged a substantial 1,120.68 million chickens annually. This figure fluctuated significantly over the period, from a low of 795.73 million in

2019 to a peak of 1,873.67 million in 2022, reflecting changes in population, domestic consumption patterns, and global feed price volatility.

The growth analysis in Table 7 indicates that this horizontally defined potential capacity grew at a modest but significant rate of 1.6% per year. It is revealing that the sector's actual capacity grew faster (4.0%) than this potential. This suggests that while attracting new projects is important, the primary bottleneck in the sector may not be a lack of new investment opportunities, but rather the chronic underperformance and inefficiency of the vast number of existing farms, reinforcing the importance of the vertical expansion strategy as a complementary approach to achieve balanced and sustainable growth. The associated potential for employment under this scenario averaged 1.12 thousand jobs annually, with potential investment returns of EGP 14.57 million and wages of EGP 26.47 million, showcasing the immense scale of the opportunity.

Table 6. Estimated employment opportunities, investment returns, and wages resulting from horizontal expansion in the Egyptian broiler sector (2000–2024).

| Years | Average per capita consumption (kg/year) | Actual productive capacity (million chickens) | productive capacity that achieved horizontal expansion* (million chickens) | Employment opportunities generated by horizontal expansion ** (thousand employment opportunities) | Investment return generated by horizontal l expansion *** (million pounds) | Wages generated by horizontal expansion**** (million pounds) |
|---|---|---|---|---|---|---|
| 2000 | 445.69 | 7.30 | 1037.91 | 1.04 | 13.49 | 2.97 |
| 2001 | 454.75 | 9.50 | 813.76 | 0.81 | 10.58 | 2.41 |
| 2002 | 628.14 | 12.30 | 868.16 | 0.87 | 11.29 | 2.71 |
| 2003 | 564.12 | 11.20 | 856.25 | 0.86 | 11.13 | 2.68 |
| 2004 | 505.5 | 10.10 | 850.84 | 0.85 | 11.06 | 6.99 |
| 2005 | 491.23 | 9.00 | 927.88 | 0.93 | 12.06 | 8.07 |
| 2006 | 462.34 | 6.00 | 1309.96 | 1.31 | 17.03 | 11.97 |
| 2007 | 440.15 | 6.70 | 1116.80 | 1.12 | 14.52 | 8.88 |
| 2008 | 382.59 | 5.50 | 1182.55 | 1.18 | 15.37 | 10.18 |
| 2009 | 408.28 | 6.30 | 1101.71 | 1.10 | 14.32 | 12.93 |
| 2010 | 443.16 | 6.80 | 1107.90 | 1.11 | 14.40 | 16.14 |
| 2011 | 479.83 | 7.20 | 1132.93 | 1.13 | 14.73 | 16.39 |
| 2012 | 512.98 | 7.30 | 1194.61 | 1.19 | 15.53 | 21.69 |
| 2013 | 544.7 | 8.30 | 1115.65 | 1.12 | 14.50 | 24.15 |
| 2014 | 577.82 | 8.50 | 1155.64 | 1.16 | 15.02 | 25.71 |
| 2015 | 589.00 | 12.30 | 814.07 | 0.81 | 10.58 | 21.19 |
| 2016 | 576.96 | 8.20 | 1196.14 | 1.20 | 15.55 | 33.37 |
| 2017 | 595.24 | 12.70 | 796.78 | 0.80 | 10.36 | 40.32 |
| 2018 | 600.44 | 9.70 | 1052.32 | 1.05 | 13.68 | 56.55 |
| 2019 | 594.46 | 12.70 | 795.73 | 0.80 | 10.34 | 50.69 |
| 2020 | 622.96 | 13.30 | 796.26 | 0.80 | 10.35 | 39.25 |
| 2021 | 1433.00 | 15.40 | 1581.88 | 1.58 | 20.56 | 52.49 |
| 2022 | 1432.81 | 13.00 | 1873.67 | 1.87 | 24.36 | 69.75 |
| 2023 | 1400.00 | 14.00 | 1700.00 | 1.70 | 22.10 | 62.92 |
| 2024 | 1425.63 | 14.80 | 1637.55 | 1.64 | 21.29 | 61.80 |
| Average | 664.47 | 9.92 | 1120.68 | 1.12 | 14.57 | 26.49 |
| Min | 382.59 | 5.5 | 795.73 | 0.8 | 10.34 | 2.41 |
| Max | 1433 | 15.4 | 1873.67 | 1.87 | 24.36 | 69.75 |

The table notes are as follows: (*) Productive capacity achieved through horizontal expansion was calculated using the formula: (Actual productive capacity × the recommended global average per capita consumption of approximately 17 kg/person per year) divided by the average per capita consumption (Mansour and Shenishen, 1998). (**) Employment opportunities resulting from horizontal expansion were estimated using technical coefficients to provide sustainable employment, with one job generated per thousand chickens (Mansour and Shenishen, 1998). (***) Investment return on horizontal expansion was calculated based on the investment equivalent of each job opportunity, set at 13,000 Egyptian pounds (Mansour and Shenishen, 1998). (****) Wage volume from horizontal expansion was computed as the number of employment opportunities achieved multiplied by the average wage per worker. Data sources include the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, *Poultry Wealth Statistics Bulletin* (2000–2024) and *Food Balance Sheet* (2000–2024), the Central Agency for Public Mobilization and Statistics, *Annual Statistical Book* (2000–2024), and Table 1 in this research.

Table 7. Estimated growth function for the volume of employment opportunities, investment returns, and wages resulting from the horizontal expansion of productive capacities in the Egyptian broiler sector (2000–2024).

| | Statement | Equation | Mean | Determination Adjusted Coefficient ($R^2$) | (F) Value | Annual Rate Change (%) |
|---|---|---|---|---|---|---|
| (Horizontal expansion) | Employment opportunities generated by horizontal expansion (thousand employment opportunities) | Ln Yi= 6.776 + 0.016xt<br>(72.73)** (2.626)** | 1120.68 | 0.197 | **6.895 | 1.6 |
| | Employment opportunities generated by horizontal expansion (thousand employment opportunities) | Ln Yi= -0.131 + 0.016xt<br>(-1.417)** (2.64)** | 1.12 | 0.199 | 6.971** | 1.6 |
| | Investment return generated by horizontal expansion (million pounds) | Ln Yi= 2.433 + 0.016xt<br>(26.11)** (2.62)** | 14.57 | 0.197 | 6.890** | 1.6 |
| | Wages generated by horizontal expansion (million pounds) | Ln Yi= 1.012 + 0.141xt<br>(8.79)** (18.13)** | 26.49 | 0.932 | 328.94** | 14.1 |

Ln ŷi represents the logarithmic values of productive capacity, available employment opportunities, return on investment, and wages in Egypt. Xt denotes the time factor, with i ranging from 1 to 25. Adjusted $R^2$ refers to the adjusted coefficient of determination, and F indicates the calculated F value. Numbers in parentheses below the regression coefficients correspond to the calculated t values. Statistical significance is indicated as (** ) for 0.01, (*) for 0.05, and n.s for not significant at either 0.05 or 0.01 levels. The Annual Rate of Change (%) represents the yearly growth or decline in the dependent variable, calculated as the regression coefficient multiplied by 100. Data are sourced from Table 6 in this research.

Table 8. Estimated employment opportunities, investment returns, and wages resulting from the horizontal expansion of productive capacity in the Egyptian broiler sector (2000–2024).

| Years | Agricultural worker annual average wage (thousand pounds) | Total productive capacity For horizontal expansion | | | | Actual productive capacity | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | productive capacity that achieved horizontal expansion (million chickens) | Employment opportunities generated by horizontal expansion * (thousand employment opportunities) | Investment return generated by horizontal expansion ** (million pounds) | Wages generated by horizontal expansion*** (million pounds) | Productive capacity (million chickens) | Employment opportunities* (thousand employment opportunities) | Investment return** (million pounds) | Wages*** (million pounds) |
| 2000 | 2.86 | 1037.91 | 1.04 | 13.49 | 2.97 | 445.69 | 0.45 | 5.80 | 1.28 |
| 2001 | 2.97 | 813.76 | 0.81 | 10.58 | 2.42 | 454.75 | 0.46 | 5.92 | 1.35 |
| 2002 | 3.11 | 868.16 | 0.87 | 11.29 | 2.70 | 628.14 | 0.63 | 8.16 | 1.95 |
| 2003 | 3.12 | 856.25 | 0.86 | 11.13 | 2.67 | 564.12 | 0.56 | 7.33 | 1.76 |
| 2004 | 8.22 | 850.84 | 0.85 | 11.06 | 6.99 | 505.5 | 0.51 | 6.58 | 4.16 |
| 2005 | 8.68 | 927.88 | 0.93 | 12.06 | 8.05 | 491.23 | 0.49 | 6.38 | 4.26 |
| 2006 | 9.14 | 1309.96 | 1.31 | 17.03 | 11.97 | 462.34 | 0.46 | 6.01 | 4.22 |
| 2007 | 7.93 | 1116.80 | 1.12 | 14.52 | 8.86 | 440.15 | 0.44 | 5.72 | 3.49 |
| 2008 | 8.63 | 1182.55 | 1.18 | 15.37 | 10.21 | 382.59 | 0.38 | 4.98 | 3.31 |
| 2009 | 11.75 | 1101.71 | 1.10 | 14.32 | 12.95 | 408.28 | 0.41 | 5.30 | 4.79 |
| 2010 | 14.54 | 1107.90 | 1.11 | 14.40 | 16.11 | 443.16 | 0.44 | 5.76 | 6.44 |
| 2011 | 14.50 | 1132.93 | 1.13 | 14.73 | 16.43 | 479.83 | 0.48 | 6.24 | 6.96 |
| 2012 | 18.23 | 1194.61 | 1.19 | 15.53 | 21.78 | 512.98 | 0.51 | 6.67 | 9.35 |
| 2013 | 21.56 | 1115.65 | 1.12 | 14.50 | 24.05 | 544.7 | 0.55 | 7.09 | 11.75 |
| 2014 | 22.16 | 1155.64 | 1.16 | 15.02 | 25.61 | 577.82 | 0.58 | 7.51 | 12.81 |
| 2015 | 26.16 | 814.07 | 0.81 | 10.58 | 21.30 | 589.00 | 0.59 | 7.66 | 15.41 |
| 2016 | 27.81 | 1196.14 | 1.20 | 15.55 | 33.26 | 576.96 | 0.58 | 7.50 | 16.05 |
| 2017 | 50.40 | 796.78 | 0.80 | 10.36 | 40.16 | 595.24 | 0.60 | 7.74 | 29.99 |
| 2018 | 53.86 | 1052.32 | 1.05 | 13.68 | 56.68 | 600.44 | 0.60 | 7.80 | 32.32 |
| 2019 | 63.36 | 795.73 | 0.80 | 10.34 | 50.42 | 594.46 | 0.59 | 7.72 | 37.64 |
| 2020 | 49.06 | 796.26 | 0.80 | 10.35 | 39.06 | 622.96 | 0.62 | 8.10 | 30.56 |
| 2021 | 33.22 | 1581.88 | 1.58 | 20.56 | 52.55 | 1433.00 | 1.43 | 18.63 | 47.60 |
| 2022 | 37.30 | 1873.67 | 1.87 | 24.36 | 69.89 | 1432.81 | 1.43 | 18.63 | 53.45 |
| 2023 | 37.01 | 1700.00 | 1.70 | 22.10 | 62.92 | 1400.00 | 1.40 | 18.20 | 51.81 |
| 2024 | 37.68 | 1637.55 | 1.64 | 21.29 | 61.70 | 1425.63 | 1.43 | 18.54 | 53.73 |
| Average | 22.93 | 1120.68 | 1.12 | 14.57 | 26.47 | 664.47 | 0.66 | 8.64 | 17.86 |
| Min | 2.86 | 795.73 | 0.8 | 10.34 | 2.42 | 382.59 | 0.38 | 4.98 | 1.28 |
| Max | 63.36 | 1873.67 | 1.87 | 24.36 | 69.89 | 1433 | 1.43 | 18.63 | 53.73 |

(*) Employment opportunities were calculated using technical coefficients, with one job opportunity provided for every thousand chickens (Mansour and Shenishen, 1998). (**) Investment return was estimated based on the investment equivalent of each available job opportunity, set at 13,000 Egyptian pounds (Mansour and Shenishen, 1998). (***) Wage size was determined by multiplying the estimated available employment opportunities by the average worker wage. Data sources include the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Poultry Wealth Statistics Bulletin (2000–2024), the Central Agency for Public Mobilization and Statistics, Annual Statistical Book (2000–2024), and Tables 1 and 6 in this research.

### *3.2.2. Quantifying Horizontal Opportunity Cost*

The gap between the sector's actual output and its horizontal potential is even larger than the vertical gap. As shown in Table 9, this opportunity cost reached its zenith in 2006 at 847.62 million chickens and its nadir in 2021 at just 148.8 nadir in 2021 at just 148.88 million, indicating high volatility. On average, the annual production deficit of 456.21 million chickens represents a massive opportunity cost. In socio-economic terms, this translates into an estimated 0.46 thousand potential jobs and EGP 5.93 million in investment returns being lost each year. The trend analysis for this gap (Table 10) offers a more optimistic outlook compared to the vertical scenario. The gaps in productive capacity, employment, and investment returns close at a statistically significant annual rate of approximately 3.1%. This pace is notably faster than the 0.9% closure rate of the vertical gap, which could reflect the tangible impact of government incentives for new agricultural projects or increased private sector investment in recent years. However, the troubling pattern regarding wages repeats itself with stark clarity. The wage gap associated with this scenario, which averaged EGP 8.61 million annually, widened at a staggering and statistically significant rate of 9.3% per year. This confirms the systemic nature of wage stagnation, demonstrating that the issue persists regardless of whether growth is driven by intensifying existing farms or adding new ones. This finding strongly suggests that the factors suppressing wage growth are independent of the mode of production expansion and are more deeply embedded in the structure of the agricultural labor market itself.

Table 9. Horizontal expansion and its impact on employment opportunities, investment returns, and wages in the Egyptian broiler sector (2000–2024).

| Years | Surplus productive capacity resulting from horizontal expansion (million chickens)* | Surplus Employment opportunities resulting from horizontal expansion (thousand Employment opportunities)** | Surplus investment resulting from horizontal expansion (million pounds)*** | Change in wages resulting from horizontal expansion (million pounds)**** |
|---|---|---|---|---|
| 2000 | 592.22 | 0.590 | 7.70 | 1.70 |
| 2001 | 359.01 | 0.360 | 4.67 | 1.07 |
| 2002 | 240.02 | 0.240 | 3.12 | 0.75 |
| 2003 | 292.13 | 0.300 | 3.80 | 0.91 |
| 2004 | 345.34 | 0.340 | 4.49 | 2.83 |
| 2005 | 436.65 | 0.440 | 5.67 | 3.79 |
| 2006 | 847.62 | 0.850 | 11.02 | 7.74 |
| 2007 | 676.65 | 0.680 | 8.80 | 5.37 |
| 2008 | 799.96 | 0.800 | 10.40 | 6.91 |
| 2009 | 693.43 | 0.690 | 9.01 | 8.15 |
| 2010 | 664.74 | 0.670 | 8.64 | 9.67 |
| 2011 | 653.10 | 0.650 | 8.49 | 9.47 |
| 2012 | 681.63 | 0.680 | 8.86 | 12.43 |
| 2013 | 570.95 | 0.580 | 7.42 | 12.31 |
| 2014 | 577.82 | 0.580 | 7.51 | 12.81 |
| 2015 | 225.07 | 0.220 | 2.92 | 5.89 |
| 2016 | 619.18 | 0.620 | 8.05 | 17.21 |
| 2017 | 201.54 | 0.200 | 2.62 | 10.16 |
| 2018 | 451.88 | 0.450 | 5.87 | 24.34 |
| 2019 | 201.27 | 0.210 | 2.61 | 12.76 |
| 2020 | 173.30 | 0.180 | 2.25 | 8.50 |
| 2021 | 148.88 | 0.150 | 1.93 | 4.95 |
| 2022 | 440.86 | 0.440 | 5.73 | 16.45 |
| 2023 | 300.00 | 0.300 | 3.90 | 11.11 |
| 2024 | 211.92 | 0.210 | 2.76 | 7.98 |
| Average | 456.21 | 0.46 | 5.93 | 8.61 |
| Min | 148.88 | 0.15 | 1.93 | 0.75 |
| Max | 847.62 | 0.85 | 11.02 | 24.34 |

(*) Surplus productive capacity resulting from horizontal expansion, calculated as the difference between total productive capacity and actual productive capacity; (**) Surplus employment opportunities resulting from horizontal expansion, calculated as the difference between the employment opportunities available for total productive capacity and those available for actual productive capacity; (***) Surplus investment resulting from horizontal expansion, calculated as the difference between the volumes of investment in employment opportunities for total productive capacity and for actual productive capacity; and (****) Change in wages resulting from horizontal expansion, calculated as the difference between the volumes of wages for employment opportunities for total productive capacity and for actual productive capacity. Data sources include the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, *Poultry Wealth Statistics Bulletin* (2000–2024), the Central Agency for Public Mobilization and Statistics, *Annual Statistics Book* (2000–2024), and Table 11 in this research.

Table 10. Estimated growth function for the impact of horizontal expansion on employment opportunities, investment returns, and wages in the Egyptian broiler sector (2000–2024).

| | Statement | Equation | Mean | Determination Adjusted Coefficient ($R^2$) | (F) Value | Annual Rate Change (%) |
|---|---|---|---|---|---|---|
| Effect of horizontal expansion | Surplus productive capacity resulting from horizontal expansion (million chickens) | Ln Yi= 6.396 - 0.031 xt<br>(31.30)** (-2.23)* | 456.21 | 0.142 | **4.980 | 3.1 |
| | Surplus Employment opportunities resulting from horizontal expansion (thousand Employment opportunities) | Ln Yi= -0.511 - 0.030 xt<br>(-2.51)* (-2.23)* | 0.46 | 0.142 | **4.967 | 3 |
| | Surplus investment resulting from horizontal expansion (million pounds) | Ln Yi= 2.053 - 0.031 xt<br>(10.042)** (-2.23)* | 5.93 | 0.142 | **4.98 | 3.1 |
| | Change in wages resulting from horizontal expansion (million pounds) | Ln Yi= 0.633 + 0.093 xt<br>(2.37) * (5.197)** | 8.61 | 0.520 | **27.005 | 9.3 |

Ln ŷi represents the logarithmic values of productive capacity, employment opportunities, investment return, and wages in Egypt. Xt denotes the time factor, with i ranging from 1 to 25. Adjusted $R^2$ refers to the adjusted coefficient of determination, and F indicates the calculated F value. Numbers in parentheses below the regression coefficients correspond to the calculated t values. Statistical significance is indicated as (** ) for 0.01, (*) for 0.05, and n.s for not significant at either 0.05 or 0.01 levels. The Annual Rate of Change (%) represents the yearly growth or decline in the dependent variable, calculated as the regression coefficient multiplied by 100. Data are sourced from Table 9 in this research.

### *3.2.3. Statistical Significance of Horizontal Expansion Impacts*

The t-test results for the horizontal expansion scenario (Table 11) provide statistical certainty to these observations. Again, Levene's Test confirmed the homogeneity of variances. The analysis confirms that the average gaps in productive capacity (mean difference = 456.21 million chickens), employment opportunities (mean difference = 0.46 thousand jobs), and investment returns (mean difference = EGP 5.93 million) are all highly significant ($p < 0.001$). This empirically demonstrates that horizontal expansion is a powerful and viable strategy for boosting national production and creating jobs on a large scale. Yet again, and with striking consistency, the t-test for the difference in wage volume, with its mean difference of EGP 8.61 million, was not statistically significant ($p = 0.136$). The recurrence of this null result across two distinct analytical models is arguably the study's most powerful conclusion. It provides undeniable evidence that the economic mechanisms governing production growth and those governing aggregate wages operate independently within this sector.

Table 11. Results of t-test analysis (independent samples test) of the impact of horizontal expansion in the Egyptian broiler sector during the period (2000-2024).

| Statement | Equal Variances assumed | | Equal Variances not assumed | | | |
|---|---|---|---|---|---|---|
| | (F) Value | (F) Significant | Means Difference | (T) Value | Degrees of Freedom | (T) Significant |
| Productive capacity (Million Chickens) | 0.124 | $0.727^{n.s}$ | 456.21 | 4.97 | 48 | .0000** |
| Employment Opportunities (Thousand Employment Opportunities) | 0.130 | $0.720^{n.s}$ | 0.456 | 4.98 | 48 | .0000** |
| Investment Return (Million Pounds) | 0.124 | $0.726^{n.s}$ | 5.93 | 4.97 | 48 | .0000** |
| Wage (Million Pounds) | 0.908 | $0.345^{n.s}$ | 8.61 | 1.52 | 48 | $0.136^{n.s}$ |

n.s indicates not significant at any significance level (0.05 or 0.01), and (**) denotes significance at the 0.01 level. Data were calculated from Table 8.

## 3.3. Comparative Discussion and Synthesis of Findings

A direct comparison of the two expansion strategies reveals that horizontal expansion offers quantitatively greater potential for immediate socio-economic gains. The capacity to create a larger number of jobs (an average annual gap of 0.46 thousand vs. 0.34 thousand) and generate higher investment returns (an average gap of EGP 5.93 million vs. EGP 4.36 million) makes it a compelling policy choice, particularly in a national context of high rural unemployment and the need for economic growth. This finding suggests that while improving the efficiency of existing farms (vertical expansion) is crucial for long-term sustainability and resource optimization, fostering new investment in productive units (horizontal expansion) serves as a more direct and impactful engine for employment generation. This aligns with development

theories that prioritize new capital formation as a primary driver of economic growth and job creation (Moss, 2013). However, the defining narrative emerging from this research is the consistent, statistically robust failure of both expansion models to translate into higher aggregate wages for the agricultural workforce. This wage-productivity decoupling is a critical finding that fills a significant gap in the literature. While prior Egyptian studies have extensively analyzed production economics and farm-level profitability (El-Qadi, 2020; El-Naggar, 2016), this study provides empirical evidence of a systemic labor market issue. The implication is profound: policies that focus solely on production targets, whether through intensification or expansion, are likely to fall short of achieving inclusive growth. To make meaningful progress towards national development objectives and international commitments like SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth), agricultural expansion strategies must be integrated with proactive labor market policies designed to ensure that economic gains are shared more equitably. The visual summary presented in Figures 1 to 4 powerfully illustrates this central conclusion, showing large potential gains in production and employment juxtaposed with stagnant wages, thereby providing a clear graphical representation of the study's core findings.

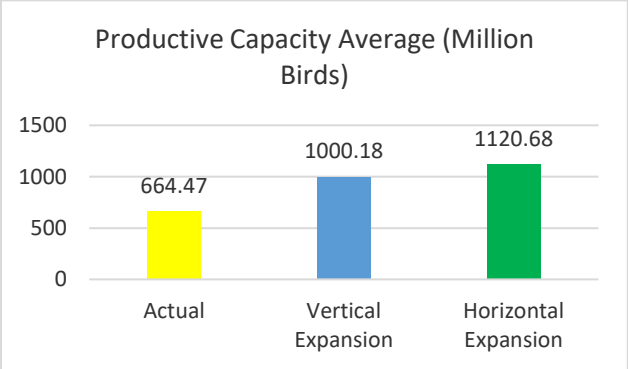


Figure 1. Productive Capacity by Scenario (Million Birds): potential increase in productive capacity under vertical and horizontal expansion strategies compared to the actual level.

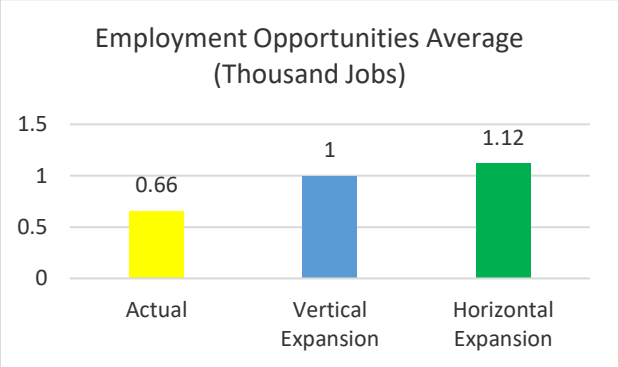


Figure 2. Employment Opportunities by Scenario (Thousand Jobs): estimated number of jobs that could be created under each expansion strategy relative to the current situation.

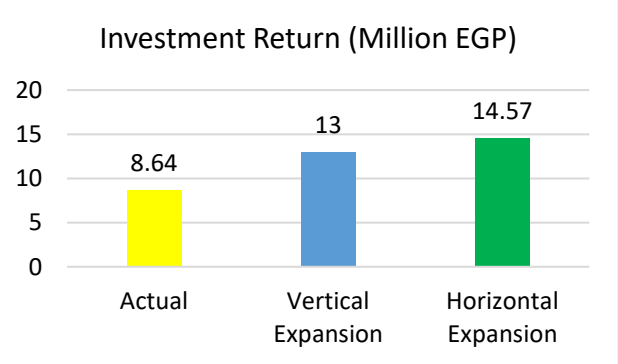


Figure 3. Investment Return by Scenario (Million EGP): investment returns improve when productive capacity is expanded vertically or horizontally.

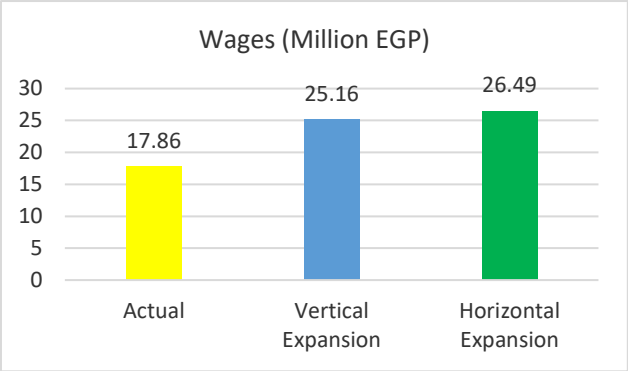


Figure 4. Wages by Scenario (Million EGP): average wage trends under the three scenarios, highlighting that wage changes are relatively limited despite expansion.

## 4. Conclusion

This study empirically demonstrates that while both vertical and horizontal expansion strategies in the Egyptian broiler sector hold significant potential for enhancing productive capacity, generating employment, and increasing investment returns, neither strategy, in isolation, leads to a statistically significant improvement in aggregate agricultural wages. The core conclusion is that production-focused expansion is insufficient to improve the economic welfare of the sector's workforce, likely due to underlying structural labor market limitations such as wage rigidities, informal employment, and a lack of collective bargaining power. The persistent and widening gap between potential production value and actual worker compensation underscores a critical disconnect that hinders the sector's ability to contribute to inclusive and sustainable development. Based on these findings, a dual-strategy policy approach is recommended. First, policymakers should implement programs that support the intensification and modernization of existing farms (vertical expansion) to optimize infrastructure, enhance resource use, and safeguard current jobs. Second, the government should continue to foster a favorable investment climate to encourage the establishment of new, modern production units (horizontal expansion), as this remains the most direct path to large-scale job creation, particularly in rural and newly reclaimed areas. Crucially, these production-focused initiatives must be complemented by targeted labor market reforms. These should include measures to encourage the formalization of labor contracts, the establishment of fair wage-setting mechanisms tied to productivity, and investment in vocational training programs to upskill the agricultural workforce. By adopting such an integrated strategy, Egypt can leverage the growth of its vital broiler sector not only to enhance food security but also to achieve its broader goals of inclusive and sustainable economic development.

**Author Contributions:** Conceptualization: Aziza Ibrahim Hussein; Methodology: Aziza Ibrahim Hussein; Software: Rania Rashad Abdel Nabi; Validation: Hossam Hosny Abdul Aziza; Formal Analysis: Aziza Ibrahim Hussein; Investigation: Hossam Hosny Abdul Aziza; Resources: Hossam Hosny Abdul Aziza; Data Curation: Aziza Ibrahim Hussein; Writing – Original Draft: Aziza Ibrahim Hussein; Writing – Review & Editing: Rania Rashad Abdel Nabi; Visualization: Hossam Hosny Abdul Aziza; Supervision: Rania Rashad Abdel Nabi; Project Administration: Aziza Ibrahim Hussein. The author has read and agreed to the published version of the manuscript.

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