**Egyptian Poultry Science Journal**

**http://www.epsaegypt.com**

**ISSN: 1110-5623 (Print) – 2090-0570 (On line)**

# EFFECT OF SEMI-CLOSED AND CLOSED HOUSING SYSTEMS ON LAYERS PRODUCTION AND ECONOMICAL PERFORMANCE.

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Received:18/08/2016 Accepted: 02/09/2016

**ABSTRACT:** This study was carried out to investigate two main table-egg production systems, semi-closed and closed and their effect on some productive traits of laying hens in Al-Sharkia governorate. Two commercial table-egg production farms were surveyed, one farm of semi-closed system named Ebrahemia and another farm of closed system was Salhia, both farms have layers flocks from Lohmann brown (L.B) strain. Completed three production cycles data from year 2011-2015 were obtained of each one and compared with others and with their standards. The comparison between Ebrahemia and Salhia farms with Lohmann brown strain under semi- closed and closed systems respectively, at age of 52 wks of production and also at the end of production cycle indicated that hens kept under closed system had significantly the best age (day) at 50% of production, mortality percentage, hen day %, hen housed egg number, while feed conversion (g / Egg) and hen housed percentage were also better under the closed system than the semi closed system but the differences were not statistically significant. In General, production efficiency coefficient value was significantly higher (364.79 and 326.13) for Salhia farm than Ebrahemia farm (286.94 and 274.12) at (52 wks and the end) of production cycle, respectively. Moreover, the economical study showed the significantly superiority of closed system‘s economical efficiency characters than the semi-closed, the efficiency of every spent pound was better in the closed system, while the difference of layer cost was not significant. Finally, results indicated that Lohmann brown layers showed more efficient production performance under closed system than semi- closed system in Al-Sharkia governorate.

**Key Words:** Housing systems, layers Performance, strain and Production Cycle.

## INTRODUCTION

At present more attention is focused on poultry production due to its remarkable development, poultry production has witnessed an increasing intensification in Egypt. During the 1990's, the poultry industries grew at around 8.7 percent (Taha, 2003) with over 17 billion L.E. investments in 2004. The poultry sector provides job opportunities for approximately 1.4 million employees when it is operational at its full potential (Maged Ossman & Hamdey EL Sawallhey, 2006).

Egg production systems in Egypt are classified into two main sectors a) the commercial sector with an annual production of 5.9 billion eggs ; b) the rural sector with an annual production of 2.1 billion eggs. (MALR, 2013). It's obviously that the larger production of Egyptian eggs belongs to the commercial system with a flock size up to 70000 laying hen, and the production system either in closed or open system. The closed system owned by companies, provides the optimum circumstances (temperature, ventilation, artificial lighting, cleaning and disinfection facilities) for the birds, it is managed more scientifically than the open one. The open system is an open sided house owned by individuals under very traditional management practices and the flock size is smaller than that in the closed system. Recently, there is a new system named "semi-closed" it's a mix between the closed and the open systems, and still yet not clearly classified or evaluated.

Collected data showed that full and actual capacity of table- egg production were significantly increased ($P \leq 0.01$), but not in the same rate, during the period from year 2002-2013 in AL-Sharkia governorate farms. (MALR, 2002- 2014) which means that the production performance of this farms was not enough to cover the gap between the full and actual capacity of table-egg production.

Therefore, this study was conducted to evaluate the effect of semi- closed and closed systems on layers production and economical performance.

## MATERIALS AND METHODS

### Data collection

Al-Sharkia is considered the first governorate in total table-egg production farm's number (526) with production of approximately 1.07 billion egg from 7.2 million hen in the year 2013 (MALR, 2014). A questionnaire assessing basic information at the farm was designed in accordance with a set of indicators which reflected the objectives of the study to describe the existing commercial poultry production systems. The data were obtained for total alternated three production cycles through weekly visits to the farms during the actual production period for the last cycle, and from production documents of the others. Data were obtained on overall productivity and feeding. The collected data included information about flock size, strain, performance, management, age at the beginning of the productive cycle, weekly feed consumption, weekly mortality rate, weekly egg production, age at 50% of egg production, manure disposal system, labour, economical efficiency characters, and bio-security.

**Measures:**

- The age at 50% egg production (day) calculated as (total eggs divided by hen number x 100) when achieved for each production cycle.
- Weekly Hen-Day (H.D %) egg production was calculated as (number of eggs produced during the 7 days ÷ number of live hens at the same period) x 100.
- Weekly Hen-House (H.H %) egg production was calculated as (number of eggs produced during the 7 days ÷ number of hens at the beginning of production period) x100.

- Average weekly feed consumption
- Weekly feed consumption (g) ÷ Number of live hens at the same period) ÷ 7
- Feed conversion or feed to egg ratios (g feed /1 egg) was calculated by the equation: Weekly feed consumption (g) ÷Weekly number of eggs produced.
- Productivity Efficiency coefficient (P.E.C) % was calculated by the equation of Abu-Ela (2007) as follow:

P.E.C = Viability % × egg number (H.D) ÷ production cycle (weeks) × Feed conversion.

- Total mortality % = Total died hens number per cycle ÷ Total hens number at beginning of cycle.
- Economical efficiency Characters (E.E) were declared by John & Orazem (1978) and Debertin (1986) as follow:
  - Net profit = total revenues – total costs.
  - Gross margin = total revenues – total variable costs.
  - Net profit / total fixed costs.
  - Total revenues / total fixed costs.
  - Total revenues / total variable costs.
  - Total revenues / total costs.
- Statistical analysis

Recorded data between 21weeks of age to the beginning of selling out the flocks were compared and analyzed by one-way ANOVA. Multiple Regression Analysis was performed using SPSS 20 software for windows with $P \leq 0.01$ and $P \leq 0.05$ considered statistically significant. The flowing statistical model was used according to Snedecor and Cochran (1981):

$x_{ij} = \mu + Li + e_{ij}$

Where:

$x_{ij}$ = an observation.

$\mu$ = the overall mean.

$L_i$ = the effect of factor housing system.

$e_{ij}$ = random error.

And the flowing statistical model was used for Stepwise Regression Analysis according to Wonnacott *et al* (1981):

$\hat{y} = a + b_i X_i$

Where as:

$\hat{y}$ = the amount of production.

$X_i$ = the amount of the user resource.

a, $b_i$ = constants.

- Graphic forms for the average of three production cycles per each farm were performed separately, using the regression equation in a linear form of the seventh degree through the production cycle in order to delete oscillations on the studied traits curves from the beginning of the egg lying to the end of production cycles through the Excel computer program.

## RESULTS AND DISCUSSION

### A – Production performance to 52 weeks of production.

Age (day) at 50% of production, mortality percentage, feed consumption per day (g) , feed conversion (g / egg), hen day ,hen housed, hen housed (egg number), production efficiency coefficient for Lohmann layers under semi-closed and closed system and it's standard at 52 weeks of production cycle are presented in Table (2).

Results showed that age (day) at 50% of production was lower in closed system than the semi-closed (156 and 176 day, respectively) and the both values were higher than the standard (150 days). Mortality percentage were significantly higher in semi-closed than closed system (20.12% and 13.84%, respectively) while the standard was 5% at the same age. Similar results were reported by El-Hossari, *et.al*. (1992), Zatar (1998) and Rayan, G.N. *et al* (2015). Barnett *et al*. (2001), Le-Bihan *et al* (2001) and Hameed *et al* (2012) indicated that birds under controlled housing condition showed lower mortality rate than others under traditional housing system.Feed consumption (g /hen /day) also significantly affected ($P \leq 0.01$) by housing system, it was (105.92, 119.24 and 115 g) for hens under semi-closed, closed systems and standard, respectively. The decrement of feed consumption for hens under semi-closed system could be due to the weakness of ventilator system of the farm. El-Attar, *et al* (1995) indicated that the average daily feed intake was (116.1 and 96.3 g / hen) for Lohmann Brown (L.B) and Hy-Line Wight - 36, respectively during the first 40 weeks of production.

Feed conversion (g /egg) for L.B strain seems to be not significantly affected by housing system. However, the hens under semi-closed system consumed less feed and give less production than others under closed system.Hen day percentage was significantly ($P \leq 0.01$) higher (77.67%) for hens under closed system than semi-closed system (71.28 %), but the both values was less than the standard (88.3 %). The same trend was found for hen housed percentage but differences were not statistically significant.

Hen housed egg number under semi-closed system was lower than closed system and standard by about (41.26 and 59.06 eggs) at 52 weeks of production. Zatar (1998) indicated that actual egg number was lower than standard by about (33.07 eggs / hen) for Lohmann Brown strain under semi-closed system. While Atallah (1997) reported that hen housed egg number during the production cycle was (227.12, 189.9, 172.21, 252.73, 258.32 eggs) for LSL, ISA Brown, Leghorn, Lohmann Brown and Hy-Line, respectively.

Production Efficiency Coefficient percentage was affected by housing system. That was significantly ($P \leq 0.01$) higher (364.79) for hens under closed system than others under semi-closed system (286.94). Studies of Lewis and Morris (2006); Ahlers *et al* (2009) indicated that improvement in housing system due to improvement in bird's welfare health.

### B- Production performance to the end of production cycle.

Table (3) showed the mortality percentage, feed consumption per day (g) , Feed Conversion (g / egg), hen day ,hen housed, hen housed (egg number), production efficiency coefficient for Lohmann layers under semi-closed and closed system and it's standard at the end of production cycle.Mortality percentage was significantly higher 23.95% in semi-closed system at 60.3 weeks of production than closed system 17.84 % at 54 weeks of production, while the standard was 6% at 60.3 weeks of production (Figure 1and 2), and of course these values were higher than others of 52 weeks of production, which means that mortality percentage

was significantly differed according housing system, this is agree with Rayan, G.N. *et al* (2015). Feed consumption (g /hen /day) also significantly affected ($P \leq 0.01$) by housing system, the lowest value was recorded for hens under semi-closed and the highest was for hens under closed systems, while the standard was 115 g (Figure 3and 4), highly significant ($P \leq 0.001$) relationships between all feed traits and temperature were found (Donald Bell 1998).Feed conversion (g /egg) for Lohmann Brown hens not significantly affected at the end of production cycle also by housing system, but slightly increases by advancing of age. The same trend was found by Yasmeen *et al*. (2008).

Hens under closed system showed significantly ($P \leq 0.01$) higher (77.34 %) hen day percentage than another under semi-closed system (70.87 %), while the standard was (85.7 % at 60.3 weeks of production) (Figure 6 and 5). Hen housed percentage at the end of production cycle was also significantly ($P \leq 0.05$) differed, but the differences were less than the hen day percentage values.

Even though the average of production cycles periods was longer in the semi-closed system by about 6.3 wks, but the hen housed egg number under closed system was higher by about (3.3 eggs) at the end of production. Production efficiency coefficient percentage was significantly ($P \leq 0.01$) affected by housing system and showed the differences between hen performance under semi-closed and closed system, the difference has reached to77.85% in favor of the closed system.

**C – Economical study**

The economical comparisons between semi-closed and closed systems were presented in Table (4). Results showed that both of Net profit and Gross margin were significantly higher for closed system than semi-closed system, (709863.8, 1242196.8 and 207931.4, 223979.6, respectively). Conversely, the total revenue / total fixed costs, was significantly ($P \leq 0.05$) lower for closed system than semi-closed system, that could be because the high values of fixed costs of closed system farms compared with traditional systems. While, the total revenue / total variable costs was significantly ($P \leq 0.05$) higher for closed system than semi-closed system (1.12 and 1.07 respectively). Zatar (1998) reported that average total revenue attributed to the total variable costs was (0.92 and 1.09) for table egg production of semi-closed and closed system farms respectively. Although, the hen cost per cycle was much more under closed system, but the efficiency of every spent pound (total revenue / total costs) was better (1.07) than semi closed system (1.06) and that is higher than values recorded by Zatar (1998).Finally, it could be concluded that Lohmann Brown hen's production and economical performance during 52 weeks of production and at the end of egg production cycle under closed housing system was significantly better than semi- closed housing system.

**Table (1):** Description of Ebrahemia and Salhia farms.

| Farm | Ebrahemia | Salhia |
|---|---|---|
| Housing system | Semi-closed | Closed |
| District | Al-Ebrahemia | El-Salhia El-Gadida |
| Belongs to | Co-operation sector | Governmental sector |
| Houses Num. | 2 | 6 |
| House area | 12 x 60 m | 12 x 80 m |
| Strain | Lohmann Brown | Lohmann Brown |
| Full capacity (hens) | 20,000 | 130,000 |
| Full capacity (eggs) | 5,000,000 | 30,000,000 |
| Battery type | Pyramid | Pyramid |
| Battery tiers | 2 vertical tier | 3 vertical tier |
| Cages per battery | 30 | 24 |
| Cooling system | Pad cooling and ventilators | Pad cooling and ventilators |
| pad cooling | In the front of both sides | In the front of both sides |
| Ventilators location | In the back | In the back and both sides |
| Ventilators Num. | 2 big | 9 big |
| Feeding system | Manually | Automatically (chain system) |
| Drinking system | Automatically | Automatically |
| Manure disposal | Manually | Automatically |
| Egg collection | Manually | Automatically |
| Lighting | Natural and artificial | Artificial light |
| Bio-security | Poor | Good |

**Table (2):** Some productive traits (Means ± SE) of Al-Sharkia farms as affected by housing system at 52 weeks of production.

| **Housing System** / **Farm** / **Strain** | **Semi-Closed** **Ibrahimia** **Lohman** | | **Closed** **Salhia** **Lohman** | | **Total** | **Standard** | **T (Differences)** |
|---|---|---|---|---|---|---|---|
| Trait | P.C. (wks) | ẋ ± S.E | P.C. (wks) | ẋ ± S.E | ẋ ± S.E | ẋ ± S.E | |
| Age/d at 50% of production | 52 | 176.0 ± 2.0 | 51.3 | 156.0 ± 6.0 | 166 ± 5.2 | 150 | 3.16* |
| Mortality % | | 20.12 ± 1.04 | | 13.84 ± 0.16 | 16.98 ± 1.2 | 5.00 | 2.34** |
| Feed Consumption g / hen /day | | 105.92 ± 0.91 | | 119.24 ± 0.63 | 112.54 ± 0.67 | 115 ± 0.0 | 11.93** |
| Feed Conversion g / egg | | 151.30 ± 3.11 | | 150.67 ± 2.36 | 150.99± 1.93 | ---- | 0.16 |
| Hen day % | | 71.28 ± 1.42 | | 77.67 ± 0.84 | 74.46 ± 0.85 | 88.3 ± 0.71 | 3.85** |
| Hen housed % | | 64.42 ± 1.29 | | 67.01 ± 0.72 | 65.71 ± 0.74 | ---- | 1.74 |
| Hen housed (egg number ) | | 234.34 ± 9.34 | | 275.60 ± 1.35 | 254.97± 11.25 | 293.4 | 3.46* |
| Production efficiency coefficient % | | 286.94 ± 16.94 | | 364.79 ± 2.51 | 325.87± 6.92 | ---- | 3.58** |

(**) $P \leq 0.01$ (*) $P \leq 0.05$ P.C: Production Cycle.

**Table (3):** Some productive traits (Means ± SE) of Al-Sharkia farms as affected by housing system at the end of production cycle.

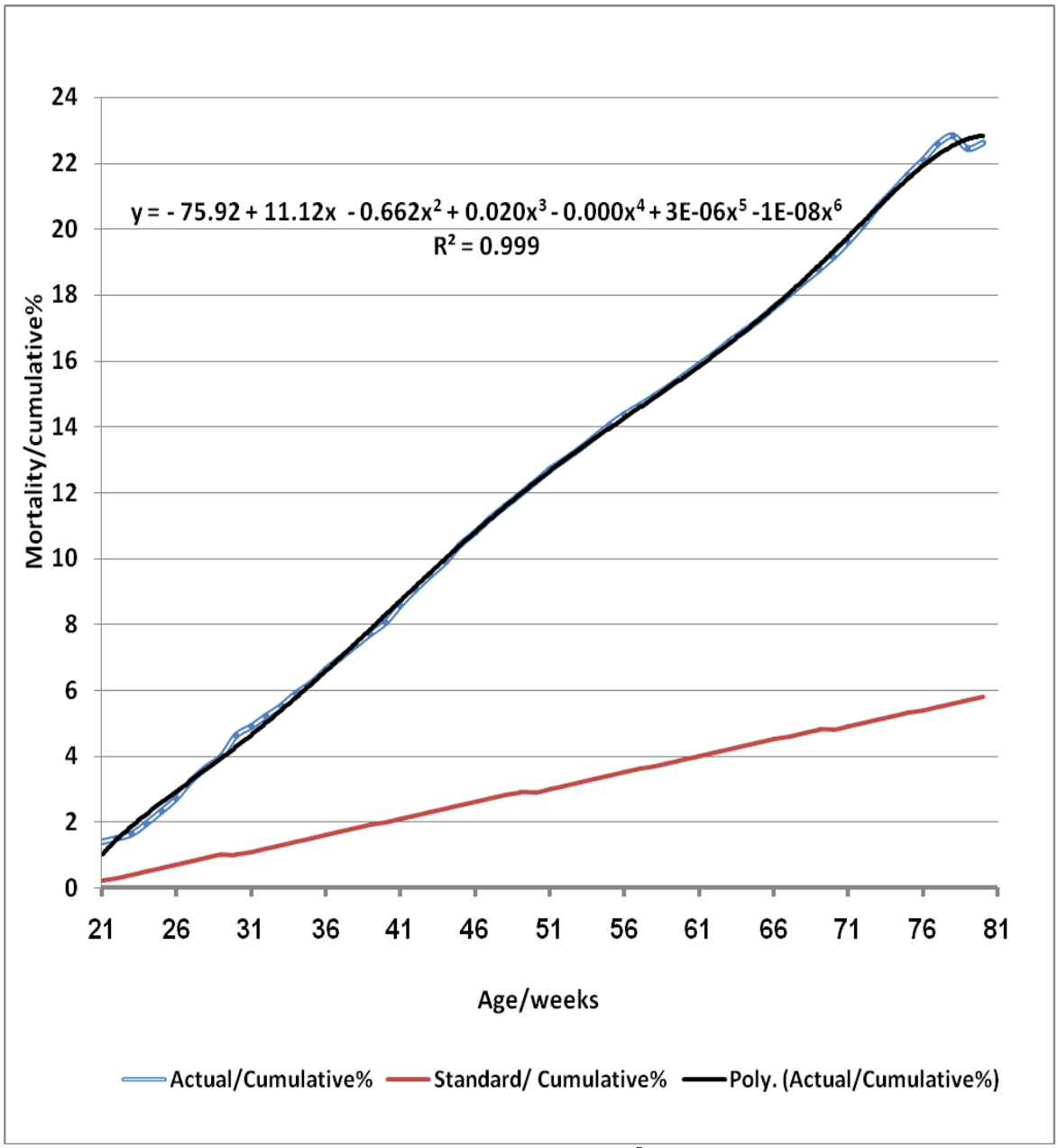
| **Housing System** / **Farm Strain** / **Trait** | **Semi-Closed** **Ibrahimia Lohman** | | **Closed** **Salhia Lohman** | | **Total** | **Standard** | **T (Differences)** |
|---|---|---|---|---|---|---|---|
| | **P.C. (wks)** | **ẋ ± S.E** | **P.C. (wks)** | **ẋ ± S.E** | **ẋ ± S.E** | **ẋ ± S.E** | |
| Age/d at 50% of production | 60.3 | 176.0 ± 2.0 | 54 | 156.0 ± 6.0 | 166 ± 5.2 | 150 | 3.16* |
| Mortality % | | 23.95 ± 0.67 | | 17.84 ± 0.50 | 20.89 ± 1.42 | 6.00 | 7.31** |
| Feed Consumption g / hen /day | | 107.04 ± 0.04 | | 119.01 ± 0.62 | 112.69 ± 0.6 | 115 ± 0.0 | 11.93** |
| Feed Conversion g / egg | | 152.26 ± 2.63 | | 151.23± 2.26 | 152.01± 1.8 | ---- | 0.16 |
| Hen day % | | 70.87 ± 1.23 | | 77.34 ± 0.81 | 73.93 ± 0.77 | 85.7 ± 1.08 | 3.85** |
| Hen housed % | | 63.12 ± 1.14 | | 66.42 ± 0.71 | 64.68 ± 0.69 | ---- | 1.74* |
| Hen housed (egg number ) | | 266.31 ± 18.67 | | 269.92 ± 22.55 | 268.12± 11.9 | 337.5 | 0.14 |
| Production efficiency coefficient % | | 274.12 ± 14.39 | | 326.13 ± 23.27 | 300.13± 9.43 | ---- | 2.16** |

(**) P ≤ 0.01 (*) P ≤ 0.05 P.C: Production Cycle.

**Table (4):** Average of some economical efficiency characters (Means ± S.E) of Ebrahemia and Salhia farms in Sharkia governorate from year 2011/2015.

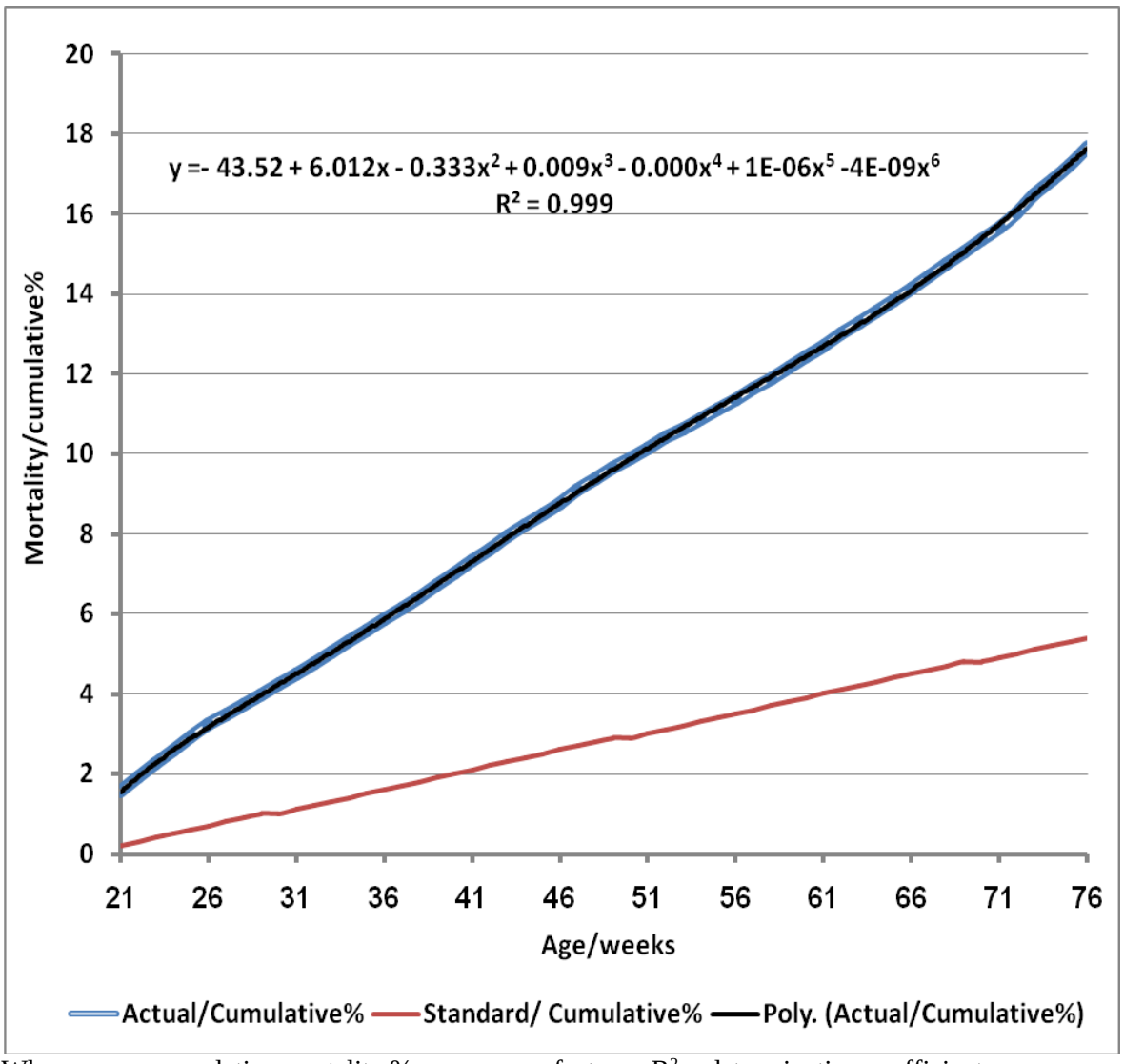
| **Farm** | **Ebrahemia** | **Salhia** | **T (Differences)** |
|---|---|---|---|
| **Housing System** | **Semi-closed** | **Closed** | |
| **Character** | **ẋ ± S.E** | **ẋ ± S.E** | |
| Net profit | 207931.4 ±62185.4 | 709863.8 ± 251748.3 | 2.9 * |
| Gross margin | 223979.6± 62638.4 | 1242196.8± 171114.3 | 7.1** |
| Revenue / total fixed costs | 6.1 ± 5.1 | 1.6 ± 0.8 | 0.7* |
| Revenue / variable costs | 1.07 ± 0.02 | 1.12 ± 0.02 | 1.37* |
| Revenue / total costs | 1.06 ± 0.02 | 1.07 ± 0.03 | 0.6 |
| Hen cost per cycle | 153.82 ± 11 | 157.5 ± 4.8 | 0.6 |

(*) $P \leq 0.05$ (**) $P \leq 0.01$



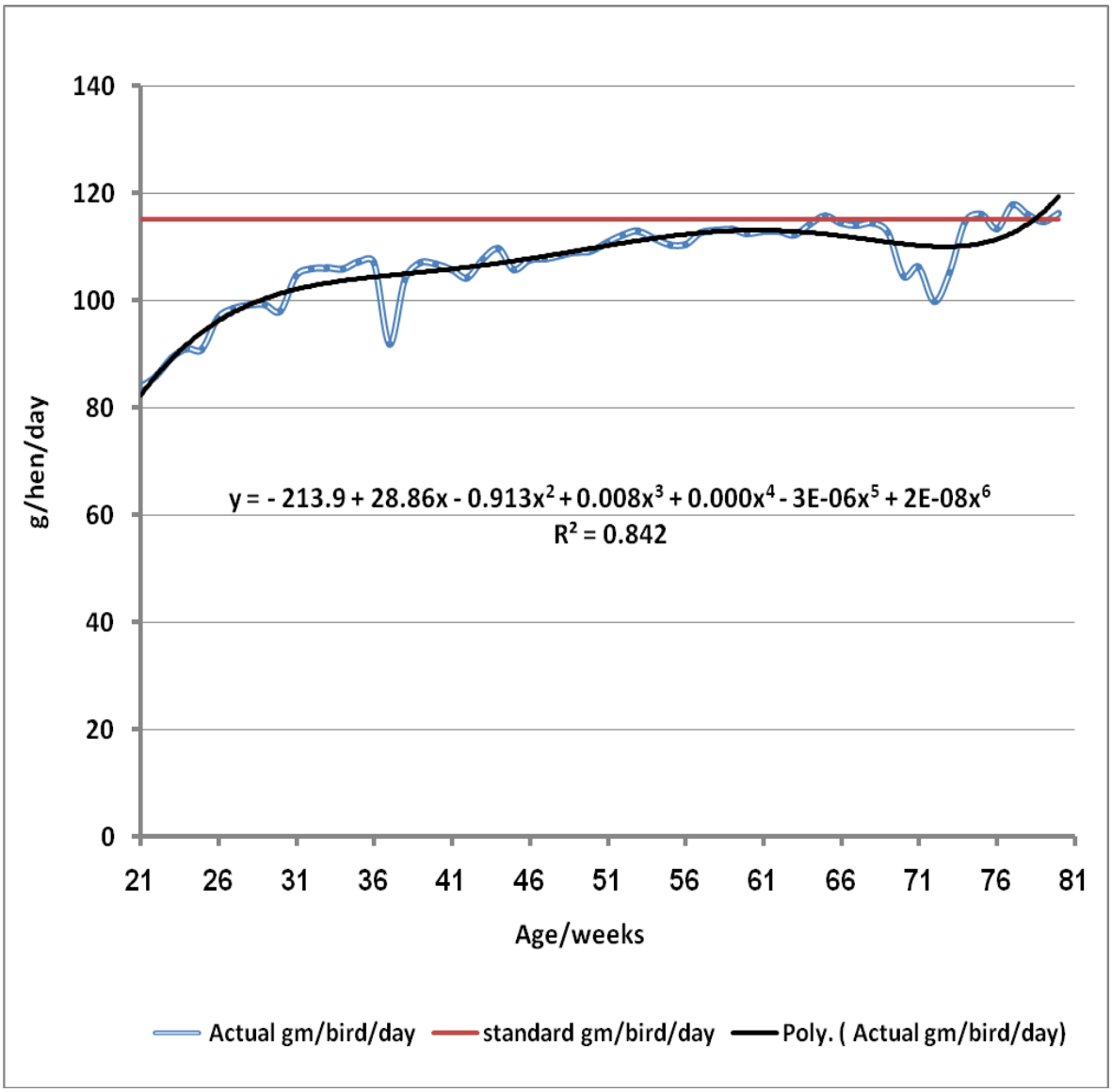

Whereas: y = cumulative mortality% x = age factor $R^2$ = determination coefficient

**Fig. (1):** Average of weekly cumulative mortality % for Ebrahemia farm compared with standard curve of Lohmannn Brown Strain.



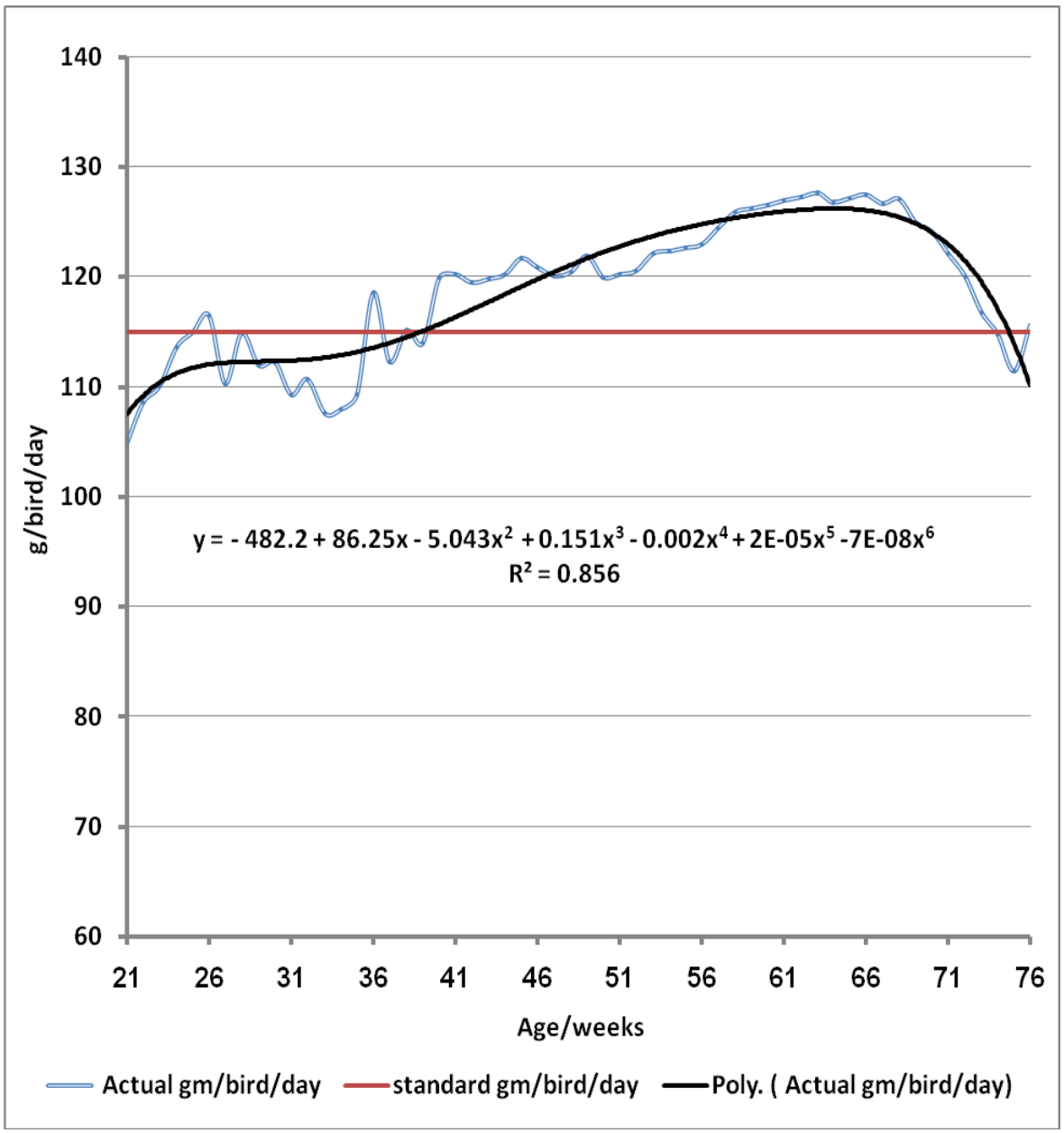

Whereas: y = cumulative mortality % x = age factor $R^2$ = determination coefficient

**Fig. (2):** Average of weekly cumulative mortality % for Salhia farm compared with standard curve of Lohmann Brown strain.



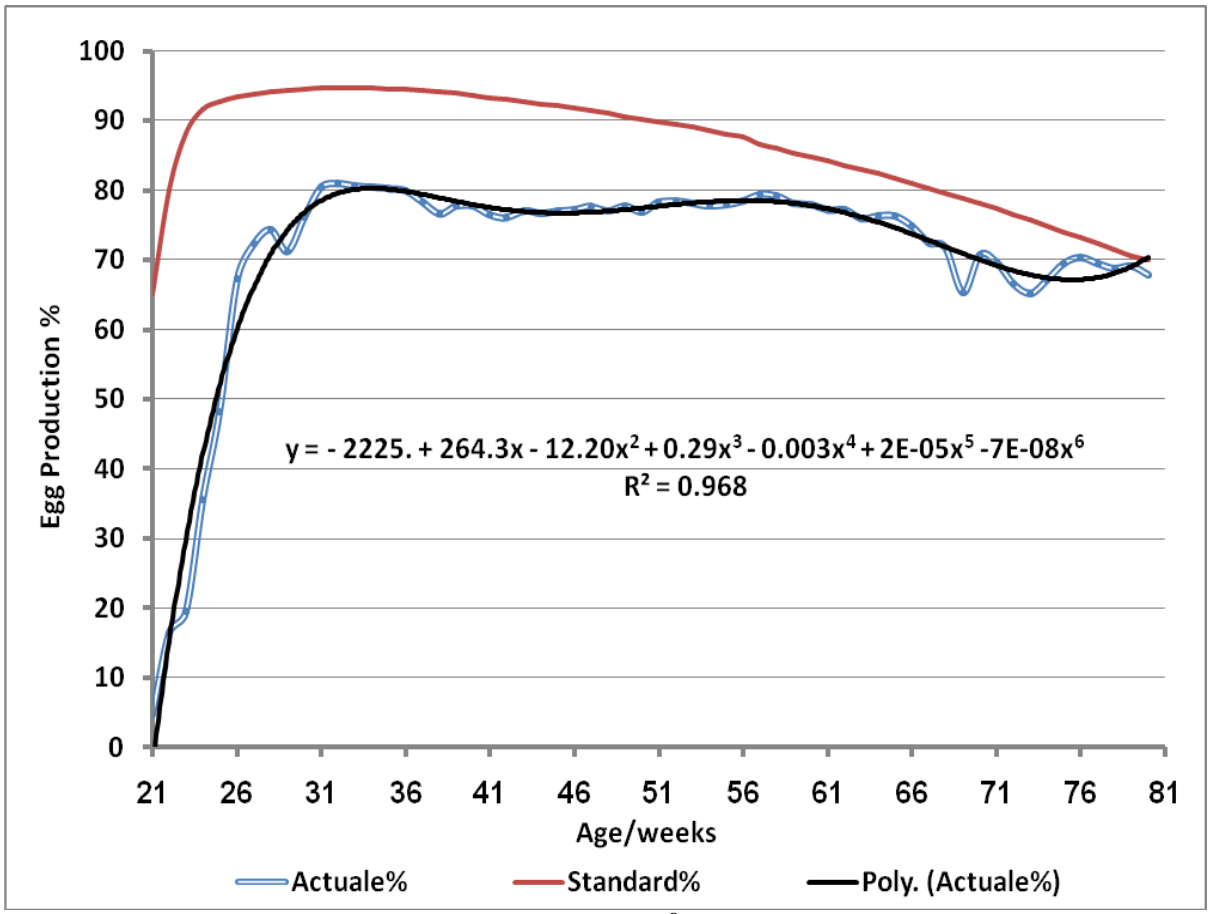

Whereas: y = feed consumption (g/hen/day) x = age factor $R^2$ = determination coefficient

**Fig. (3):** Average of weekly feed consumption for Ebrahemia farm compared with standard curve of Lohmannn Brown Strain.



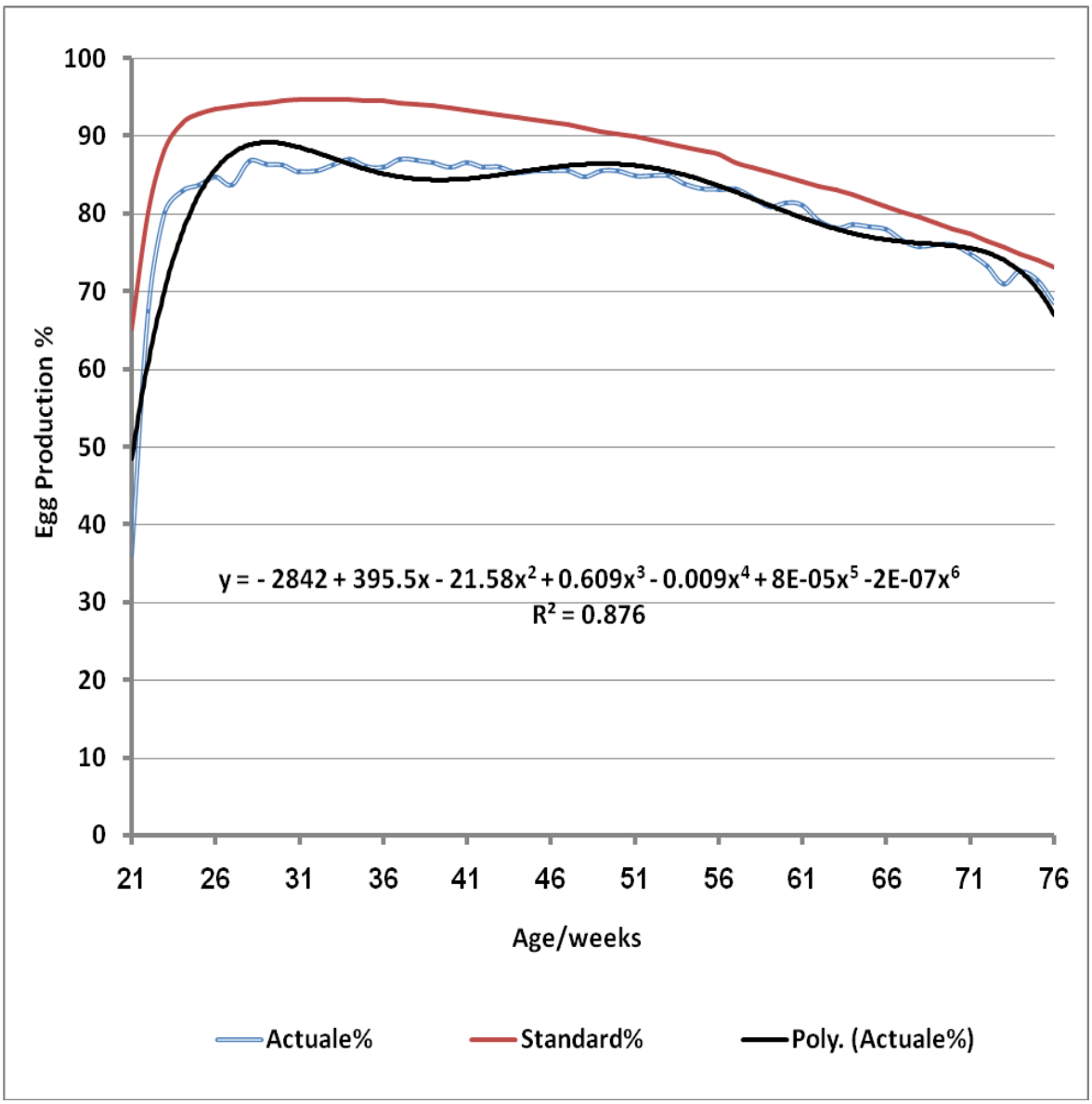

Whereas: y = feed consumption (g/hen/day). x = age factor. $R^2$ = determination coefficient

**Fig. (4):** Average of weekly feed consumption for Salhia farm compared with standard curve of Lohmann Brown Strain.




Whereas: y = Egg Production %. x = age factor. $R^2$ = determination coefficient.

**Fig. (5):** Average of actual weekly egg production % for Ebrahemia farm compared with standard curve of Lohmannn Brown Strain.




Whereas: y = Egg Production %. x = age factor. $R^2$ = determination coefficient.

**Fig. (6):** Average of actual weekly egg production % for Salhia farm compared with standard curve of Lohmann Brown strain.

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## الملخص العربى

### تأثير نظام الإسكان الشبه مغلق والمغلق على الأداء الإنتاجى والإقتصادى للدجاج البياض

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تم دراسة تأثير نظامى المسكن المغلق والشبه مغلق على الأداء الأنتاجى والإقتصادى للدجاج البياض من سلالة اللوهمان البنى خلال مرحلة انتاج البيض. وقد تم إجراء الدراسة على مزرعتين من مزارع الأنتاج التجارى لبيض المائدة بمحافظة الشرقية حيث أنها تعتبر المحافظة الأولى فى أنتاج البيض بجمهورية مصر العربية. حيث تم جمع البيانات الإنتاجية و الإقتصادية لآخر ثلاث دورات إنتاجية كاملة فى الفترة ما بين 2011وحتى 2015 لمزرعة الصالحية (نظام العنابر المغلقة) وكذلك مزرعة الإبراهيمية (نظام العنابر الشبه مغلق). وبمقارنة النتائج المتحصل عليها من كلا النظامين ببعضهما البعض وكذلك بالأداء القياسى لسلالة اللوهمان البنى حتى عمر 52 أسبوع أنتاجى وأيضا حتى نهاية الدورة وبيع القطيع ، وجد أن الدجاج المُسكن تحت ظروف العنابر المغلقة بمزرعة الصالحية كان افضل بصورة معنوية من الدجاج المُسكن تحت ظروف العنابر شبه المغلقة بمزرعة الإبراهيمية فى صفات العمر عند 50% من الإنتاج، نسبة النفوق، النسبة المئوية لإنتاج البيض (دجاجة / يوم) ، عدد البيض المنتج لكل دجاجة مسكنة وكذلك معامل الكفائة الإنتاجية. بينما كانت الفروق غير معنوية لكلاً من معامل التحويل الغذائى و النسبة المئوية لإنتاج البيض لكل دجاجة مسكنة، كما أن الأداء الإنتاجى الفعلى للدجاج فى كلا النظامين كان أقل من الأداء القياسى للسلالة لجميع الصفات المدروسة، وذلك خلال مرحلة 52 أسبوع أنتاجى وكذلك عند نهاية الدورة. أما من الناحية الإقتصادية فقد أظهر نظام الإسكان المغلق تقدما معنوياً على النظام شبه مغلق فى جميع مؤشرات الكفائة الإقتصادية رغم عدم معنوية الفرق بين تكلفة الدجاجة الواحدة تحت ظروف كلا النظامين. مما سبق يتضح أن الدجاج البياض من سلالة اللوهمان البنى المُسكن تحت ظروف العنابر المغلقة أظهر كفائة أنتاجية وإقتصادية أفضل عند مقارنتة بالدجاج المُسكن تحت ظروف العنابر شبه مغلقة.