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ENVIRONMENTAL MEASUREMENTS IN LAYING HENS HOUSES

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Abstract

Experiments were conducted in a farm in Mansoura during the period from June 2017 to October 2018, and the farm's capacity was 40,000 laying hens. The ideal environmental conditions needed for hens inside the closed houses such as air temperature, humidity, lighting for hours, air speed, to raise the higher rate of egg production and raise the rate of daily consumption of feed and reduce the mortality percentage, so measurements were used in the presence of ideal environmental factors and the absence of this ideal factors.The experiments aimed to determine the production capacity of the farm and the performance of laying hens, under measured and standard environmental conditions with the aim of increasing meat and egg production. Also, the environmental conditions were adjusted according to the ideal parameters to reduce the losses of feed and hen egg weight. The results revealed that the weekly growth in average weight of chickens approached the closest weekly increase of the standard weight of the herd breeding index to 244 g at the 24^{th} week. Weight homogeneity increased from 83% to 92% at week 24. The difference of the mean weekly egg weight from the mean egg weight of the standard egg was the closest between them at the twenty-fourth week, and the difference between them was 1.6 grams. The mortality rate then decreased to 0.1% at the 24^{th} week.

Key words: *poultry, environmental control, laying hens, egg, closed houses*

INTRODUCTION

The closed system in laying hens houses allows control of environmental factors such as humidity, temperature, number of hours of illumination and air speed have a direct impact on the percentage of eggs production, the rate of body weight increase, the rate of mortality and the spread of pathogens within the farm, so attention is needed to connect the climatic factors surrounding the bird to the standard level.

Over the last three decades, the poultry sector has grown at a rate of more than 5% per year and its proportion of global meat production has climbed from 15% three decades ago to 30% now. Local meat production was on average 1,454,856 tons during the period 2019, local egg production was 617,521 tons on average for the same period, according to (FAO, 2019) [8] .

DAFF (2011) suggested that Food production is a key 21st-century worldwide continuity challenge. The food and beverage industry accounts for 23% of world resource usage, 31% of acidifying emissions, and 18% of greenhouse gas emissions. Food consumption is expected to rise by 50% by 2050, and meat demand by 85%, according to the World Bank, due to the rising nations like China and India becoming wealthier and adopting Western-style eating habits heavy in meat and dairy products, where the productivity of Egypt in poultry meat recorded 1,454,856 ton in 2019 [4].

Linker et al. (2011) stated that the raising of domesticated birds, such as layers and broiler chicken in a small area is a big challenge. Poor management of the air conditioning systems could cause an excessive level of internal temperature and humidity, which could reduce poultry house productivity and result in severe consequences, such as lower feed conversion ratio, excessive energy consumption and accelerated mortality rate. Thus, new technologies, equipment, as well as new control methods, are still required to meet the target for the sustainable development of chicken production [15] .

David Farrell (2013) reviewed that Poultry meat and eggs are readily available, relatively affordable, and can play a critical role in meeting important nutritional deficiencies, particularly among the poor. [9].

Hosny (2006) suggest that Poultry production plays a major role in providing a large and cheap source of animal protein in Egypt. Eggs are the major business outputs in commercial table egg production and the higher egg production the better will be the profit. The layers usually start laying at about 20 weeks of age and peak of egg production is attained during the first production cycle (at about 32 weeks). The average production rate of commercial layers usually remains very close to 0.9 eggs per day. However, as the age increases, their egg production decreases. Egg production is a dependent variable and is influenced by several factors like strain, hen age, feeding, mortality, culling, health and management practices [13].

Scanes (2007) reported that he production of major poultry products (meat and eggs) has been quickly increasing across the world. This indicates consumption, which is based on customer demand for these high-quality items as well as the comparatively low price due to manufacturing efficiency. Between 1995 and 2005, consumption, and hence output, increased. The global percentage of chicken meat increased by (53%), duck meat by (67%), turkey meat by (13%), goose meat (53%), chicken eggs (39%) and other eggs (27%). The value added to chicken products, whether it is food processing and restaurants or alternative production techniques that attract higher pricing, is not taken into account in poultry production figures [16].

FAO (2013) pointed out that the chicken industry is one of the most rapidly developing and resilient of all animal industries. Because of the enormous demand for it, it has increased and spread across nations of all income levels during the last fifteen years. It accounts for around 80% of chicken stock in low-income food-deficit nations and contributes considerably to:

(1)producing income and modest savings, particularly for women, therefore increasing resilience to shocks and lowering economic vulnerability.

(2)supplying organic manure for vegetable gardens and agricultural production

(3)improving human nutrition by supplying high-quality nutrients and micronutrients in food (eggs and meat); and reducing food waste. Beyond its economic and nutritional value, the social, cultural, and religious aspects of village poultry farming have been generally acknowledged as important to smallholder livelihoods [7].

Gerber et al. (2013) showed that the global demand for chicken meat and chicken eggs is forecast to grow by 61%, and 39%, respectively, between 2005 and 2030. However, many studies have warned that increasing livestock production could cause environmental problems, particularly exacerbating global warming, also the global poultry supply chains contribute GHG emissions of 0.6 Gg CO^2-eq/year, representing eight percent of the livestock sector emissions [11].

Undesa (2015) found that the cumulative population growth is increasing at a much faster rate than food supply in all parts of the world. According to the United Nations, The main challenge facing the agricultural sector is not so much growing 70% more food in 40 years, but making 70% more food available on the plate [17].

Ekram et al. (2018) pointed out that the annual per capita share of chicken and poultry meat increased from approximately 8.6 kg/year in 2010 to about 12.83 kg/year in 2016, but poultry meat self-sufficiency fell from about 97.1 percent in 2010 to about 94.1 percent in 2013. Imports of chicken meat grew from around 24 thousand tonnes in 2009 to nearly 37 thousand tonnes in 2014 [1].

Dozier et al. (2001) Early in life, the chick is poorly equipped to regulate its metabolic processes to adequately control its body temperature. As a result, the young chick is dependent on environmental temperature to maintain optimal body temperature. Indoor air temperature is one of the most important environmental factors because, maintaining the correct air temperature is crucial in chicks brooding, especially during the first 7 to 10 days of the chick's life. [5].

Lacy et al. (2003) stated that the furnaces produce warmth by producing heated air. This means that the floor must be warmed from hot air, which can require a long period since hot air rises, the forced-air furnace is more difficult to manage than pancake or radiant brooders for two primary reasons [14].

Czarick et al. (2005) mentioned that If litter moisture content exceeds 30%. this limit, ammonia was released. This means at higher moisture content leads to diffusion of ammonia [3].

Cobb Broilers Guide (2008) It is reported that, at placement floor temperatures should be at least 32°C with forced-air heating the heat source in heating the house with forced air furnace, it was found that a 10˚C, the difference between also floor and ceiling was problematic from a heating cost and chick performance [2].

Fairchild et al. (2012) confirmed that the temperature and relative humidity should be stabilized for at least 24 h prior to chick arrival. litter cackling can occur during the first week brooding should be at 34 ºC floor temperature and to decrease about 3 ºC every week until the cycle end reaching 24 ºC. If the air relative humidity is below 50%, litter would be too much dry, and if air relative humidity is above 70% [6].

Ghoname and Fouda (2015) mentioned that the indoor air temperatures decreased as the broiler age increased throughout the living cycle, during the first stage of brooding, the recommended floor temperature was 34°C at the first day of chick's life and reduced gradually until reached 30°C at the end of brooding stage [12].

Fouda and Kassab (2020) mentioned that during these last decades, the production of poultry meat increased from 54 to 112 million tons, its share in total meat production. Incubators need to maximize chick production, and this entails not only the incubation of more fertile eggs [10].

A lot of problems facing laying hens affect the health of laying hens and the high level of ammonia and the spread of pathogenic agents inside the houses, reflecting that the environmental factors do not meet the standard level at which laying hens produce their highest level of production.

The main objectives of this study were to e evaluate the effect of variation between environmental measurements and ideal parameters in closed system of laying hens housing.

MATERIALS AND METHODS

Experiment was carried out through 2019/2020 in Gamasa, Dakahlia Governorate, Egypt. The capacity of the farm was 40,000 laying hens.

A sample of 500 chicken was used, and its characteristics are given in Table (1).

The sample is characterized by the presence of two reproductive periods, the first of which is 24 weeks of age for chickens, called the breeding period, and the second has a period of 40 weeks, which is the period of production.

Table 1. Cobb characteristics

Breeder	Performance
Age at depletion	65 weeks
Age at 5% production	24 weeks
Total eggs / hen housed	181.3 %
Hatching eggs / hen housed	176.3 %
Peak hatchability	90 %
Cumulative hatchability	85.6 %
Broiler chicks / hen housed	150.9 %
Livability from 24 weeks	92.3 %

Source: Cobb Broiler management guide, www.Cobb.com.

Work was carried out in farm with a closed system for the production of eggs. consists of 6 floors, each floor has two houses without side dimensions (25 m wide x 150 m), the dimensions of the house (55 m x 12.5 m x 3 m) with a nominal capacity of 4,000 chickens in the production period, the house system is dark for breeding. The drinking system was used on three per line, containing 17 pieces, the length of the piece is 3 meters, and each piece has 12 nipples, one of which is sufficient for 10 birds. The heating system on an air-driven heater. A ventilation system with a circulating air for 44,000 m^3/h was used, and the feeding system is a closed floor chain feeding system.

A mathematical equations was used to calculate the production capacity of the farm, the amount of feed for poultry, egg productivity and the mass of the resulting eggs, which are:

-Hen-Day Egg Production (HDEP)

$$HDEP = \frac{\text{Total number of eggs produced during the period}}{\text{Total number of hen} - \text{days in the same period}} * 100$$

-Feed efficiency (Feed conversion ratio – FCR)

$$\text{FCR (per kg egg mass)} = \frac{\text{Kg of feed consumed}}{\text{Kg of egg produced}}$$

-Feed efficiency per dozen eggs

$$\textbf{FCR (per dozen eggs)} = \frac{\textbf{Kg of feed consumed}}{\textbf{Total eggs produced}} * \textbf{12}$$

-Net Feed Efficiency Index (NFEI) is calculated using egg production, egg weight, feed consumption, and body weight increase

$$NFEL = \frac{(EM + BW) * 100}{FC_S}$$

where:

EM = Mean egg mass in g during a specific period.

BW = Mean body weight gain or loss in g during a particular period.

FC = Mean Feed consumption/hen in g during a particular period.

RESULTS AND DISCUSSIONS

The laying body weight and age

Figure 1 depicts the connections between the average weight of the bird in grams and the age of the laying hens every week for the duration of the research period, and it was discovered that the average body weight is directly related to the age of the bird. The average body weight of the bird has progressively risen with age, from 145 g in the first week to 4,624 g at the conclusion of the cycle. The typical bird's average weight grew from 145 g in the first week to 4,260 g at the conclusion of the cycle.

A linear relationship was obtained between the laying body weight and age as presented below.

Actual: y = 74.364x + 761.07 $R^2 = 0.8635$

Target: y = 66.218x + 812.23 $R^2 = 0.8628$

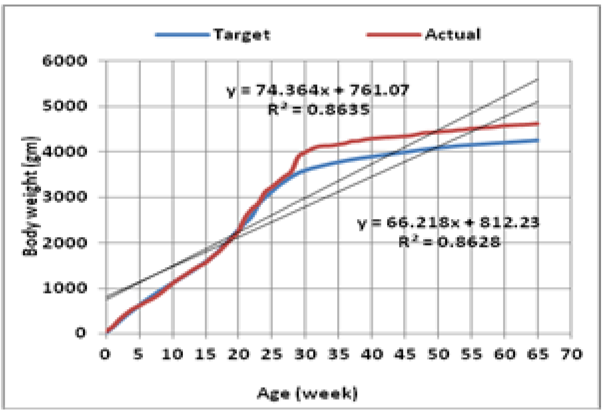

Fig. 1. Body weight of laying hens with age per week.
Source: Authors' determination.

The age of the bird and the amount of mass gained weight

Figure 2 depicts the relationship between the age of laying hens every week and the mass gained in grams throughout the research period. It was discovered that during the breeding period the mass gained increases at a rate greater than the production period, as it gains 99 grams in the first week, while it only gains 13 grams at the end of the cycle, and the largest mass gained in the twenty-ninth week is 318 grams.

A linear relationship was obtained between the age of the bird and the amount of mass gained weight.

y = -2.4315x + 150.67 $R^2 = 0.4237$

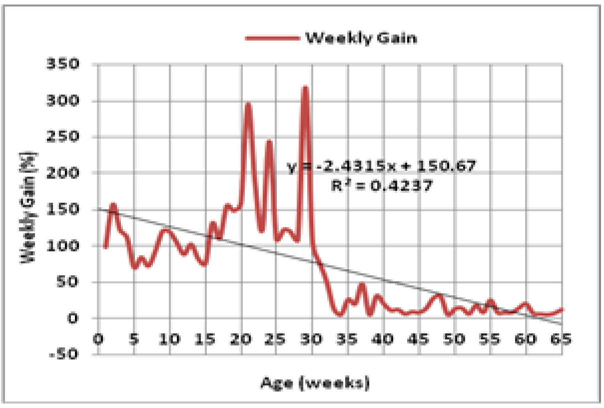

Fig. 2. Weekly gain weight with age per week.
Source: Authors' determination.

Bird age and uniformity ratio

Figure 3 depicts the relationship between the age of laying hens each week and the percentage of weight uniformity throughout the research period. the range of optimal weight uniformity is between 90 % and 110 %. it was discovered that during the breeding period, the percentage of weight uniformity is 83% in the first week, while the percentage of uniformity is in the twenty-fifth week, it reached 92%, and the highest percentage of uniformity reached by the farm was 97%.

A linear relationship was obtained between bird age and uniformity ratio:

$y = 0.1823x + 90.71$ $R^2 = 0.1422$

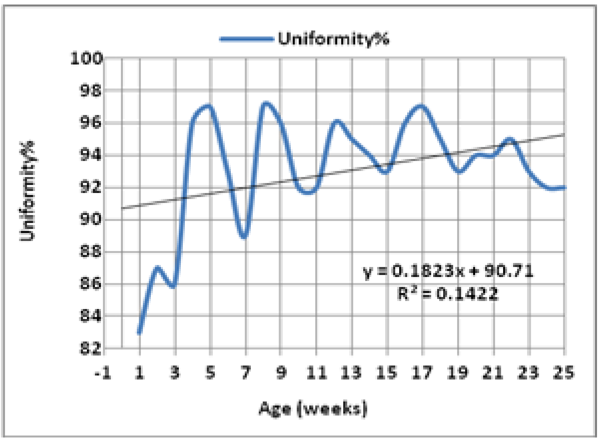

Fig. 3. Body weight of laying hens with age per week.
Source: Authors' determination.

Feeding laying hens

Figure 4 depicts the average amount of feed provided to laying hens weekly and calculated in grams.

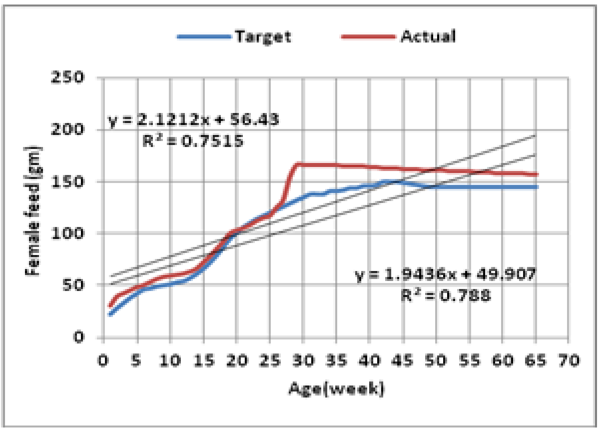

Fig. 4. Female feed per (gm) with age per week.
Source: Authors' determination.

It was noticed that the standard quantity in the first week begins with 22 gm in Figure 5 and increases to 145 gm at the end of the cycle, whereas the actual average amount of feed provided to each bird begins with 30 gm and increases to 157 gm at the end of the cycle.

A linear relationship was obtained between depicts the average amount of feed provided to laying hens weekly.

Actual: $y = 2.1212x + 56.43$ $R^2 = 0.7515$

Target: $y = 1.9436x + 49.907$ $R^2 = 0.788$

Poultry mortality rate

Figure 5 depicts that the experiment began with a total of 26,250 chicks, however due to the birds' inability to adjust to their surroundings or weather variables, a tiny number of birds perished, resulting in a total of 24,093 birds in Figure 6 at the end of the period. Whereas the death rate in the first week began at 0.4 percent and decreased to 0.1 percent at the conclusion of the period, the cumulative mortality rate reached 8.6 percent at the end of the cycle. A linear relationship was obtained for poultry mortality rate

$y = -28.709x + 25809$ $R^2 = 0.9423$

$y = 0.1127x + 1.7778$ $R^2 = 0.9518$

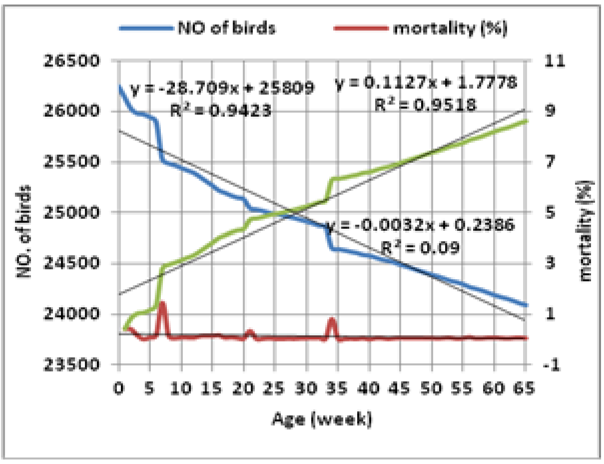

Fig. 5. Number of birds with age per week.
Source: Authors' determination.

Laying hens production

Figure 6 depicts the egg production rate in laying hens and the number of eggs per week were determined after 24 weeks, and because the percentage of egg production began at 1%, the number of eggs in the 24th week was 250 eggs. While the greatest rate of production was 87.1 percent at week 30, with a value of

21,699 eggs, egg production dropped until it reached 42.1 percent at week 65, with a value of 10,143 eggs. A linear relationship was obtained for the egg production rate in laying hens and the number of eggs per week

$y = -0.5254x + 85.823$ $R^2 = 0.125$

$y = -141.11x + 21609$ $R^2 = 0.143$

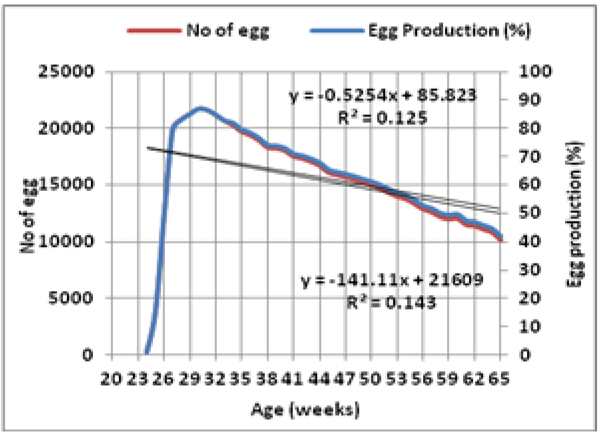

Fig. 6. Weekly Number of Eggs and egg Production.
Source: Authors' determination.

Egg weight of a laying hen

Figure 7 depicts the weight of chicken eggs was calculated on a weekly basis. At week 24, the egg weight was 50.1 g, which was higher than the normal figure of around 48.50 g. While the egg's maximum weight was 73.5 gm in the 65th week. This number was also higher than the normal value of about 71.1 gm. A linear relationship was obtained for the weight of chicken eggs.

$y = 0.4769x + 42.872$ $R^2 = 0.8892$

$y = 0.4549x + 47.014$ $R^2 = 0.8482$

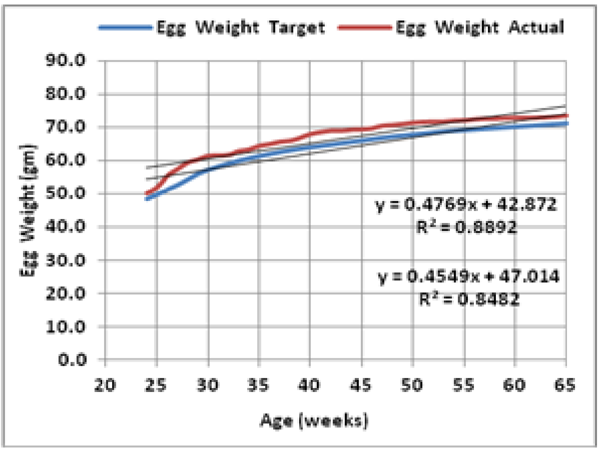

Fig. 7. Weekly weight of Eggs and age
Source: Authors' determination.

CONCLUSIONS

The main objectives of this study to reach of optimum environmental inside laying hens houses to avoided a higher production rate. The weekly increase in average weight of chickens approached the closest weekly increase of the standard weight of the herd breeding index to 244 g at the 24th week. Weight homogeneity increased from 83% to 92% at week 24. The difference of the mean weekly egg weight from the mean egg weight of the standard egg was the closest between them at the twenty-fourth week, and the difference between them was 1.6 grams. The mortality rate then decreased to 0.1% at the 24th week.

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