Factors affecting quail egg production under the changing climate at Kulonprogo Regency, Indonesia

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Abstract. Based on the results of this research, the production of quail eggs at high environmental temperatures (31-34°C) is 10.77% lower than those at low environmental temperatures (26-30°C). High environmental temperatures can reduce the production of eggs. At high environmental temperatures, more energy is needed for the regulation of body temperature instead of for the production of eggs. This present study aims at analyzing the factors affecting the production of quail eggs at Kulonprogo Regency under the weather uncertainty as a result of climate change. Employing convenience sampling, 60 respondents took part in this research. Data were analyzed through the use of Durbin Watson, Kolmogorov - Smirnov, Glejser, ANOVA, and Regression tests. The result found that the air temperature difference between day ranges (31-34°C) and night ranges (26-30°C) significantly affected the feed variable and the quail egg productivity. The IDR 1 of feed cost would increase the profit of IDR 0.96.

1. Introduction
Situated in the Special Region of Yogyakarta, the province with the third largest population of quails (Coturnix coturnix japonica L.) in Indonesia, Kulonprogo belongs to one of the districts with the largest population of quails. In the district, poultry livestock business activities are heavily influenced by weather, especially in the transition season and the rainy season where the wind is quite swift. As a result, the air becomes cold enough so that the need for feed becomes greater.

Based on the research conducted in the quail cage, the temperature of the enclosure is high (31-34 °C) during the day. Meanwhile, at night (early morning), the temperature in the enclosure is considerably low (26-30 °C). In high environmental temperatures, more energy is needed for the regulation of body temperature so that there is a less supply of energy for egg production. In addition, as the feed consumption decreases, the nutrients in the body are reduced, leading to the decrease of egg production. The high temperature due to climate change can make quails stressed, so the energy for egg-producing are used to overcome the stress. The stress usually begins to emerge when the temperature reaches up to 29°C. Humidity levels can also trigger the stress because the moisture also plays a role in affecting the temperature felt by the quails.
Thermal stress can be defined as the interaction between protective reactions and stress factors [2]. Thus, to obtain the best performance of a given production system, the operation of the system on animals thermal comfort zone is needed [3]. The thermal environmental affects the behavior of laying birds and, through the expression of these factors, it is possible to understanding better its effects on birds, making it possible to predict animal welfare [4].

It is commonly known that the ideal temperature and humidity for quails are, i.e. 25-27 °C and 60-70%, respectively. Thus, high environmental temperatures may have a negative effect on the health and performance of laying birds [5]. It also causes behavioral changes, for example, they likely tends to consume less food and remain prostrated, opening their wings as an attempt to dissipate the body heat [6]. And a more obvious loss is seen in the decline in quail productivity. Therefore, based on these ongoing problems, the purpose of this study is to analyze what factors that affect the production of quail eggs under the weather uncertainty and the changing climate at Kulonprogo Regency.

2. Material methods

2.1 Sampling
The study was conducted in Kulonprogo District for one month, in June 2018. The basic method of this research is a sampling method through convenience sampling. Employing the survey method, samples were taken from the population using questionnaires [7]. Sampling was done with 60 respondents in Kulonprogo Regency spread over 12 districts. Considering that Kulonprogo Regency is a potential producer of quail eggs, this district was selected purposively as the location of the study.

2.2 Data measurement
The data obtained in this study can be classified into two groups: primary data and secondary data. The method used to collect the primary data is a survey method with a questionnaire technique. The secondary data in this research is garnered from the results of research, library search, and official documents from the relevant agencies such as the Ministry of Agriculture and the Agriculture Department of Kulonprogo district.

2.3 Data analysis
SPSS-21 software was employed to ease the task of analyzing the relationship between the level of egg production and the factors of production. To find out the factors that influence the production, the analysis is done using a multiple linear function approach as follows:

\[
\log Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \mu_i
\]

Where:
- \(Y\) = the number of eggs produced (eggs)
- \(X_1\) = amount of feed (kilograms)
- \(X_2\) = vitamin needs (gram)
- \(X_3\) = drugs needs (gram)
- \(X_4\) = child cage (person)
- \(X_5\) = temperature change (°Celcius)
- \(\mu_i\) = error
- \(\beta_0\) = intersep
- \(\beta_1 \ldots \beta_k\) = regression coefficient
- \(X_1 \ldots X_k\) = variable observed
- \(U\) = variable not observed
- \(i\) = responden \(i = 1, 2 \ldots n\)
3. Results and discussion

From the results of research of quail livestock business in Kulonprogo Regency, it is known that there are about 42% of quail farmers who have 3-5 years of experience and 23% with more than 5 years of experience.

| Experience quail breeding | Amount | Percentage (%) |
|---------------------------|--------|----------------|
| < 1 year                  | 4      | 9.52           |
| 1 - 3 year                | 10     | 23.81          |
| 3 - 5 year                | 18     | 42.86          |
| > 5 year                  | 10     | 23.81          |
| **Amount**                | **42** | **100**        |

It is necessary to educate quail breeders for the purpose of familiarizing them with the innovation and the use of recent technology on the production of quail eggs. The consideration that done requires a lot of insight and intelligence gained through education so that the higher the level of education of a quail farmer, the higher the level of adoption of livestock technology. A sufficient knowledge and intelligence gained through education will enhance their level of adoption of livestock technology. In line with this, Drakel [8] states that the level of education influences the way of thinking about innovative responses and recommended changes. In terms of accepting new innovations, respondents with this condition belong to the group that accepts new innovation easily. It is expected that farmers with diverse experiences and levels of education can help each other by exchanging experiences on how to breed quails so that they can increase the production of eggs on their farms.

| Last education            | Amount | Percentage (%) |
|---------------------------|--------|----------------|
| Elementary school         | 3      | 7.14           |
| Junior high school        | 5      | 11.90          |
| Senior High School        | 24     | 57.14          |
| Bachelor's degree         | 10     | 23.81          |
| **Amount**                | **42** | **100**        |

The following is the data of egg production in high environmental temperatures (31-35 °C) and in low environmental temperatures (26-30 °C).

| Description | Environmental temperature |
|-------------|---------------------------|
|             | low (31-35°C)             |
|             | high (26-30°C)            |
| Number of respondents | 20 | 22 |
| Percentage of eggs | 0.9076 | 0.7999 |

The high environmental temperature will cause the decreasing of egg size and production, as a result of the decreased consumption of nutrients in poultry, especially energy and protein [9]. The high temperature due to climate change can make quails stressed, so the energy for egg-producing are used to overcome the stress. It can be seen from their changing behavior such as their rapid breathing and gasping sounds. Nataamijaya et al. [10] suggested that high environmental temperatures have a negative influence on the production of broiler eggs and it turns out that the same thing will happen to quail egg production.
Based on the results of research, the production of quail eggs at high environmental temperatures (31-34 °C) is 10.77% lower than at low environmental temperatures (26-30 °C). According to Bird et al. (2003) [1], high environmental temperatures can reduce the production of eggs. At high environmental temperatures, more energy is needed for the regulation of body temperature instead of for the production of eggs. In high environmental temperature, the consumption of feed decreases and the nutrients in the body is reduced and ultimately decreases egg production. In an adult female quail, the food consumed is used for basic living needs and egg production needs so that the decrease of feed consumption has a direct effect in the decrease of egg production.

3.1 Factors affecting the production of quail eggs
Quail egg production is influenced by various things related to the condition of quail breeders (internal) and the influencing environment (external). The analysis is conducted to determine what factors that influence the production level of quail eggs. It employs multiple linear regressions with the production of quail eggs as the dependent variable (\( Y \)). Meanwhile, the independent variable (\( X_i \)) in this study are the internal factors from quail breeders (knowledge, age, and education) and the external factors of quail farmers (feed requirements, vitamin needs, drug requirements, labor requirements, and temperature factors).

\[
Y = 3.20 + 0.96X1 + 0.01X2 - 0.02X3 + 0.06X4 + 0.04X5
\]

Regression results show that variables X1 to X5 have a significant effect on the level of quail egg production. Of the five independent variables, 98.47% affected the production level of quail eggs, while 1.53% was influenced by factors outside the model. The variable regression coefficient of the amount of feed (X1) and the temperature factor in the quail cage (X5) significantly affected the level of production of quail eggs in each breeder.

**Table 4. Results of multiple linear regression analysis**

| Model          | Standardized Coefficients | t     | Sig. | Collinearity Statistics |
|----------------|---------------------------|-------|------|-------------------------|
| (Constant)     |                           |       |      |                         |
|                | Beta                      | 52.160| .000 |                         |
| Amount of feed | .942                      | 26.064| .000 | 3.076                   |
| Vitamin needs  | .048                      | 1.672 | .103 | 1.920                   |
| Drugs needs    | -.011                     | -.391 | .698 | 1.731                   |
| child cage     | .028                      | .770  | .446 | 3.004                   |
| Temperature change | .071                 | 3.375 | .002 | 1.053                   |
| R square       |                           | 0.984722426 |      |                         |

a. Dependent Variable: the number of eggs produced

From the result of a classic assumption test consisting of multicollinearity VIF value < 5, the value of 2.28 is obtained from the autocorrelation test with Durbin Watson obtained. Then, from the normality test with Kolmogorov – Smirnov, the P-value is smaller than 0.05, signifying that the data is normally distributed. In addition, in this study, a heteroscedasticity test with Glejser method and a regression analysis of independent variable with absolute residuals show that there is no existence of heteroscedasticity. From the result of ANOVA test, the sig value is < 0.05 so that the hypothesis is accepted. Then, from the result of coefficient determination test, the four independent variables provide 98% influence of the number of eggs produced. Moreover, from the result of t-test, the value is significantly smaller than 0.05. Therefore, it can be known that, from those four variables, the number of eggs produced is greatly influenced the feed and temperature.
To achieve the maximum production of the quail eggs, the farmers should paid more attention to the feed variable. In this case, all farmers should have a proficient knowledge and perspective that the feed variable has an enormous effect on the number of quail eggs produced. From the results of the study, it is concluded that if the increase of 1 IDR for the cost of feed will increase the profit of IDR 0.96. This shows that the business of quail cattle can provide benefits as what has been expected by the farmers.

This study was conducted in dry season with the range of temperature between 24 °C and 34 °C. It is known that when a temperature is above 32 °C, the water consumption could increase by 50%. For quails, the temperature above 30 °C was considered as an extreme and can generate various diseases such as ND, bird flu, defecated, and others. Thus, farmers need to have preventive strategies when the temperature is reaching the highest point and when the humidity is at the lowest point.

The results of this study show that temperature is the biggest factor affecting the number of eggs. It can be seen from the increase of water consumption when the temperature is above 30 °C and the increase of feed consumption when the temperature is below 25 °C. The temperature above 30 °C will make the quails uncomfortable so that they will be experiencing stress. If the farmers do not anticipate this condition, there will be inevitably an increase on the death of quails because of cannibalism or the scramble of food or drink. Meanwhile, the lowest temperature has a positive effect on egg weight whereas the amount of feed has a positive effect on the number of eggs.

Therefore, farmers should conduct the modification of the microenvironment, according to Huffman [11], through increasing the ventilation air when the environment temperature is high. The principle of the microenvironment modification is to make an environment in the cage equal to the ideal conditions for production, without depending on the external environment. In a hot area, cooling tools is formed through the use of a fan or blower. Quail breeders in Kulonprogo District make a cage with the open house system (open cage), where the atmosphere inside the cage is strongly influenced by the state of the environment. In addition, it should be noted by farmers that normally the condition of the cage will become hotter because of the body heat produced by the quails. It is also better for farmers to make the size of the cage a little bit larger to avoid quail competition in obtaining the oxygen.

4. Conclusion

The result showed that the production of eggs is greatly influenced by the feed and temperature. To achieve the maximum production of the quail eggs, the farmers should paid more attention to the feed variable. The results of the study showed that the increase of 1 IDR for the cost of feed will increase the profit of IDR 0.96. In addition, from the temperature standpoint, the difference of air temperature between day and night was significantly affecting the feed variable and the egg productivity of quail. Having a closer look at the increase of water consumption when the temperature is above 30 °C and the increase of feed consumption when the temperature is below 25 °C, it can be considered that temperature is the biggest factor affecting the production of quail eggs. The production of quail eggs at high environmental temperatures (31-35 °C) is 10.77% lower than at low environmental temperatures (26-30 °C). High environmental temperatures can reduce the number of eggs since there was more energy needed by the quails for the regulation of body temperature instead of for the production of eggs. As high temperatures also increase the level of stress experienced by the quails, there was also more energy used to overcome stress. Findings also showed that less consumption of food caused by high environmental temperature resulted in the reduced nutrients in the body and lead to the decrease of egg production.

Therefore, farmers should have a proficient knowledge and perspective that the feed variable has an enormous effect on the number of quail eggs produced. Then, farmers should have preventive strategies dealing with the change of temperature by conducting the modification of the microenvironment through installing the ventilation air to make an environment in the cage equal to the ideal conditions for production. Then, it is also better for farmers to make a comfortable cage with a little bit larger size to avoid quail competition in obtaining the oxygen.
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