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The Effect of Male-to-Female Ratio and Enclosure Area in a Housing System on Productivity and Sales Revenue of Jumbo Farming in Rajagaluh District, Majalengka

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Abstract

Jumbo Muscovy duck farming offers opportunities to improve the availability of animal protein and increase farmers' sales revenue; however, productivity remains sensitive to reproductive management and housing conditions. This study examined the associations of the breeding sex ratio, expressed as the number of females per male, and enclosure area with offspring production and sales revenue in Rajagaluh District, Majalengka Regency, Indonesia. This quantitative observational study employed a cross-sectional design. Thirty farmers were purposively selected from a population of 50 based on their group-housing practices and the completeness of their data. Data were collected through direct observations, structured interviews, questionnaires, and document reviews and subsequently analyzed using descriptive statistics and two multiple linear regression models. On average, farmers maintained 6.57 females per male in enclosures with an area of 8.56 m², producing 28.60 offspring and generating IDR 1,716,442.37 in sales revenue per production period. The breeding sex ratio and enclosure area were positively associated with both offspring production and sales revenue, individually and jointly, with all p-values below 0.001. The regression models explained 81.1% and 90.6% of the variation in offspring production and sales revenue, respectively. These findings underscore the importance of breeding composition and housing space as key management considerations in Jumbo Muscovy duck farming. Appropriate breeding ratios and adequate enclosure space may contribute to improved farm performance. However, the observational study design precludes causal inferences and does not establish an optimal combination of management practices.

INTRODUCTION

Duck farming, particularly Muscovy duck farming, has considerable potential to increase the availability of animal protein and farmers' sales revenue because of the birds' adaptability and ability to utilize locally available feed resources. However, improving productivity remains a significant challenge, particularly in relation to the housing and management systems employed (Aziabah et al., 2023; Hassoon et al., 2025; Khan et al., 2025; Mishra & Singh, 2023). Housing systems are recognized as important nongenetic factors influencing production performance, product quality, and animal welfare (Abdel-Hamid et al., 2020).

Numerous studies have demonstrated that housing systems significantly influence duck productivity (El Sabry & Almasri, 2023; Han et al., 2022; Krunt et al., 2022, 2023; Szoke et al., 2025). Outdoor and semi-intensive systems may improve body weight and carcass quality, whereas intensive systems may provide greater feed efficiency (Damaziak et al., 2014; Mariani, 2025). Conversely, intensive housing conditions may contribute to animal welfare concerns, including stress and abnormal behaviors, which can adversely affect production performance (Abdel-Hamid et al., 2020).

In addition to housing systems, stocking density is an important determinant of duck production performance (Chung et al., 2026; El Sabry & Almasri, 2023; Oketch et al., 2023; Vorel et al., 2026). Higher stocking densities have been associated with reduced body weight and poorer carcass characteristics, as well as behavioral changes and increased physiological stress (Eratalar et al., 2021; Negm & Mohammed, 2023). Furthermore, microenvironmental conditions, including temperature, humidity, and airflow within enclosures, can influence production performance and immune function in ducks (Hu et al., 2024).

Nevertheless, the existing literature remains fragmented. Most studies have examined individual management factors separately, with limited integration of breeding-flock composition, particularly the male-to-female ratio, and spatial characteristics, such as enclosure area, within group-housing systems. Moreover, research specifically addressing Muscovy ducks remains relatively limited compared with research on Pekin ducks, and previous investigations have predominantly emphasized biological performance without systematically examining economic outcomes, particularly sales revenue. These limitations highlight the need for a more integrated approach that considers breeding sex ratios and enclosure area simultaneously when examining offspring production and sales revenue in jumbo Muscovy duck farming in Rajagaluh District, Majalengka Regency.

The relevance of this issue is particularly evident in Indonesian Muscovy duck production, especially in the Ciayumajakuning region of West Java, which includes Majalengka Regency. Widianingrum et al. (2020) surveyed 22 Muscovy duck farmers in this region and reported that 81.8% practiced semi-intensive management, whereas traditional and intensive management systems each accounted for 9.1%. The researchers also found that 95.5% of farmers used floor-based housing systems and concluded that technical production practices had not been standardized. These findings provide regional evidence of variations in housing systems and husbandry practices. In the context of jumbo Muscovy duck farming in Rajagaluh District, such variations raise an important management question regarding the extent to which breeding sex ratios and enclosure area are associated with offspring production and farmers' sales revenue under group-housing conditions.

Breeding-flock composition is particularly important because the number of females allocated to each male may influence mating opportunities, fertilization success, and reproductive performance. Nickolova (2004) investigated Muscovy duck breeding groups with male-to-female ratios of 1:5, 1:6, 1:7, and 1:8, including groups containing either single or multiple drakes. Egg fertility ranged from 93.41% in the 1:8 group with a single drake to 97.09% in the 1:5 group with multiple drakes. The study identified a ratio of 1:5 as the most suitable under the experimental conditions, while a ratio of 1:6 was also considered acceptable for certain breeding-group arrangements. Although these findings demonstrate

the importance of breeding sex ratios and social hierarchy among drakes, they do not establish a universally optimal ratio for farms operating under different housing, feeding, and flock-management conditions.

In addition to breeding-flock composition, previous research has demonstrated that housing conditions can influence duck production performance. Damaziak et al. (2014) investigated housing systems for Pekin and Muscovy ducks, focusing on growth performance, feed conversion, carcass characteristics, and muscle structure. Their findings indicated that responses to housing conditions differed between the two duck types, emphasizing the importance of species-specific interpretations. Similarly, Abo Ghanima et al. (2020) experimentally compared four housing arrangements involving 300 Pekin ducklings. At 56 days of age, ducks housed in facilities providing both an outdoor yard and a swimming pool achieved an average body weight of approximately 3,901 g, compared with 3,682 g among ducks maintained in enclosed housing. These findings demonstrate the relevance of housing arrangements to production performance. However, the growth-related outcomes examined in these studies do not directly explain reproductive output or sales revenue in Muscovy duck breeding enterprises.

More recent evidence further emphasizes the importance of investigating housing requirements specifically for Muscovy ducks. Zita et al. (2025) examined the availability of swimming ponds for Muscovy ducks and reported improvements in hygiene, natural behaviors, and selected production characteristics when access to swimming facilities was provided. The authors also highlighted the need for further investigation into economic feasibility and practical management considerations. Together with earlier housing studies, these findings suggest that improvements in biological performance should be assessed alongside outcomes relevant to farm enterprises. Nevertheless, enclosure area should be distinguished from stocking density because larger enclosures do not necessarily provide greater space per bird when flock size increases proportionately. Consequently, associations between enclosure area and production outcomes should be interpreted in relation to the number and composition of birds housed within each enclosure.

Collectively, the reviewed literature identifies a research gap at the intersection of reproductive management, housing conditions, and farm-level economic performance. Nickolova (2004) primarily investigated breeding sex ratios and egg fertility; Damaziak et al. (2014), Abo Ghanima et al. (2020), and Zita et al. (2025) examined biological outcomes associated with housing conditions; and Widianingrum et al. (2020) documented regional husbandry practices. Although these studies provide an important scientific foundation, directly applicable evidence remains limited regarding the combined associations of breeding sex ratios and enclosure area with offspring production and sales revenue in jumbo Muscovy duck enterprises in Rajagaluh District. Therefore, the research gap concerns the integration of established management variables within a specific biological and economic context rather than the absence of previous investigations into either variable independently.

Addressing this research gap is important because farmers must make breeding and housing decisions while allocating limited resources among breeding stock, feed, facilities, and routine husbandry activities. Without locally relevant empirical evidence, decisions concerning the addition of breeding females, retention of drakes, or expansion of enclosure

space may rely on assumptions that do not adequately reflect actual farm conditions. Furthermore, increased offspring production does not necessarily result in a proportional increase in sales revenue because revenue also depends on the number of birds sold and their selling prices. Sales revenue must also be distinguished from profit because it does not account for production costs. Examining biological output and gross sales revenue separately may therefore provide a more informative basis for farm-management decisions while avoiding unsupported conclusions regarding profitability.

The novelty of the present study lies in the simultaneous examination of breeding-flock composition and enclosure area within an integrated assessment of biological production and economic outcomes in Rajagaluh District, Majalengka Regency. Specifically, the study considers the breeding sex ratio and enclosure area as explanatory variables and examines their associations with offspring production and sales revenue using separate multiple linear regression models. This approach extends previous descriptive regional research by investigating statistical relationships under actual group-housing conditions on farms. The study's contribution is both contextual and analytical, as it integrates reproductive management and housing-space considerations within a single analytical framework while maintaining a clear distinction between biological production and sales revenue. Because the study employs an observational, cross-sectional design, its findings are intended to identify statistical associations rather than establish causal relationships or determine a universally optimal combination of management practices.

Accordingly, this study aims to examine the associations of breeding sex ratios and enclosure area with offspring production and sales revenue among jumbo Muscovy duck farmers in Rajagaluh District, Majalengka Regency. Specifically, the study seeks to describe existing breeding and housing practices, assess the individual and joint statistical associations of the two management variables with offspring production, and investigate their corresponding associations with sales revenue. The findings are expected to contribute farm-level empirical evidence to the literature on Muscovy duck husbandry and agricultural enterprise management. From a practical perspective, the study may inform farmers' decisions regarding breeding-group composition and enclosure planning, support locally relevant livestock extension programs, and provide a foundation for future experimental or longitudinal research incorporating flock size, production costs, feeding practices, and reproductive performance.

METHOD

Research Location and Time

This study was conducted in Rajagaluh District, Majalengka Regency, West Java, Indonesia, from November 2025 to May 2026. The location was selected because of its potential for jumbo Muscovy duck farming and the presence of active farmers. Data were collected throughout the rearing period, from the starter phase to market readiness, to assess production performance and associated costs.

Type and Approach of Research

This study is non-experimental, employing a descriptive and quantitative method with a descriptive approach (describing the actual condition of the research object) and an analytical

approach (examining relationships among variables). Data were collected on a cross-sectional basis at a single point in time, through observation, structured interviews, questionnaires, and documentation.

Variable Operationalization

This study involves two independent variables and two dependent variables, summarized in Table 1 below.

Table 1. Operational Variables of the Study

Variable	Operational Definition	Unit/Scale
X_1 - Male-Female Ratio	The ratio of the number of female ducks to one male duck within a single cage group	Ratio
X_2 - Cage Area	Total floor area of the cage used for one rearing group	Ratio (m^2)
Y_1 - Productivity (Offspring Yield)	Number of jumbo Muscovy duck offspring successfully produced in one rearing period	Ratio (head)
Y_2 - Sales Revenue	Total monetary value obtained by the farmer from the sale of jumbo Muscovy duck offspring in one period	Ratio (IDR/period)

Population and Sample

The study population consisted of all jumbo Muscovy duck farmers in Rajagaluh District, totaling 50 farmers. The sampling technique used was purposive sampling with the following inclusion criteria: (1) applying a group housing rearing system; (2) having complete data on male-female ratio, cage area, number of offspring, and sales revenue; and (3) willing to serve as respondents. Of the 50 farmers, 30 met the criteria and provided complete, valid data, resulting in a study sample of 30 farmers.

Type and Source of Data

Primary data were obtained directly from farmers through structured interviews (business conditions, rearing systems, costs, production output, and constraints) and questionnaires (quantitative data on flock size, costs, production, and sales revenue). Secondary data were obtained from literature (books, journals, theses related to jumbo Muscovy duck farming) and relevant agencies (Department of Agriculture/Livestock, Statistics Indonesia).

Data Analysis Technique

Descriptive Analysis: conducted with the aid of IBM SPSS to process data through frequency distribution, mean values, percentages, standard deviation, minimum-maximum values, and data tabulation, in order to describe farmer characteristics, scale of business, application of the cage system, productivity, and the structure of costs and sales revenue.

Quantitative Analysis: comprising classical assumption tests (Normality Test using Kolmogorov-Smirnov and Shapiro-Wilk, considered normal if Sig. > 0.05; Multicollinearity Test using Tolerance > 0.10 and VIF < 10; Heteroscedasticity Test using a Scatterplot) and multiple linear regression analysis (as more than one independent variable is involved), comprising the t-test (partial, significant if Sig. < 0.05), the F-test (simultaneous, significant if Sig. < 0.05), and the Coefficient of Determination (R^2, measuring the independent variables' ability to explain the dependent variable, ranging from 0 to 1). Regression analysis was used

to examine the effect of male-female ratio and cage area on two dependent variables separately: offspring yield (Model 1) and sales revenue (Model 2).

RESULTS AND DISCUSSION

Respondent Characteristics

The characteristics of the 30 jumbo Muscovy duck farmer respondents are presented in Table 2 below.

Table 2. Respondent Characteristics

Characteristic	Category (Dominant)	n	%
Age	28-50 years (all respondents); 37 years most common	3	10.0
Education Level	Senior High School	15	50.0
	Elementary School	8	26.7
	Junior High School	7	23.3
Farming Experience	1 year & 3 years (each)	5	16.7
	2, 4, 5, 6, 7 years (each)	4	13.3
Rearing Method	Group Housing System	30	100.0
Group/Cage Ownership	Categories 1, 2, and 3 (evenly distributed)	10	33.3

Source: Primary Data (2026)

All respondents fell within the productive age range (28-50 years), with a fairly diverse age distribution. The majority held a senior high school education (50.0%), with farming experience evenly distributed between 1-7 years. All respondents (100%) applied a Group Housing System, with a balanced distribution of group/cage ownership across three categories.

Descriptive Statistics

The results of the descriptive statistical analysis of the research variables are presented in Table 3 below.

Table 3. Descriptive Statistics of Research Variables (N = 30)

Variable	Minimum	Maximum	Mean	Std. Deviation
Farming Experience (years)	1	7	3.87	2.047
Cage Area (m^2)	4.50	12.00	8.5573	2.37640
Male-Female Ratio	5	8	6.57	1.135
Flock Size per Cage (head)	6	9	7.57	1.135
Number of Offspring (head)	18	37	28.60	4.606
Sales Revenue (IDR)	1,255,778	2,068,284	1,716,442.37	197,493.436

Source: Primary Data (2026, processed with SPSS)

On average, farmers applied a ratio of approximately one male to six-to-seven females, with an average cage area of 8.56 m^2, yielding an average of 28.60 offspring per period and

average sales revenue of approximately IDR 1.72 million. The relatively small standard deviation values compared with the means indicate a reasonably good and representative data spread.

Classical Assumption Test

The results of the classical assumption tests for both regression models (Model 1: offspring yield; Model 2: sales revenue) are presented in Table 4 below.

Table 4. Classical Assumption Test Results for Model 1 and Model 2

Classical Assumption Test	Model 1 (Y_1 Offspring Yield)	Model 2 (Y_2 Sales Revenue)	Conclusion
Normality (Kolmogorov-Smirnov)	Sig. = 0.200	Sig. = 0.200	Residuals normally distributed (> 0.05)
Normality (Shapiro-Wilk)	Sig. = 0.991	Sig. = 0.911	Residuals normally distributed (> 0.05)
Multicollinearity (Tolerance/VIF)	0.988 / 1.012	0.988 / 1.012	No multicollinearity (Tolerance > 0.10; VIF < 10)
Heteroscedasticity (Scatterplot)	Points scattered randomly, no pattern	Points scattered randomly, no pattern	No heteroscedasticity

Source: Primary Data (2026, processed with SPSS)

Both regression models satisfied all classical assumptions (normality, absence of multicollinearity, and homoscedasticity), and were therefore deemed suitable to proceed to multiple linear regression analysis.

Multiple Linear Regression Analysis

The results of the regression analysis, t-test (partial), F-test (simultaneous), and coefficient of determination for both models are presented in Table 5 below.

Table 5. Regression, t-Test, F-Test, and Coefficient of Determination Results for Model 1 and Model 2

Parameter	Model 1 (Y_1 Offspring Yield)	Model 2 (Y_2 Sales Revenue)
Regression Equation	$Y_1 = 5.549 + 1.553X_1 + 1.502X_2$	$Y_2 = 801{,}593.062 + 42{,}487.090X_1 + 74{,}304.778X_2$
t-Test - X_1 (Male-Female Ratio)	t = 4.552; Sig. < 0.001 (Significant)	t = 4.124; Sig. < 0.001 (Significant)
t-Test - X_2 (Cage Area)	t = 9.213; Sig. < 0.001 (Significant)	t = 15.101; Sig. < 0.001 (Significant)
F-Test (Simultaneous)	F = 58.037; Sig. < 0.001 (Significant)	F = 130.824; Sig. < 0.001 (Significant)
R	0.901	0.952
R Square	0.811 (81.1%)	0.906 (90.6%)
Adjusted R Square	0.797 (79.7%)	0.900 (90.0%)

Source: Primary Data (2026, processed with SPSS 26)

Both independent variables (male-female ratio and cage area) were found to have a positive and significant effect, both partially and simultaneously, on both dependent variables. In Model 1, the two variables explained 81.1% of the variance in offspring yield; in Model 2,

they explained 90.6% of the variance in sales revenue - both indicating a very strong relationship ($R > 0.90$).

Discussion of Model 1 (Offspring Yield)

Male-female ratio and cage area had a positive and significant effect on jumbo Muscovy duck offspring yield, both partially (Sig. < 0.001 for both variables) and simultaneously ($F = 58.037$; Sig. < 0.001), with $R^2 = 0.811$. These results indicate that appropriate male-female ratio management and the provision of adequate cage area are important factors in increasing offspring yield under a Group Housing System, as they support successful reproduction and create more optimal rearing conditions.

Discussion of Model 2 (Sales Revenue)

Male-female ratio and cage area also had a positive and significant effect on sales revenue, both partially (Sig. < 0.001 for both variables) and simultaneously ($F = 130.824$; Sig. < 0.001), with $R^2 = 0.906$. Applying an ideal male-female ratio together with adequate cage area was able to increase jumbo Muscovy duck productivity, thereby increasing farmers' sales revenue under the Group Housing System.

Discussion: The Relationship between Model 1 and Model 2

The increase in sales revenue did not occur directly, but was preceded by an increase in reproductive productivity. The more ideal the male-female ratio and the more adequate the cage area, the greater the number of offspring produced, thereby increasing the number of market-ready birds and ultimately raising farmers' sales revenue. An appropriate male-female ratio increases mating success and egg fertility, while adequate cage area provides sufficient movement space, reduces stocking density and stress, and supports growth and animal health through to market size.

Comparison with Prior Research

These findings are consistent with Damaziak et al. (2014), who state that the rearing system affects duck growth and performance, and support Abdel-Hamid et al. (2020), who reported that litter-based cage systems provide better welfare and performance than cage systems - in this study, adequate cage area reduced stocking density and stress, supporting feeding and reproductive activity. These findings are also consistent with Eratalar et al. (2021), Negm and Mohammed (2023), and El Sabry and Almasri (2023), who state that stocking density is an important factor in poultry production performance, and align with Hu et al. (2024) regarding the effect of cage environmental conditions on duck performance and immune systems.

In terms of productivity, these results are consistent with Mariani (2025) and Sunarno et al. (2021), who show that better rearing systems improve production efficiency, and align with Tanwiriah (2011), who reported that cage systems affect Income Over Feed Cost (IOFC) values. Meanwhile, Makagon and Riber (2022) state that duck welfare standards still require further development; this study provides empirical evidence that male-female ratio management and cage area are important components of rearing management capable of improving reproductive productivity and farmers' sales revenue.

Overall, these findings reinforce prior evidence that the success of poultry farming depends not only on genetic factors or feed, but is also strongly influenced by rearing system management. Optimal management of male-female ratio and cage area under a Group Housing

System can serve as an effective management strategy for simultaneously improving productivity and sales revenue in jumbo Muscovy duck farming.

CONCLUSION

Based on the findings of this study, the male-to-female ratio and enclosure area were positively and significantly associated with offspring production in jumbo Muscovy duck farming under a group-housing system in Rajagaluh District, Majalengka Regency. Both variables demonstrated statistically significant associations with productivity, individually and jointly, suggesting that breeding-flock composition and enclosure space were important factors associated with reproductive performance.

The male-to-female ratio and enclosure area were also positively and significantly associated with sales revenue. These findings suggested that breeding management and housing conditions were relevant to both biological production and economic outcomes. However, the observed associations did not establish that increased offspring production directly caused higher sales revenue. Overall, the findings highlighted the potential importance of appropriate breeding-flock composition and adequate enclosure space in supporting productivity and sales revenue in jumbo Muscovy duck farming.

Based on these findings, jumbo Muscovy duck farmers were encouraged to consider breeding sex ratios and enclosure area when planning and managing group-housing systems. Particular attention should be given to breeding-flock composition, enclosure capacity, and routine reproductive management to support offspring production and farm performance. Nevertheless, the findings did not establish an optimal breeding ratio or enclosure size, and management decisions should account for individual farm conditions and available resources.

Local governments and relevant livestock agencies could use these findings as preliminary evidence to develop extension services, training programs, and technical assistance focused on reproductive management, breeding-flock composition, and enclosure planning. Such initiatives could help farmers improve their management practices and support the sustainable development of jumbo Muscovy duck farming.

Future research should incorporate additional variables potentially associated with productivity and sales revenue, including feed quality, breeding-stock age, animal health, breeding-stock quality, husbandry practices, flock size, and environmental conditions within enclosures. Studies involving larger samples, broader geographical coverage, and longitudinal or experimental designs are also recommended to improve the generalizability of the findings and provide stronger evidence regarding the relationships among breeding management, housing conditions, offspring production, and economic performance.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of the research, preparation, or publication of this article.

AUTHOR CONTRIBUTION

All authors contributed to the preparation of this article. The first author, Fahrur Rizki, was responsible for the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation. The other authors contributed to the review, editing, and final approval of the manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The authors declare that no generative artificial intelligence was used in the preparation of this article.

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