Productivity and profitability of commercial duck breeds versus broilers under Egyptian conditions: The role of agricultural cooperatives in supporting and sustaining the poultry sector

M. Sh. Abougabal [1,*], and A. E. ElShazly [2]

[1] *Department of Animal Production, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt*
[2] *Agricultural Economics Department, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.*

[*] Corresponding author E-mail: dr.mabougabal@gmail.com (M. Abougabal)

ABSTRACT:

Egyptian poultry industry, especially broiler sector, faces numerous problems and challenges including inflation production costs, disease outbreaks, and fluctuating market conditions. These challenges negatively affect small- and medium-scale producers. Therefore, there is a growing interest in identifying alternative poultry species that offer better economic resilience and sustainability. This study aims to evaluate the productivity and profitability of four commercial duck breeds (Muscovy, Mule, Pekin, and Shershery) as potential alternatives to broiler chickens under Egyptian production conditions. A total of 240 one-day-old ducklings (60 from each breed) and 60 *Cobb*^{500} broiler chicks were reared under identical environmental and management conditions until they reached marketing age. Growth performance, performance indexes, economic feasibility and annual profitability were assessed for each duck breed and broiler chicks. The results indicated that broiler chickens had higher growth performance, feed conversion efficiency (FCR) and economic productivity indexes; European Production Efficiency Index (EPEI), Performance Index (PI) and Russian Production Index (RPI) during the first six experimental weeks. However, by the 10th week, regardless of the broiler chickens, Muscovy and Mule duck breeds had higher LBW, livability rates, better EPEI, PI, Yield per Unit Area (YUA) and Unit Production (UP) indexes and superior economic efficiency compared to Pekin and Shershery ducks. Muscovy ducks had the highest total revenue and net profit followed by Mule ducks, while Shershery ducks recorded the lowest economic returns, making them the least viable option for commercial production. Furthermore, the study highlights the essential role of agricultural cooperative associations in supporting poultry and duck producers through financial support, technical training and improved market access, thereby reducing reliance on broiler production and promoting sustainable poultry diversity. In conclusion, based on these findings, expanding the production of Muscovy and Mule ducks can improve profitability and reduce the common risks associated with broiler chickens, particularly under current economic and industrial challenges. These insights contribute to the optimization of sustainable poultry production strategies and the development of sustainable agricultural policies.

Keywords: productivity; profitability; duck breeds; broilers; agricultural cooperatives.

INTRODUCTION

The poultry industry is one of the most significant and rapidly expanding sectors in the global and Egyptian agricultural production. This industry plays a crucial role in food security and animal protein supply, with investments in Egypt reaching approximately 4.5 billion USD, generating around 2.5 million direct and indirect jobs (MALR, 2019; FAO, 2020; Abu Hatab et al., 2021). The commercial broiler production constitutes the largest component of Egypt's poultry industry, producing 1.8 billion tons of meat annually valued at 3.5 billion USD, with a self-sufficiency ratio of 95% (MALR, 2019; FAO, 2020; Selim, 2021). However, since the 2006 avian influenza (H5N1) outbreak, the sector has faced rising costs, disease outbreaks and fluctuating prices, significantly impacting small- and medium-scale farmers (Abdelwhab et al., 2016; El-Shazly & Helal, 2017; El-Shamy et al., 2020). Broiler mortality rates have reached 50% in some flocks, forcing many small producers to reduce or halt production, leading to a 13.15% decline in broiler meat output between 2019 and 2021 (Bassyouni et al., 2021; FAO, 2021).

In complete contrast, duck meat production has grown steadily globally, reaching approximately 5.22 billion birds with 71,052 tons in 2021. Egypt ranks as the leading producer of duck meat in Africa, with a production volume of 28,990 ×10^{6} duck birds

(FAOSTAT, 2020; FAO, 2021). Ducks, especially Muscovy, Pekin and Mule breeds, are more resilient to environmental stressors, diseases and management challenges than broiler chickens (El-Zoghby et al., 2012; Makram, 2016). Their stable input costs and growing consumer demand further contributed to the sector's growth. Several duck breeds in Egypt, including Muscovy, Mule, Pekin and Shershery are widely used for meat production (El-Zoghby et al., 2012; Makram, 2016).

In 2022, cooperative investments in egg and chick production reached 18 million and 2.8 million EGP, respectively, highlighting their economic significance (CAPMAS, 2023). Cooperatives help stabilize prices, reduce broker influence and encourage farmers to diversify poultry production, mitigating risks associated with broiler industry challenges (Bassyouni et al., 2021). Additionally, the vital role of agricultural cooperative societies in supporting sustainable poultry farming, facilitating broiler and duck production, incubation and marketing activities (Elshazly, 2016). Numerous studies have investigated the productivity, physiological traits and meat quality of different duck breeds (El-Ghamry et al., 2004; Shamma et al., 2011; Hassan et al., 2018; Nasr et al., 2022; Abdelsalam et al., 2024). However, research on their economic feasibility remains limited, and comprehensive field-based comparisons between duck breeds and broiler chickens are still lacking.

We hypothesized that by integrating growth performance, economic feasibility and cooperative support, a comparative analysis of four commercial duck breeds (Muscovy, Mule, Pekin, and Shershery) would demonstrate their viability as sustainable alternatives to broiler chickens under Egyptian production conditions. Therefore, to bridge this gap, the present study aims to evaluate the productivity and economic viability of four commercially available duck breeds compared to broiler chickens under standardized production conditions. These data can provide poultry production strategies, promote food security and support sustainable poultry farming and strengthening food security in Egypt or under similar agricultural economic conditions.

MATERIAL AND METHOD

Experimental site:

The herein experiment was conducted at the experimental poultry farm of the Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

Birds and experimental design:

A total of 240 one-day-old-unsexed ducklings from four duck breeds (Muscovy, Mule, Pekin and Shershery) were used, with 60 ducklings per breed. Additionally, 60 one-day-old unsexed *Cobb^{500}* broiler chicks were included as the control group. The Muscovy and Mule ducklings were obtained from the French Group Company, El-Sadat City, Menofia Governorate, Egypt, while the Pekin and Shershery ducklings were obtained from a reputable commercial hatchery in Berma Village, Gharbia Governorate, Egypt. While *Cobb^{500}* broiler chicks were purchased from Dakahlia Company hatchery, El-Obour City, Egypt.

Birds' management and husbandry:

All birds were raised from one day old until marketing age during the winter season (October to December) under uniform environmental and management conditions. Upon arrival, each duckling's breed and broiler chicks were placed in separate brooding pens for the first two weeks. After the brooding period, each breed was transferred to open-sided, naturally ventilated pens measuring approximately 12 m² (0.16 m² per bird) and reared until the end of the experiment. Each pen was equipped with round bell drinkers, plastic feeders, fresh wheat straw bedding and electrical heaters and LED lamps were provided for temperature control and artificial lighting. The brooding temperature was maintained at 32 °C initially and gradually reduced to 22 – 25 °C by the end of the experiment period. The lighting schedule was 24 h of light (24L:0D) at 15 – 20 lux during the first two weeks, followed by 20 h of light (20L:4D) at 10 lux until the end of the experimental period.

Birds had free access to feed and fresh water for *ad-libtum* consumption throughout the study. The diets were iso-caloric and iso-nitrogenous, formulated to meet the nutritional requirements recommendations of each breed guide. The feeding program was divided into three stages: a starter diet (22% crude protein (CP) and 2950 K.cal.ME/kg) from days 1 to 14, a grower diet (20% CP and 3050 K.cal.ME/kg) from days 14 to 28, and a finisher diet (18% CP and 3150 K.cal.ME/kg) from day 29 until marketing age. Ducklings were vaccinated against duck virus hepatitis (DVH), duck virus enteritis (DVE) and duck cholera, while broiler chicks were vaccinated against

Newcastle disease (ND) and infectious bursal disease (IBD) by the farm's veterinary authority, following the manufacturers' recommendations. The experiment lasted until the conventional marketing age, which was six weeks (42 days) for broiler chickens and ten weeks (70 days) for all duck breeds.

Data collection and measurements

Productive performance

Throughout the experimental period, data was collected uniformly across all groups. Individual body weights were recorded biweekly from day 0 until marketing age using an electric balance. Daily feed intake, total feed provided, feed residue, and any mortalities were also recorded. We estimated growth performance parameters such as average live body weight (LBW), body weight gain (BWG), average daily gain (ADG), relative growth rate (RGR), feed consumption (FC), average daily feed consumption (ADFC), feed conversion ratio (FCR), mortality and livability % as follows:

BWG (g) = Final BW (g) at the end period – Initial BW (g) at start

$$\text{ADG} = \frac{\text{BWG (g)}}{\text{Growth period (d)}}$$

$$\text{RGR \%} = \frac{\text{W2} - \text{W1}}{0.5\ (\text{W2} - \text{W1})} \times 100$$

$$\text{FC (g/bird)} = \frac{\text{Feed offered} - \text{Feed residue}}{\text{No. of bird}}$$

$$\text{ADFC} = \frac{\text{Total FC (g)}}{\text{Total production period (d)}}$$

$$\text{FCR (g feed/g gain)} = \frac{\text{Cumulative feed consumed}}{\text{Total Weight gain}}$$

$$\text{Mortality (\%)} = \frac{\text{No. of dead birds}}{\text{Total number } of\ birds} \times 100$$

Livability (%) = 100 – Mortality %

$$\text{Flock uniformity (\%)} = 100 - \frac{\text{Standard deviation (g)}}{\text{Average body weight (g)}} \times 100$$

Performance indexes

After calculation of livability % and FCR, we estimated other performance indexes including European Production Efficiency Index (EPEI), Performance Index (PI), Russian Production Index (RPI), Yield per Unit Area (YUA) and Unit Production (UP). Such indexes were calculated according to the following formulas:

$$\text{EPEF \%} = \frac{\text{Livability \%} \times \text{BW (kg)}}{\text{Age (d)} \times \text{FCR}} \times 100$$

$$\text{PI \%} = \frac{\text{Final LBW (kg)}}{\text{FCR}} \times 100$$

$$\text{RPI} = \frac{\text{Total } m\text{eat produced (kg. m}^2) \times \text{Livability (\%)}}{\text{FCR}} \times 10$$

$$\text{UP} = \frac{\text{Net revenue}}{\text{growth period (d)}}$$

YUA = Final LBW (kg) × Density × Liveability (%)

Economic efficiency

The economic efficiency of each breed was calculated according to the actual prices prevailing in the Egyptian market during the experiment.

The total cost (TC) represents all expenses used for production. This cost depicts the result of the addition of the total fixed cost (TFC) and total variable cost (TVC). Systematically, TC was calculated as follows:

TC = TFV + TVC

Where:

TVC = feed cost +chick price + cost of drugs, vaccine and disinfection + litter price.

TFC = rent + building and equipment depreciation.

Total Revenue (TR) was calculated from the following formula:

TR = (Q × P) + other (litter + feed sack)

Where:

Q = The harvest LBW (kg) and P = Sale price per kg of live weight.

Net revenue (profit) was calculated by subtracting the total revenue from the total cost expended by farmers. Net Revenue systematically is described as follows:

π = TR – TC

Where:

π = Net revenue, TR = Total revenue of farmers and TC = Total cost.

$$\text{Economic efficiency (E.E)} = \frac{\text{Net revenue per bird}}{\text{Total cost per bird}}$$

$$\text{Relative economic efficiency} = \frac{\text{Economic efficiency of each experiment group}}{\text{Economic efficiency of the control group}} \times 100$$

Annual economic profitability:

The annual economic profitability of each breed was calculated according to the following formulas:

$$\text{No. of Cycles/Year} = \frac{356\ \text{d.}}{\text{Growing Period} + \text{Resting Period(d)}}$$

$$\text{Total Cost bird/Year} = \frac{\text{Net revenue per bird}}{\text{Total cost per bird}}$$

$$\text{Economic efficiency/Cycle} = \frac{\text{Net revenue bird}}{\text{Total cost per bird}}$$

$$\text{Economic Efficiency (bird/year)} = \frac{\text{Economic efficiency/Cycle} \times \text{No. of Cycles}}{365}$$

Agricultural cooperatives Data

To clarify the role of agricultural cooperatives in supporting and developing the poultry sector, the study relied on published secondary data issued by the Central Agency for Public Mobilization and Statistics (CAPMAS). Appropriate percentage analysis and arithmetic means were utilized, in addition to applying a simple linear model to estimate general time trend equations.

Statistical analysis:

All data were expressed as mean ± standard error of the means (SEM). A one-way ANOVA was performed using statistical software of SPSS version 24 (IBM SPSS, 2016), with breed as the main factor. The Duncan test (1955) was used to compare means when significant differences ($p < 0.05$) were detected, except for LBW at 8 and 10 weeks of age, where Dunnett's t-test (1995) was applied.

RESULTS AND DISCUSSIONS

The current comparative study was conducted to evaluate the growth performance of four duck breeds (Muscovy, Mule, Pekin, and Shershery) as alternatives to commercial broiler chickens (*Cobb*[500]) regarding growth performance, performance indexes and economic considerations reread under similar production conditions.

Growth performance:

The results presented in Table 1 reveal the biweekly growth performance among the examined groups. At the first two wk, Muscovy had the lowest LBW of duck breeds, while the higher values were observed in broiler chickens and Shershery ducks in respective orders (p<0.01). These differences highlight the influence of breed genetic factors on growth performance. This could be attributed to the superior genetic potential of broiler chickens, as well as differences in egg mass and volume among the duck breeds. These findings align with El-Ghamry et al., (2004) who reported a similar genetic advantage in broiler chickens. Although Shershery ducks had the lowest LBW among all the experimental groups from the 4th wk to end of the experimental period, the Mule duck and broiler chicken had the highest values of LBW in respective order till the 6th wk. This dominance during the early growth period reflects the well-documented efficiency of Mule duck and broiler chickens in converting feed into body mass due to their high genetic potential.

Further, by 10th week, a shift in growth performance was observed. Muscovy and Mule ducks emerged as the heaviest breeds, surpassing Pekin and Shershery ducks. These results suggest that while Mule duck and broiler chickens surpass during early growth stages, exotic duck breeds such as Muscovy and Mule superior growth potential over extended fattening periods. The higher LBW in Muscovy and Mule ducks may be related to their enhanced ability to store abdominal and subcutaneous fat, as shown by Ghonim et al., (2009) and Makram et al., (2020). Also, it could be attributed to the extended growth period required for duck breeds (10 – 12 wk.) compared to broiler chickens (only 6 weeks) likely contributes to their higher final weights.

The findings of this study align with previous trials that indicated higher growth rates in Muscovy and Mule ducks compared to Pekin and other local duck breeds such as Baladi and Sudani ducks (El-Ghamry et al., 2004; Ghonim et al., 2009; Hassan, 2011; Makram et al., 2020 and Abdelsalam et al., 2024). These studies found that Muscovy and Mule ducks exhibit superior growth performance, particularly during the first 8th to 10th weeks of age. These findings also emphasize the influence of genetic differences on feed intake and conversion efficiency. For example, Muscovy and Mule ducks were observed to consume more feed and achieve better feed conversion ratios than Shershery ducks, resulting in their heavier body weights. Heavier body weight for Muscovy at a similar age was obtained by El-Badry (2004) and Shamma et al., (2011) and lower body weight for local duck breed (Sudani) at the same ages. Consistent with these findings, Awad et al., (2007, 2013) reported that Pekin ducks reached a body weight of 2.55 kg at 12 weeks of age. This weight was significantly higher than that of Domyati ducks, which weighed 2.20 kg during the same period. Regarding growth performance, this study demonstrates that Mule ducks and broiler chickens exhibited optimal growth rates in the short term (up to the 6th week). While Muscovy and Mule ducks outperformed Pekin and Shershery ducks over extended production cycles. These results highlight the potential of Muscovy and Mule ducks as viable alternatives to broiler chickens, particularly in regions where duck production is more economically feasible. Further research is recommended to explore the long-term economic and environmental impacts of integrating these duck breeds into commercial poultry production systems.

Productive and performance indexes:

Data presented in Table 2 provides a comprehensive overview of the productive performance traits and performance indexes for the studied duck breeds and broiler chickens. The results revealed significant differences (p<0.01) among the groups in all evaluated parameters, highlighting the influence of genetic potential and production characteristics.

At the start of the experiment, broiler chickens and Shershery ducks exhibited the highest initial LBW, while Muscovy ducks exhibited the lowest values. By the end of the experimental period, Muscovy and Mule ducks had the highest values of final LBW and BWG. These duck breeds outperformed Pekin and Shershery ducks. However, broiler chickens recorded a superior average daily gain (ADG) of 58.92 g/day. While, their final body weights were lower due to a shorter production cycle. This trend indicates that Muscovy and Mule ducks are more suited for extended fattening periods, aligning with findings by Bochno et al., (1994); Galal et al., (2011) Makram et al., (2020) and Abdelsalam et al., (2024).

The highest values of total FC, average daily FC, and livability were observed in Muscovy duck, while the lowest values for the same parameters were observed in broiler chicken (p<0.01). Interestingly, Muscovy ducks consumed the highest total and average daily feed, followed by Mule ducks. This greater feed consumption contributed to their higher final weights and in higher feed conversion ratios (FCR). Broiler chickens indicated the most efficient FCR (1.81), reflecting their superior genetic selection for rapid growth within a short production period. These findings are consistent with previous reports by Awad et al., (2007 and 2013), who noted similar feed consumption trends among Pekin and Domyati ducks (Kout Elkloub et al., 2010).

In terms of mortality rates, broiler chickens exhibited the highest mortality (4.17%), significantly exceeding that of all duck breeds, while Muscovy ducks had the lowest mortality (0.83%). This result clearly proved that duck breeds, particularly Muscovy and Mule ducks, are more adapted and tolerant to diverse environmental conditions and to common avian diseases. This adaptability underscores their potential as sustainable alternatives to broiler chickens in regions with challenging production environments.

Regarding the performance indexes (PIs), the PIs indicated the superiority of broiler chickens in terms of EPEI, PI and RPI. Such superiority is related to their superior FCR and shorter production periods. However, Muscovy and Mule ducks surpassed in YUA and UP indexes, reflecting their higher meat yield per unit area and economic value / kg. These results align with studies of Galal et al., (2011) and Makram et al., (2020) who highlighted the economic viability of exotic duck breeds in extended production systems. To sum up, the results demonstrate that while broiler chickens are optimal for rapid, short-term production, Muscovy and Mule duck breeds exhibit superior performance over extended periods. Therefore, these duck breeds are suitable candidates for sustainable poultry production systems. These differences in performance traits and indexes confirm the importance of genetic potential and production objectives in selecting appropriate poultry breeds. Also, these results reveal the significance of determining the optimal slaughter age between different poultry species, breeds or both actions (Muscovy, Mule, Pekin and Shershery).

Economic feasibility

The economic feasibility of the examined duck breeds and broiler chickens is summarized in Table 3. The findings highlight significant differences (p<0.01) among the groups regarding total costs, revenues, and economic efficiency, illustrating the impact of breed characteristics on profitability. The Muscovy duck breed recorded the highest total cost, which can be attributed to its greater feed consumption and higher chick price. Similarly, Muscovy ducks achieved the highest total revenue and net revenue, driven by their superior live body weight (LBW) and higher market price per kilogram of meat. These factors contributed to their outstanding economic efficiency (33%), surpassing all other breeds. On the other hand, broiler chickens had the lowest total cost due to their minimal feed consumption during the shorter rearing period and the lower cost of feed, which represents 65 – 70% of total production costs. Despite their low total revenue, broiler chickens demonstrated moderate economic efficiency (19%), reflecting their efficient feed conversion and shorter production cycle.

In comparison, the Mule and Pekin ducks exhibited intermediate economic performance. Mule ducks ranked second in total revenue and economic efficiency (26%), benefiting from their relatively high final LBW and moderate feed consumption. Pekin ducks, while having lower total costs than Muscovy and Mule ducks, showed limited net revenue (6.24 L.E.) and economic efficiency (8%), likely due to their smaller LBW and lower market price per kilogram of meat. Shershery ducks, however, showed the least favorable economic outcomes, with a negative net revenue (-3.11 L.E.) and economic efficiency (-3%). This poor performance reflects their lower LBW, limited market demand, and higher relative production costs, making them the least economically viable option among the studied breeds.

These findings align with previous research by Ali and Islam (1995) which emphasized the importance of breed-specific traits in determining profitability. Additionally, the higher net revenue and economic efficiency observed in Muscovy ducks could be attributed to their genetic potential for greater final LBW, higher price per kilogram of meat, and superior adaptability as reported by Solomon et al., (2006); Gouda & Essawy (2010) and Hassan et al., (2018). Moreover, the superior livability percentages observed in Muscovy and Mule ducks further enhance their economic viability, as these traits reduce mortality-related losses and stabilize production outputs. In brief, while broiler chickens offer cost-effective production for shorter cycles, Muscovy and Mule ducks demonstrate significant economic advantages for extended production periods. These results underscore the importance of selecting breeds based on production goals and market demands to optimize profitability in poultry farming systems.

Annual economic feasibility

The data presented in Table 4 illustrates the annual economic feasibility of the studied duck breeds and broiler chickens. The results reveal significant differences (p<0.01) among the breeds in terms of total costs, revenues and economic efficiency, highlighting the impact of production cycle duration and genetic potential on profitability. Muscovy ducks recorded the highest total bird cost per cycle and per year, as well as the highest total revenue per bird per cycle. This can be attributed to their higher feed consumption, extended growth period and superior live body weight (LBW), which contribute to increased production costs. In contrast, broiler chickens exhibited the lowest total cost per cycle and per year, mainly due to their shorter production cycle (42 days) and lower feed requirements. These findings align with previous studies by Ali and Islam (1995) and Solomon et al., (2006), which noted the economic advantages of shorter production cycles in minimizing costs.

Regarding profitability, Muscovy duck breed achieved the highest net revenue per cycle and per bird per year, as well as the highest economic efficiency (E.E.), significantly outperforming all other duck breeds. This superior performance is primarily due to their higher final LBW, greater market value per kilogram of meat, and improved livability %. These results are consistent with the findings of Gouda & Essawy (2010) and Hassan et al., (2018), who reported that Muscovy ducks exhibit better adaptability and economic returns in comparison to the other commercial duck breeds.

In contrast, Shershery ducks recorded the lowest values for net revenue and economic efficiency, with negative profitability (- 50.96 L.E. per bird per year). This poor financial performance is likely due to their lower LBW, reduced market weight, and higher relative production costs. These findings highlight the economic limitations of Shershery ducks in commercial duck production, suggesting that they may not be a viable option for intensive and commercial production.

Interestingly, Mule duck breed ranked as second breed in overall economic performance, achieving moderate net revenue and economic efficiency. Their performance can be attributed to their intermediate growth rate and final LBW. While Pekin ducks, showing lower total costs, exhibited limited net revenue, reflecting their lower market value and smaller LBW. To sum up from the annual economic feasibility view, differences observed in economic feasibility across the studied breeds can be attributed to a combination of genetic potential, growth efficiency, feed utilization, market demand, and production cycle duration. While broiler chickens remain the most cost-effective option for rapid growth production, Muscovy and Mule ducks demonstrate higher profitability over extended production periods due to their superior final LBW, higher market price, and better livability %. These findings underscore the importance of breed selection based on economic efficiency and market demand to optimize poultry production profitability.

Agricultural cooperative associations and their role in the poultry sector:

Trends of broilers, ducks, and slaughtered birds during the period (2016-2021):

The data presented in Table 5 provide valuable insights into the trend's numbers of broilers, ducks and slaughtered birds during the period from 2016 to 2021. These data illustrate notable fluctuations in the numbers of broilers, ducks and slaughtered birds, reflecting variations in production dynamics, market demand, and industry developments.

Data in Table 5 showed that, the average number of slaughtered farm broiler chickens reached approximately 1152.6 $\times10^6$ birds, with a minimum of about 858.8 $\times10^6$ birds in 2016 and a maximum of approximately 1588.4 $\times10^6$ birds in 2021. Similarly, the average annual production of broilers was around 868.12 $\times10^6$ birds, ranging from a low of 576.96 $\times10^6$ birds in 2016 to a high of approximately 1433.9 $\times10^6$ birds in 2021. For ducks, the average annual production was about 11.6 $\times10^6$ birds, with production levels fluctuating between a minimum of 10.5 $\times10^6$ birds in 2018 and a maximum of 12.9 $\times10^6$ birds in 2021. Additionally, the annual average number of slaughtered ducks was approximately 26.5 $\times10^6$ birds, reaching its lowest point of around 19.6 $\times10^6$ birds in 2020 and peaking at 33.9 $\times10^6$ birds in 2018. Generally, the results in Table 5 indicate a clear expanding in broiler chicken production motivated by industry upgrading and increased consumer demand. However, the results indicate a relative increase in duck production numbers. For this reason, this study attempts to further lighten on the productive and economic efficiency of duck meat production projects to enhance their profitability and increase the competition of broiler chickens under current production conditions challenges such as environmental changes, epidemic disease and unstable market conditions.

Development in the number of agricultural cooperative associations in the poultry sector:

The data in Table 6 illustrates the development of cooperative associations for poultry wealth, their capital and total investments in the poultry sector during the period from 2009/2010 to 2021/2022. Clearly the data in Table 6 showed that the average number of poultry wealth cooperative associations was approximately 6 associations, with a minimum of about 2 in 2011/2012 and a maximum of about 8 in 2021/2022. By estimating the general time trend equation for the number of qualitative cooperative associations for poultry wealth in Egypt during the period (2009/2010 - 2021/2022), it is clear from the data in Table 7 that the statistical significance of the model is confirmed at a probability level of (0.01), indicating an increase in the total number of specialized cooperative associations at an annual growth rate of approximately 0.4 associations per year. The calculated value of (F) was about 18.16, which is greater than the tabulated value at conventional significance levels. Additionally, the value of the coefficient of determination (R2) was about 0.62, meaning that approximately 62% of the occurring changes are reflected by the time element.

Regarding the average capital of these associations, qualitative cooperative associations for poultry wealth reached nearly 5 $\times10^6$ pounds during the period (2009/2010 - 2021/2022), with a minimum of about 278 $\times10^3$ L.E. in 2014/2015 and a maximum of about 11.49 $\times10^6$ L.E. in 2021/2022. By estimating the general time trend equation for the capital of qualitative cooperative associations for poultry wealth in Egypt during the period (2009/2010 - 2021/2022), it is clear from the data in Table No. 7 that the statistical significance of the model is confirmed at a probability level of (0.01), indicating an increase in the capital of specialized cooperative associations at an annual growth rate of approximately 1.23 $\times10^6$ L.E. per year. The calculated value of (F) was about 47.02, which is greater than the tabulated value at conventional significance levels. Additionally, the value of the coefficient of determination (R2) was about 0.81, meaning that approximately 81% of the occurring changes are reflected by the time element.

Moreover, the ratio of poultry investments to total investments: It is evident from the data in Table 6 that the average value of poultry investments in the specialized cooperative associations for poultry wealth reached approximately 244 $\times10^3$ L.E., representing 1.02% of the average total investments in agricultural cooperative associations, which amounted to about 23.82 $\times10^6$ L.E. during the period (2009/2010 - 2021/2022). The lowest poultry investment value was around 8 $\times10^3$ L.E. in 2011/2012, representing 0.02% of the total investments in agricultural cooperative associations, while the highest value reached approximately 803 $\times10^3$ L.E. in 2018/2019, representing 3.31% of the total investments in agricultural cooperative associations.

By estimating the general time trend equation for the value of poultry investments in the specialized cooperative associations for poultry wealth in Egypt during the period (2009/2010 - 2021/2022), it is clear from the data in Table 7 that the statistical significance of the model is confirmed at a probability level of (0.01), indicating an increase in the value of poultry investments in specialized cooperative associations at an annual growth rate of approximately 54.91 $\times 10^3$ L.E. per year. The calculated value of (F) was about 19.13, which is greater than its tabulated counterpart at conventional significance levels, and the value of the coefficient of determination (R^2) was approximately 0.64, meaning that about 64% of the occurring changes are reflected by the time element.

Furthermore, Poultry fattening investments in the specialized cooperative associations for poultry wealth averaged 20.3 $\times 10^6$ L.E. during the period (2009/2010 - 2021/2022), with a minimum of 11.17 $\times 10^6$ L.E. and a maximum of 40.53 $\times 10^6$ pounds. statistical significance has not been established. In addition, duckling chicks' incubation investments averaged 2.8 $\times 10^6$ L.E. during the period (2009/2010 - 2021/2022), with a minimum of about 60 $\times 10^3$ L.E. in the year 2010/2011 and a maximum of around 3.9 $\times 10^6$ L.E. in the year 2015/2016. Statistical significance has not been established. However, duck fattening investments were recorded only in 2012/2013 and 2015/2016, amounting to approximately 4.72 $\times 10^6$ L.E. in each season.

The critical Role of Agricultural Cooperatives in Developing the Poultry Sector:

The findings of this study confirm that Muscovy and Mule ducks exhibit superior productive and economic performance compared to other duck breeds such, as Pekin and Shershery, making them more profitable and lower-risk alternatives to broiler chickens during the current challenges facing Egypt's poultry industry. In this context, agricultural cooperatives play a crucial role in fostering the development and sustainability of the poultry sector by reducing production costs through the collective purchasing of essential inputs, including ducklings, diets, medications and necessary other equipment, ensuring competitive pricing. Additionally, cooperatives contribute to lowering logistical expenses, such as transportation, storage and marketing costs, thereby improving overall cost efficiency.

Furthermore, agricultural cooperatives enhance productivity and product quality by providing technical training and extension services on optimum poultry management practices, ultimately improving feed conversion efficiency and reducing mortality rates. Moreover, they strengthen farmers' bargaining power through collective marketing strategies, ensuring fair pricing for poultry products and services, particularly for high-demand duck breeds. This approach also facilitates better access to local markets, increasing economic opportunities for producers.

In addition to these benefits, cooperatives provide financial and non-monetary support, along with insurance mechanisms to mitigate risks associated with price fluctuations and production losses, enabling the expansion of more profitable breeds such as Muscovy and Mule ducks. Furthermore, agricultural cooperatives enhance value chain integration by establishing comprehensive projects that encompass hatchery operations, slaughtering facilities, and food processing units, which not only improve profitability and production sustainability but also reduce reliance on intermediaries, ensuring higher revenues for producers and lower prices for consumers. Finally, promoting environmentally sustainable practices, such as waste recycling and efficient resource management, further enhances production efficiency while minimizing environmental impact. Based on these considerations, strengthening the role of agricultural cooperatives is essential for stabilizing the poultry sector and improving the economic viability of duck production, particularly for Muscovy and Mule ducks.

CONCLUSIONS

Based on these results, the study concludes that Muscovy and Mule ducks exhibit superior growth performance, lower mortality rates, and higher economic feasibility over extended production periods compared to broiler chickens and other duck breeds, making them suitable alternatives for sustainable poultry farming in Egypt. It is recommended to encourage duck production, particularly Muscovy and Mule breeds. Also, the findings highlight the critical role of agricultural cooperative associations in supporting poultry sector through diversifying poultry production projects, reducing dependency on broiler chickens, enhancing food security while mitigating risks associated with disease outbreaks and market fluctuations through collective procurement, financial support, and insurance mechanisms, ensuring greater stability and sustainability in duck farming.

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Table 1. Live body weight of different duck breeds vs broiler chicken

Age (wk)	*Duck breeds vs broiler chicken*					SEM	*p*-value
	Muscovy	Mule	Pekin	Shershery	Broiler		
0 d	44.86[bc]	45.60[bc]	46.90[ab]	47.18[a]	47.56[a]	0.246	<0.01
2nd wk	445.96[c]	568.82[a]	462.73[c]	453.27[c]	498.10[b]	4.749	<0.01
4th wk	1273.90[c]	1482.40[a]	1082.30[d]	1088.75[d]	1394.21[b]	13.709	<0.01
6th wk	2376.70[b]	2644.40[a]	2078.30[c]	1946.70[d]	2528.93[a]	25.456	<0.01
8th wk	3313.90[a]	3431.70[a]	2447.20[b]	2175.53[c]	-----	40.21	<0.01
10th wk	3884.90[a]	3734.90[a]	2886.10[b]	2553.80[c]	-----	48.32	<0.01

Table 2. Productive performance of different duck breeds vs broiler chicken.

Traits	Duck breeds vs broiler chicken					SEM	*p*-value
	Muscovy	Mule	Pekin	Shershery	Broiler		
Productive performance:							
Initial BW (g)	44.87^{c}	45.61^{bc}	46.91^{ab}	47.18^{a}	47.62^{a}	0.228	<0.01
Final BW (g)	3886.80^{a}	3736.03^{a}	2885.91^{b}	2551.24^{c}	2529.09^{c}	45.99	<0.01
Body Weight gain (g)	3841.94^{a}	3690.43^{a}	2839.00^{b}	2503.81^{c}	2481.56^{c}	46.02	<0.01
Average daily gain	54.86^{b}	52.70^{b}	40.56^{c}	36.40^{d}	58.92^{a}	0.740	<0.01
Relative growth rate	195.12^{a}	195.06^{a}	193.56^{b}	192.70^{c}	192.49^{c}	0.095	<0.01
Total FC (Kg)	12.26^{a}	10.21^{b}	8.21^{c}	9.65^{b}	4.50^{d}	0.599	<0.01
Average daily FC (g)	175.10^{a}	145.90^{b}	117.26^{c}	137.83^{b}	107.05^{d}	5.592	<0.01
FCR	3.17^{b}	2.76^{d}	2.89^{c}	3.85^{a}	1.81^{e}	0.152	<0.01
Mortality rate (%)	0.83^{d}	1.67^{c}	2.50^{b}	2.50^{b}	4.17^{a}	0.426	<0.01
Livability (%)	99.17^{a}	98.34^{b}	97.50^{c}	97.50^{c}	95.84^{d}	0.426	0.047
Flock Uniformity (%)	82.00^{b}	90.31^{a}	88.49^{b}	84.91^{c}	88.05^{b}	0.170	0.047
Performance Indexes:							
EPEI	174.82^{c}	191.18^{b}	138.88^{d}	92.64^{e}	319.09^{a}	17.46	<0.01
PI	123.35^{b}	136.05^{a}	99.73^{c}	66.50^{d}	139.85^{a}	6.279	<0.01
RPI	73.43^{c}	80.30^{b}	58.33^{d}	38.90^{e}	107.23^{a}	5.259	<0.01
YUA	23.30^{a}	22.13^{a}	16.88^{c}	14.95^{d}	19.40^{b}	0.740	<0.01
UP	0.34^{a}	0.24^{b}	0.07^{c}	0.04^{c}	0.23^{b}	0.026	<0.01

Table 3. Economic Feasibility of different duck breeds vs broiler chicken.

Traits	Duck breeds vs broiler chicken					SEM	*p*-value
	Muscovy	Mule	Pekin	Shershery	Broiler		
Productive data: *							
Chick price	14.00	15.00	7.00	4.00	10.00	---	---
FC (kg)	12.26	10.21	8.21	9.65	4.50	---	---
Average Feed cost/kg	7.75	7.75	7.75	7.75	8.50	---	---
Livability %	0.99	0.99	0.98	0.98	0.96	---	---
Price/kg.LBW	39.00	34.00	29.00	31.00	27.00	---	---
Live body weight	3.91	3.75	2.88	2.56	2.53	---	---
Variable and fixed Costs:							
Chick cost	14.00^{a}	15.00^{a}	7.00^{c}	4.00^{d}	10.00^{b}	1.477	<0.01
Feed cost	94.99^{a}	79.15^{b}	63.61^{c}	74.77^{b}	38.22^{d}	4.384	<0.01
Management & medication	5.00^{b}	5.00^{b}	4.50^{b}	3.00^{c}	6.50^{a}	0.477	<0.01
Total variable costs	113.49^{a}	99.15^{b}	75.11^{d}	81.77^{c}	54.72^{e}	4.680	<0.01
Total fixed costs	1.50^{b}	1.50^{b}	1.50^{b}	1.50^{b}	1.00^{a}	0.046	<0.01
Total cost	114.99^{a}	100.65^{b}	76.61^{d}	83.27^{c}	55.72^{e}	4.714	<0.01
Revenues:							
Revenue (selling bird)	151.33^{a}	125.42^{b}	81.55^{c}	79.79^{c}	65.50^{d}	7.586	<0.01
Others (litter, bags, etc)	1.30^{a}	1.30^{a}	1.30^{a}	1.30^{a}	0.90^{b}	0.037	<0.01
Total revenue	152.63^{a}	126.72^{b}	82.85^{c}	81.09^{c}	66.40^{d}	7.510	<0.01
Net revenue (L.E)	37.64^{a}	26.07^{b}	6.24^{d}	-3.11^{e}	10.68^{c}	3.056	<0.01
Economic efficiency (%)	0.33^{a}	0.26^{b}	0.08^{d}	-0.03^{e}	0.19^{c}	0.025	<0.01

** Note: Prices are collected and calculated according to the Egyptian market during the experimental period.*

Table 4. Annual Economic Feasibility of different duck breeds vs broiler chicken.

Traits	*Duck breeds vs broiler chicken*					SEM	*p*-value
	Muscovy	Mule	Pekin	Shershery	Broiler		
Productive data:*							
Growing period (d)	70	70	70	70	42	---	---
Resting period (d)	14	14	14	14	14	---	---
No. of cycles/year	4.35	4.35	4.35	4.35	6.52	---	---
Disinfection cost /bird/cycle	0.50	0.50	0.50	0.50	0.50	---	---
Total bird cost/cycle	116.46^{a}	100.65^{b}	76.61^{d}	90.31^{c}	54.67^{e}	4.89	<0.01
Total bird cost/year	118.63^{a}	102.83^{b}	78.79^{d}	92.49^{c}	57.92^{e}	4.82	<0.01
Revenues:							
Total revenue/bird/cycle	152.13^{a}	126.22^{b}	82.35^{c}	80.59^{c}	65.9^{d}	7.510	<0.01
Net revenue /cycle (L.E)	40.05^{a}	22.38^{b}	3.43^{d}	$- 11.72^{e}$	9.31^{c}	3.00	<0.01
Net revenue /bird/year (L.E)	174.21^{a}	97.34^{b}	14.90^{d}	$- 50.96^{e}$	60.70^{c}	0.60	<0.01
E.E/cycle (%)	0.34^{a}	0.22^{b}	0.04^{d}	$- 0.12^{e}$	0.16^{c}	0.02	<0.01
E.E/bird/year (%)	1.47^{a}	0.95^{b}	0.19^{c}	$- 0.55^{d}$	1.05^{d}	0.10	<0.01

** Note: Prices are collected and calculated according to the Egyptian market during the experimental period.*

Table 5. Average numbers of broilers, ducks, and slaughtered during the period (2016-2021).

Indicator	Number of Slaughtered Farm Chickens	Number of Broilers	Number of Ducks	Number of Slaughtered Ducks
2016	858837	576959	11130	31705
2017	882320	595245	11126	31961
2018	895794	611987	10502	33009
2019	1243942	594456	12163	22000
2020	1446332	1396201	11636	19600
2021	1588358	1433869	12862	20915
Average	1152597,17	868119,5	11569,83	26531,67

Note: Values are expressed in a thousand, **Source:** Collected and calculated from the Central Agency for Public Mobilization and Statistics, Annual Bulletin of Statistics Livestock, Various Numbers.

Table 6. Development of the number of poultry wealth cooperatives, capital, and total investments in the poultry sector during the period (2009/2010 - 2021/2022):

Item	Average	Minimum	Maximum	SD
Number of poultry wealth cooperatives	6	2	8	1.9
Capital	4963	278	11485	5324.6
Value of poultry investments	244	8	803	268.4
Total investments	23818	6935	32723	7597.9
% of poultry investments to total investments	1.02	0.02	5.57	1.68
Poultry fattening investments	20297	11168	40529	9197.3
Chick and duckling incubation investments	2797	60	3887	950.6
% of duck investments to total poultry investments	11.8	0.31	26.15	15.8

Note: Values are expressed in a thousand pounds.
Source: Collected and calculated from the Central Agency for Public Mobilization and Statistics, Annual Bulletin of Cooperative Activity in the Agricultural Sector, Various Issues.

Table 7. General time trend equations for the number of poultry cooperative societies, capital, and poultry investments during the period (2009/2010 - 2021/2022).

Indicator	General Time Trend Equations	R^2	F	% Rate of change
Number of poultry cooperative societies	$\hat{Y} = 2.85 + 0.39 X$ (4.261)**	0.623	18.16	15.35
Capital	$\hat{Y} = - 3652.46 + 1230.82 X$ (6.86)**	0.810	47.018	24.8
Poultry investments	$\hat{Y} = 140.58 + 54.91 X$ (4.374)**	0.635	19.13	22.5

Source: Compiled and calculated from the data in Table no. (6).

** Significant at the 0.01 level, Annual rate of change = Regression Coefficient / Overall Average * 100, x = time variable.

إنتاجية وربحية سلالات البط التجارية مقارنة بدجاج التسمين تحت الظروف المصرية: دور التعاونيات الزراعية في دعم واستدامة قطاع الدواجن

محمد شحاته أبوجبل[1,*], عبد الحميد عزت الشاذلى[2]

[1]قسم الانتاج الحيوانى ، كلية الزراعة، جامعة الأزهر, القاهرة, مصر.

[2]قسم الاقتصاد الزراعى ، كلية الزراعة، جامعة الأزهر, القاهرة, مصر.

[*] البريد الإليكتروني للباحث الرئيسي: **dr.mabougabal@gmail.com**

الملخص العربي:

تواجه صناعة الدواجن في مصر وخاصة قطاع دجاج التسمين العديد من المعوقات والتحديات بما في ذلك تضخم تكاليف الإنتاج وتفشي الأمراض والتغيرات المناخية بالإضافة إلى تقلبات ظروف السوق. مما أثر بشكل كبير على المنتجين لا سيما صغار ومتوسطي المربين الذين قللوا من حجم إنتاجهم جزئيًا أو توقفوا عن الإنتاج تمامًا. نتيجة لذلك هناك اهتمام متزايد بتحديد أنواع بديلة من الدواجن التي توفر مرونة اقتصادية أفضل وأكثر استدامة إنتاجيًا. لهذا الغرض تهدف هذه الدراسة إلى تقييم الأداء الإنتاجي والاقتصادي لأربعة أنواع تجارية متاحة محليًا من البط (المسكوفي والمولار والبكيني والشرشيري) كبدائل محتملة لدجاج التسمين تحت الظروف الإنتاجية الحالية. ولتحقيق هذا الهدف، تم تربية 240 كتكوت بط بعمر يوم واحد (60 كتكوتًا من كل نوع) بالإضافة إلى 60 كتكوت دجاج تسمين من سلالة الكوب (*Cobb[500]*) تحت نفس الظروف البيئية والرعائية من عمر يوم حتى عمر التسويق المناسب لكل منها. وتم تقييم أداء النمو والمؤشرات الإنتاجية وكذلك الجدوى الاقتصادية والربحية السنوية لكل نوع من البط ودجاج التسمين. أظهرت النتائج إلى أن دجاج التسمين تفوق بشكل واضح على جميع أنواع البط الأخرى من حيث أداء النمو وكفاءة تحويل الغذاء (FCR) والمؤشرات الإنتاجية الاقتصادية ومؤشر كفاءة الإنتاج الأوروبي (EPEI) والروسي (RPI) ومؤشر الأداء الإنتاجي (PI) خلال الأسابيع الستة الأولى من التجربة. ومع ذلك، بحلول الأسبوع العاشر وبغض النظر عن دجاج التسمين، حقق البط المسكوفي والمولار أعلى وزن حي نهائي وأفضل نسبة حيوية (%) وكذلك أفضل مؤشرات إنتاجية كدليل كفاءة الإنتاج الأوروبي (EPEI) وكفاءة الأداء الإنتاجي (PI) ومحصول اللحم الناتج من وحدة المساحة (YUA) والعائد من وحدة الإنتاج (UP)، فضلاً عن تحقيقها أفضل كفاءة اقتصادية مقارنة بالبط البكيني والشرشيري. ومن الجدير بالذكر أن البط المسكوفي سجل أعلى إيرادات إجمالية وأفضل أرباح صافية تلاه في ذلك البط المولار ثم دجاج التسمين ثم البط البكيني بينما سجل البط الشرشيري أقل قيم لهذه العوائد الاقتصادية سواء لدورة إنتاج واحدة أو على مدار عام كامل مما يجعله الخيار الأقل جدوى من الناحية التجارية. علاوة على ماسبق، ألقت الدراسة الضوء على الدور الفعال للتعاونيات الزراعية في دعم مربي ومنتجي الدجاج والبط من خلال تقديم الاستثمارات المالية في قطاع الدواجن وتوفير التدريب والدعم الفني للمنتجين والمربين بالإضافة إلى تحسين عمليات التسويق وقد ساهمت هذه الجهود في زيادة الإنتاج وتعزيز تنوع إنتاج الدواجن بشكل أكثر استدامة وأقل مخاطرة. وختامًا، وبناءً على هذه النتائج، توصي الدراسة بالتوسع في تربية وإنتاج البط المسكوفي أو البط المولار كبدائل أكثر ربحية وأقل مخاطرة اقتصاديًا لا سيما في ظل المعوقات والتحديات والظروف الراهنة التي تواجه صناعة الدواجن.

الكلمات الاسترشادية :الإنتاجية، الربحية، سلالات البط، دجاج التسمين، التعاونيات الزراعية.