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Indicadores de eficiencia productiva en granjas avícolas convencionales vs tecnificadas ubicadas en la provincia de Manabí - Ecuador

Indicators of productive efficiency in conventional vs. technical poultry farms located in the province of Manabí - Ecuador

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Palabras claves:
Pollo de engorde, trópico, eficiencia productiva, sistema de crianza.

Resumen

Introducción: En el sector avícola existe una creciente necesidad de optimizar los índices técnicos en la producción de carne a escala industrial, lo que ha llevado al desarrollo de estrategias de gestión dirigidas a optimizar la eficiencia de estos sistemas y a su vez el bienestar de los pollos broilers. En países en desarrollo como Ecuador una alternativa que permitiría mejorar los índices de producción es optimizar los insumos en la infraestructura existente. **Objetivo:** Evaluar los indicadores de eficiencia productiva en granjas avícolas convencionales vs tecnificadas ubicadas en la provincia de Manabí - Ecuador. **Metodología:** Se recopiló registros productivos de granjas ubicadas en el Centro y Sur de Manabí, que está bajo la administración del comercial Avícola Macías. Se procesaron datos de 413 lotes mixtos de pollos de engorde criados en 20 granjas convencionales (304 lotes) y en tres granjas tecnificadas (109 lotes), durante el período productivo 2020 a 2022. **Resultados:** Se obtuvo que las granjas convencionales con lotes < a 30000 pollos, tienden a tener mayor peso final, y, por ende, un mayor consumo de alimento, ganancia de peso y conversión alimenticia (CA) en comparación a las de mayor tamaño (grupo 4), sin embargo, estas últimas mostraron una mayor edad hasta la venta (> 55 días). Por su parte, la comparación entre un sistema de alojamiento más tecnificado y un convencional con escalas de producción similares, exponen una mejora significativa $p<0,05$ para todos los indicadores técnicos en los sistemas tecnificados a excepción del peso y la mortandad. **Conclusión:** Las granjas tecnificadas fueron las que mostraron los mejores indicadores de eficiencia productiva, probablemente debido a un conjunto de factores que favorecen dicho resultado, entre ellos las adecuadas condiciones ambientales. **Área de estudio general:** Soberanía y seguridad alimentaria. **Área de estudio específica:** Producción de animal sostenible y salud animal.

Keywords:
broiler chicken, tropics, productive efficiency, breeding system.

Abstract

Introduction: In the poultry sector there is a growing need to optimize the technical indexes in meat production on an industrial scale, which has led to the development of management strategies aimed at optimizing the efficiency of these systems and in turn the welfare of broiler chickens. In developing countries such as Ecuador, one alternative to improve production rates is to optimize

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inputs in the existing infrastructure. Objective: Evaluate production efficiency indicators in conventional vs. technician poultry farms located in the province of Manabí - Ecuador. Methodology: Production records were collected from farms located in central and southern Manabí, which are under the administration of the commercial Avícola Macías. We processed data from 413 mixed flocks of broilers raised in 20 conventional farms with 304 flocks and in three technical poultry farms with 109 flocks, during the production period 2020 to 2022. Results:It was found that conventional farms with flocks < 30,000 chicks tended to have higher final weight, and therefore, higher feed intake, weight gain and feed conversion ratio (FCR) compared to larger farms, however, the latter showed a higher age at sale (> 55 days). On the other hand, the comparison between a more technified housing system and a conventional one with similar production scales, showed a significant improvement $p<0.05$ for all indicators in the technified systems except for weight and mortality. Conclusion: The modernized farms were those that showed the best indicators of productive efficiency, probably due to a set of factors that favor this result, including adequate environmental conditions.

Introduction

The poultry sector has experienced a growing need to optimize technical indices in the production of poultry meat on an industrial scale, which has led to the development of management strategies aimed at improving the efficiency of rearing systems and the welfare of broilers at all stages (Gallard et al., 2022; Shynkaruk et al., 2023). Rearing or housing systems have been shown to be a factor that predisposes to improved productive efficiency, as well as the health and welfare of broilers.(Qaid, Albatshan, Hussein, & Al-Garadi, 2023)There are two types of housing systems: conventional and technologically advanced. The first is characterized by inducing a particular macroenvironment without major intervention, while the technologically advanced one has a ventilation system and more controlled biosecurity measures.(Qaid, Albatshan, Hussein, & Al-Garadi, 2023).

In Ecuador, poultry farming is a developing activity, however, in the last three decades it has experienced significant growth in its production.(Tapia, 2015). Around 1990, the country produced 50 million broiler chickens, by 2019 it reached 279 million, an increase of 14% compared to 2018 and 440% in the last 29 years. According to data from the

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Ecuadorian Institute of Statistics and Censuses (INEC), in 1990 per capita consumption was 7 kg of chicken meat per year, by 2020 annual consumption stood at approximately 30 kg/inhabitant (Vargas, 2016; Corporación Nacional de Avicultores del Ecuador [CONAVE], 2021). Currently, the national demand for chicken meat has been able to be supplied, and given the growth of this livestock sector in 2023, the Ministry of Agriculture and Livestock "MAG" announced the first export to the Bahamas of 28 tons of chickens from the San Isidro poultry farm, thus representing approximately 3% of the country's gross domestic product (GDP) (Ministry of Agriculture and Livestock [MAG], 2021; Agrocalidad, 2023).

However, intensive broiler breeding systems in tropical countries such as Ecuador, due to adverse weather conditions with high ambient temperature and high humidity, typical of the region and in recent years aggravated by global warming, represent a limitation in the breeding, well-being and productive efficiency of the system.(Mahmoud, et al., 2020)Resource efficiency in the poultry sector of developing countries such as Ecuador represents an alternative that would allow increasing production by optimizing inputs within the existing infrastructure.

There are several indicators that can be used to measure the efficiency of poultry farms according to Ingalls & Muñiz (2007, cited by Murillo & Vásquez, 2018), these include final live body weight, feed conversion in the production cycle of the batch and age at which the desired weight is reached. Andrade et al. (2017), report in Cobb-500 chickens raised under experimental conditions and conventional sheds in the Amazon region of Ecuador a conversion of 1.50 kg for each kg of feed supplied and a final weight of 2.773 kg at 49 days of age. In contrast, in the city of Babahoyo belonging to the Costa region of Ecuador, Guerra et al. (2019), reported under similar housing conditions, an average of 1.97 kg of feed conversion with a live weight of 2.933 kg at 42 days of age.

Khan et al. (2022) argued that output and productivity can be increased through two approaches: the first is to improve technology given a certain amount of inputs, and the second is to make farms more efficient while maintaining the same level of inputs and the same technology.

Therefore, the objective of this study was to evaluate the productive efficiency indicators in conventional vs. technologically advanced poultry farms located in the province of Manabí - Ecuador.

Methodology

The research was carried out in broiler poultry farms in the center and south of the Manabí Province, which is located in the north of the coastal region of Ecuador with an approximate area of 19,516.6 km2. In the central area (Portoviejo and Montecristi), the

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dry to semi-humid megathermal climate predominates, while in the southern area (Olmedo and Santa Ana) the humid megathermal climate prevails, with rainfall of 500 to 1000 mm and 1000 to 2000 mm per year respectively and temperatures that vary from 15-24ºC. The administration of these farms is carried out by Comercial Avícola Macías, under 3 concepts: own farms, companies and integrated farms. Therefore, from there the database that corresponds to the production records was obtained.

Animals

Retrospective production records were collected from 413 mixed batches of broiler chickens raised on 20 conventional farms with 304 batches and on three technologically advanced farms with 109 batches, during the production period from 2020 to 2022 with an approximate production of 7.2 million broiler chickens. Furthermore, due to the variation in the size of conventional farms, they were grouped into four groups:

1) small < 10,000 birds.
2) medium ≥10001 and < 20000 birds.
3) large ≥ 20,001 and <30,000 birds.
4) extra large > 30001 birds.

Feeding and management

The feed is the basis of the diet, it mainly contains macro ingredients such as corn, soy, palm oil and the kernel (ADILISA) which contains micro ingredients such as vitamins, anticoccidials, antifungals and others. The management of the feed is divided into three stages:

- Pre-initial: 0 to 7 days of age.
- Initial: 8 to 21 days of age.
- Fattening: 22 years of age until sale.

Although this work describes farms with different housing systems, the general management is very similar. The floor is covered with beds of chaff "rice husks", and prior to receiving batches of chickens, there is a process of washing equipment, walls and pipes, followed by disinfection and thermal fogging of the sheds.

Body weight record

The weight of the birds was recorded from the moment the baby chickens were received at the farm and from then on every 7 days, until the moment the live chicken was sold.

Variables to analyze

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- Final live weight: Corresponds to the total pounds of meat produced in a batch divided by the number of live birds sold (lbs).
- Age: Days of production of the batch. From reception to sale.
- Mortality: Number of dead or discarded birds/batch (%).
- Feed Consumption: Average amount of feed consumed per bird in each batch (lbs).
- Cumulative feed conversion (CF): Amount of feed consumed in the flock converted into pounds of meat (lbs).
- Gain: Weight gain or increase for age (lbs).

Statistical analysis

Conventional farms were divided into four groups based on the number of birds produced on the farms, making up different production size categories. To check whether this criterion differentiated levels of differentfarm sizes,The averages and standard deviations were estimated and the Analysis of Variance and Tukey's comparison of means tests were applied ($p<0.05$); the same statistics that were applied to analyze each of the variables based on thefarm size.For the comparison of conventional and technologically advanced farms, the criterion of comparison with the conventional group of similar size was used. Statistical analyses were performed using the JMP software package in its version 5.0 for Windows.

Results

The introduction of technologies in broiler housing systems in developing countries has focused on providing an environment that meets the thermal requirements of these birds in order to obtain better productive performance, withoutleave dand sideconventional farms, of psmall,medianand greatscalesince contribute significantlytochicken meat production;heCcommercialTOMacias wineryrecorded aproductionbetween 2020 and 2022,forThis last systemof4,5millions of birds approximately, which represents a62% of productionunder study. In the regionThere is theeminentnecessaryity ofmeasuresuch indicators of productive efficiency within each of these systemsthatIn addition to comparing,allow us to evaluate the most appropriate technical management based on the environmental and accommodation conditions existing in eachbreeding system.

Table 1

Comparison of efficiency indicators in conventional broiler farms, according to their size

	Indicators					
Cluster	Food Consumption lbs	Conversion lbs	Revenue Lbs	Weight lbs	Age days	Mortality %

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1 (125)	13.0 ± 0.1a	1.90 ± 0.01a	0.143 ± 0.001a	6.8 ± 0.04[a]	47.7 ± 0.3b	9.4 ± 0.39ab
2 (72)	13.1 ± 0.1a	1.91 ± 0.01a	0.142 ± 0.001a	6.8 ± 0.05[a]	48.1 ± 0.4b	10.4 ± 0.51a
3 (58)	12.6 ± 0.1ab	1.84 ± 0.01b	0.139 ± 0.001a	6.8 ± 0.04[a]	49.3 ± 0.5b	8.1 ± 0.57b
4 (31)	12.1 ± 0.1b	1.80 ± 0.02b	0.121 ± 0.001b	6.7 ± 0.06[a]	55.7 ± 0.7a	8.3 ± 0.79ab

Note: Different letters in the column indicate significant differences p≤0.05
All values correspond to the arithmetic mean ± standard error.

Table 1 shows that the larger conventional farms showed a tendency to consume less feed, lower conversion in lbs, lower daily weight gain in lbs and accompanied by the longest time elapsed to sale with significant differences (p≤0.05). However, the final live weight did not show significant differences between the four groups.

Figure 1

Behavior of final weight, age and mortality in batches of small conventional farms (group 1) during the period 2020 to 2022

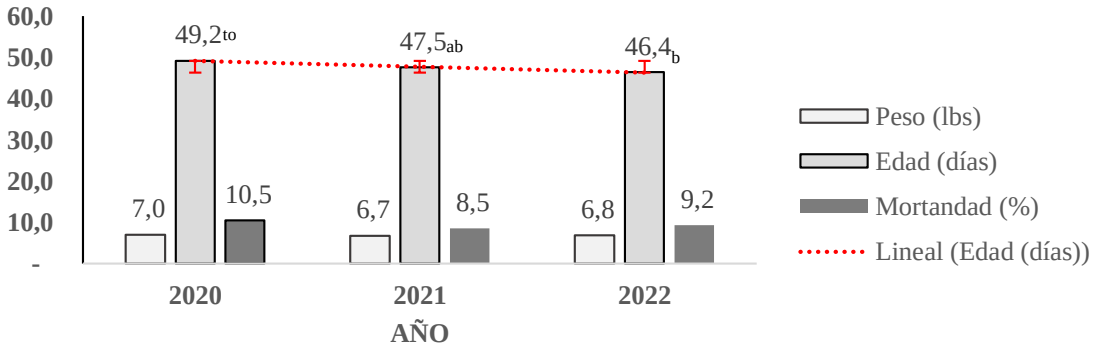

Figure 1 shows that mortality rises and falls depending on the year, while final weight remains constant over time. However, the age at sale indicator showed a tendency to decrease over the years, thus resulting in significant differences (p<0.05), with 2020 being the period in which broiler chickens were the oldest at sale.

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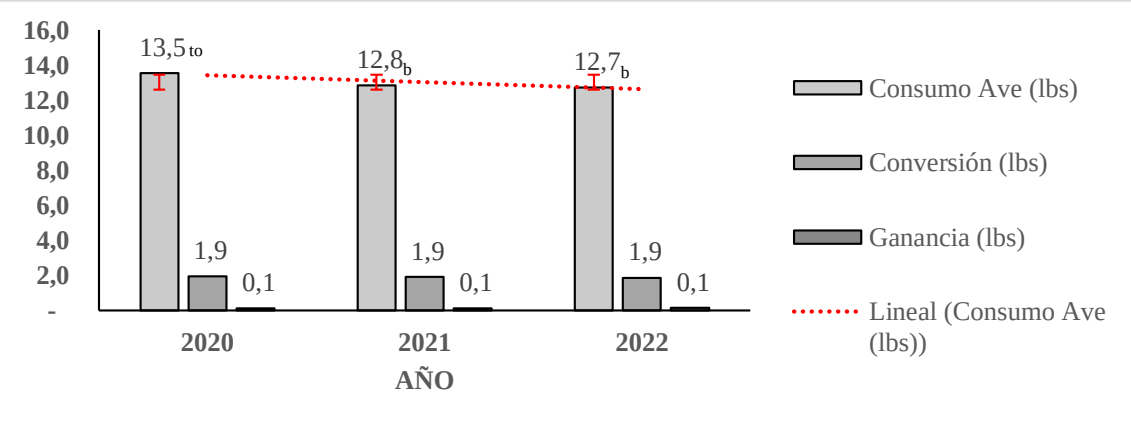
Figure 2

Comparison of productive indicators of consumption per bird, accumulated feed conversion and weight gain in conventional farms between the period 2020 and 2022



In Figure 2, feed conversion and daily weight gain were stable in the years analyzed. The only indicator that showed a tendency to decrease over time was feed consumption per bird ($p < 0.05$), therefore, the highest consumption per bird occurred in the period of 2020. The tendency to decrease age and feed consumption per bird over time synchronously probably suggests that these two parameters would be related, without influencing the other productive indicators.

Table 2

Comparison of efficiency indicators in conventional and technologically advanced broiler farms of the same size period 2022

	Indicators					
	Food Consumption lbs	Conversion lbs	Revenue lbs	Weight Lbs	Age Days	Mortality %
Technified (63)	11.4 ± 0.1	1.7 ± 0.01	0.160 ± 0.001	6.8 ± 0.03	42.3 ± 0.3	8.2 ± 0.4
Conventional (16)	12.3 ± 0.2	1.8 ± 0.02	0.146 ± 0.002	6.8 ± 0.07	46.8 ± 0.5	8.3 ± 0.5
	***	***	***	Ns	***	ns

Note: Ns: not significant $p \leq 0.0$
All values correspond to the arithmetic mean ± standard error.

Table 2 shows the comparison between a more technologically advanced housing system and a conventional one with similar production scales (group 3), where a significant improvement $p < 0.05$ is observed for all indicators in the technologically advanced systems except for weight and mortality.

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Discussion

The effect of housing density on production efficiency, carcass quality and, more recently, on animal welfare is a topic studied by a large number of researchers due to its importance in poultry production.(Škrbić, Pavlovski, & Lukić, 2009). The breeding of broiler chickens in countries with tropical and subtropical climates has limitations mainly due to climatic variations throughout the year, which have a marked influence on productive behaviour and animal welfare. The situation becomes even more complex if open sheds are used, where climatic variations have a greater impact on both indicators (Asiaín, 2018).

Increasing productivity in poultry farms requires a holistic strategy that considers technical progress and possible measures to increase production efficiency. However, research shows that in economically developing countries, increased efficiency should be the main driver of productivity growth, leading to sustainable economic development (Food and Agriculture Organization of the United Nations [FAO], 2014; Korres, 2016).

In the present study, it is shown that there is a tendency for the values of the indicators to be lower in larger conventional farms (group 4), where the feed conversion (FC) was p=1.80 and the weight (W) was 6.7 lbs, at an age > 50 days; under similar rearing conditions, Guerra et al. (2019), in contrast, report a FC> 1.9 and a weight of 6.52 lbs at an age <50 days, data that are related to the results presented in this work, but in smaller-scale farms (group 1, 2 and 3) see table 1. The finding of the final weight is partially consistent with the data reported by El-Tahawy et al. (2017), who mention that small-scale farms (<10,000 chickens) and medium-scale farms (10,001 to 30,000 chickens) showed significantly better body weight than larger batches (>30,000 chickens).

Regarding the older age in larger-scale farms (group 4), it could be indirectly related to the supply of available birds and the demand of the local market, since during the time period evaluated the COVID-19 pandemic began and its consequences in the poultry sector in Ecuador were very serious, which had an impact in 2020 with a 10% decrease in production compared to the 2019 period where chicken meat production had been around 530 thousand tons, this as a consequence of the imposition of restrictions due to the health crisis, the rise in feed costs, especially corn and soybeans, which weakened the local market and partially involved smuggling of live chickens from countries such as Colombia and Peru, which had lower costs (Ruiz, 2021; El Universo, 2023).

The number of kilograms or birds per square meter is still a debatable issue, it is assumed that higher densities result in a decrease in weight gain and individual productivity of the chickens.(Mortari, et al., 2002), coinciding with the results obtained in this work among conventional farms (Table 1). The maximum efficiency obtained through the increase in physical production is in many cases in contrast with the possibility of regulating the

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conditions of the poultry environment, worsening as the facilities and equipment used decrease their technological level, resulting in poor animal welfare.(Mortari, et al., 2002)The indicators of conventional farms (Table 1) showed significant differences in their behavior associated with the size of the farm, where the greater the volume of animals, the better the general parameters, but there was a tendency to reduce individual parameters, such as lower weight gain and, therefore, a lower final weight compared to smaller-scale conventional farms.

Regarding the lower mortality rate (p= <9%) in larger traditional farms, i.e. with a capacity for more than 20,001 birds; Arif & Shafi (2021) report similar results, where smaller farms have a higher mortality rate (p= 12.5%), compared to larger farms (p= 9.6%) however, they associate these differences with the profitability of these farms and the influence of adequate technical-sanitary management. In concurrence, in a study carried out in 125 poultry farms in Turkey between 2012-2013 where they evaluated technical productive indicators such as final live weight, age at slaughter and feed conversion, these did not obtain significant differences based on the scale of the farm (small, medium, large), which is associated with linear management in productions without distinction of the scale of these(Tandoğan, 2016).

Productivity of layer and broiler farms is increased by production inputs such as flock size, feed and labour. Although, studies find inefficiency among poultry farmers. Existing literature includes production inputs and characteristics as well as institutional factors affecting technical efficiency of layer and broiler production (Yenibehit et al., 2019; Ullah et al., 2019; Pradhan & Raut, 2019).

The factors with the greatest influence on broiler performance are related to housing conditions (including temperature and air speed), in addition to genetic background.(Baracho, Nääs, Lima, Cordeiro, & Moura, 2019). Therefore, the better performance shown in this work in technologically advanced farms vs. conventional ones, probably due to better environmental conditions, partially agrees with what was stated by Farhadi & Hosseini (2014), who indicate that modern sheds with environmentally controlled conditions and better environmental conditions increase the production efficiency index and reduce the mortality rate; facilitating the breeding of broiler chickens with a higher population density without any reduction in performance.

Improvements in poultry production efficiency and sustainable growth could be achieved through two methods: by introducing new production equipment or by improving the technical efficiency of poultry farmers, both of which are viable options to increase productivity in the industry. Technical efficiency (TE) has remained a prominent topic of research, especially in underdeveloped economies where most farmers are resource poor. Therefore, given the current state of technology in these countries, improving the

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technical efficiency of livestock and poultry farmers plays an important role in improving production and sustainability of the poultry sector (Khan et al., 2022).

Conclusions

- It is concluded that theTechnologically advanced farms were those that showed the best indicators of productive efficiency, probably due to a set of factors that favor this result, including adequate environmental conditions. typical of these accommodation systems.However, larger-scale conventional farmsThey showeda feed conversion and final live weight,more competentwith the technified ones compared to smaller farms,testingapossible relationship of thebreeding volumeandthe variability of these indicators.
- In turn,qIt is clear that this is a topic that needs to be further evaluated in order to achieveadapthandling fromprocedurecoughspecificin each of these systems, which allow inducing theImprovement in the productive indicators of both technologically advanced and conventional farms, in order also of generate data specific to the region

Conflict of interest

The authors declare that there is no conflict of interest in relation to the submitted article.

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