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Typology of Broiler Farms in M'Sila Region (Algeria): Zootechnical-Economic Performance

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Abstract | This study aims to classify broiler chicken farms in M'Sila (Algeria) using survey data collected between 2022 and 2023. The sample comprises 83 farms, 125 buildings, and 321,500 chickens. Growth parameters were initially calculated, and the statistical results revealed an overall mortality rate of 4.24%, a feed conversion ratio of 2.18, and a production index of 209.15. PCA analysis classified the farms into four categories. Large farms (class 4) were found to be the most profitable, with a gross margin of 138.42 DZD/kg, compared to 105.07, 97.09, and 64.00 DZD/kg for classes 1, 2, and 3, respectively ($p = 0.003$). This is due to better feed conversion ratios (1.97; $p = 0.000$), a higher number of chicks per flock (13,250; $p = 0.000$), and lower production costs (111.57 DZD/kg versus 135.82, 148.35, and 210.93 DZD/kg for classes 1, 2, and 3, respectively).

Keywords | Algeria, Broiler, Economic, Growth parameters, Production, Profitability

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INTRODUCTION

Globally, poultry meat will remain the main driver of meat production growth, with a projected increase of 16 % by 2031 (OECD/FAO, 2022). The shorter production cycle and the ratio of meat produced to feed prices make the poultry sector more advantageous than the ruminant sector (OECD/FAO, 2019). In Algeria, the growth of intensive poultry farming since 1980 has not only improved local supply but also helped to reduce imports of finished products or production inputs. The expansion of this activity has allowed the country to become self-sufficient in white meat and table eggs (Kaci, 2014). The province of M'Sila is considered one of the regions with significant poultry potential across the country, as its white meat production has seen remarkable growth. According to data from the Ministry of Agriculture and Rural Development (MADR), it ranked second in the country in 2018 with 91 quintals of white meat produced. By 2021, it will have made significant progress with an estimated 5,160,000 animals, 1,460 buildings, and a production of 103,249 quintals (DSA M'Sila, 2022). Despite the depressive impact of the coronavirus pandemic, a growth rate of 7.66 % was recorded compared to 2017. Despite the local self-sufficiency in white meat achieved by the wilaya of M'Sila, as in the rest of Algeria, the problem of dependence on the global market for biological inputs and food raw materials remains, and almost all poultry farms are still far from meeting international standards for

intensive farming. It is in this context that we wanted to focus this study on the situation of poultry farming in this region in order to determine the reasons for the progress or delay in this sector. On the other hand, the importation of fertilized 'broiler breeder' eggs and maize and soya, in particular, leads to very high production costs and complicates the reduction of expenses. The search for other solutions to improve productivity and offer lower-cost chickens on the local market is therefore essential.

MATERIALS AND METHODS

The survey covered 83 broiler farms in 15 municipalities (Figure 1 and Table 1). Direct observations and records were made in the field, and, to ensure the reliability of the results, about 5% of ambiguous or incorrect data were eliminated. The technical parameters checked were: mortality rate, amount of feed consumed, average live weight, and type of production costs (variable and fixed).

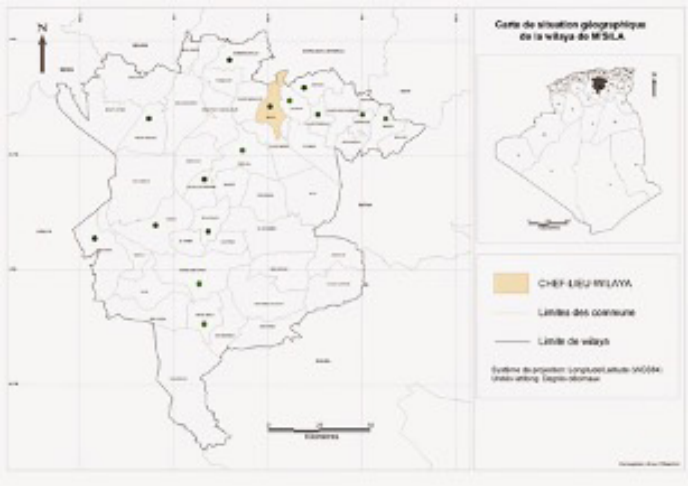

Figure 1: Location of the 15 target municipalities in the wilaya of M'Sila.

Measurements Taken

Zootechnical performances:

$$Mortality\ Rate\ (MR)\ (\%) = \frac{number\ of\ dead\ subjects}{number\ of\ subjects\ set\ up} \times 100$$

$$Feed\ intake\ (FI)\ (g/subject/day) = \frac{quantity\ distributed - quantity\ refused}{number\ of\ subjects\ set\ up}$$

$$Consumption\ Index\ (CI) = \frac{amount\ of\ food\ consumed\ (kg)}{weight\ gain\ (kg)}$$

$$Average\ Daily\ Gain\ (ADG)\ (g/subject/day) = \frac{live\ slaughter\ weight - initial\ weight}{duration\ of\ the\ breeding\ cycle}$$

$$Production\ Index\ (PI)\ (\%) = \frac{ADG \times viability*}{CI \times 10}$$

* Calculated from the mortality rate (%).

Table 1: Target municipalities and number of poultry farms selected.

No	Municipalities	No of breeding
1	Ain El-Hadjel	5
2	Ain El-Melh	3
3	Barhoum	1
4	Boussaada	6
5	Chellal	3
6	Djebel Messaad	3
7	Ouled Sidi-Brahim	2
8	Hammam Dalaa	1
9	Maadhid	2
10	Metarfa	1
11	Magra	20
12	M'Sila	8
13	Medjedel	4
14	Ouled-Derradj	22
15	Tamssa	2
Total	15	83

The PI defines the technical level of batches of broiler poultry, making it possible to compare the results of different farms independently of economic indicators and density (Magnin *et al*., 2013). It is calculated on the basis of GMQ, IC and viability. The latter corresponds to the percentage of chickens reaching slaughter age without mortality.

Economic performance: Economic performance was assessed on the basis of the average cost of producing one kilogram of chicken. The production cost corresponds to all fixed and variable costs divided by the average live weight (Table 2).

Statistical data processing: Statistical, descriptive, and variance analyses of the univariate general linear model (ANOVA) were carried out using IBM SPSS software (version 26), including analysis of weight development (LW and ADG), feed consumption (FC), feed conversion index (CI), mortality rate (MR) and duration of sanitary vacuum. The Principal Component Analysis (PCA) was carried out with the SPAD Décisia software for the treatment of nine (9) illustrative nominal variables (region, type of feed, crawl space, raised strains, etc.) and twenty-four (24) continuous variables (eight active and sixteen illustrative). For the comparison between classes, the one-way ANOVA allowed the study all the technical-economic parameters: feed cost (FC), cost of 1-day-old chicks (CC1), production cost (PC), gross margin (GM), average daily gain (ADG), conversion index (CI), etc. The post-hoc test was carried out using the Student-Newman-Keuls (SNK) test and the Duncan test to assess the significance and homogeneity between the different subgroups (mean comparison test). Differences were considered significant at the 5% level.

Table 2: Nature of charges and calculation formulas.

Direct charges (DC in DZD/kg)	**Chicks 1 day**
	Feed (starter, grower and finishing)
	Veterinary, health products, …
	Additional charges (electricity, gas, litter, taxes, water, telephone)
	Labour force
Indirect charges (IC in DZD/kg)	Building depreciation (BD) :
	BD = Building cost / Building life
	Depreciation / band = Annual depreciation / Number of band per year
	Depreciation of feeders (DF) :
	DF = Number of feeders x Price (per phase)
	Depreciation of waterers (DW) :
	DW=Number of waterers x Price (per phase)
	Annual depreciation =
	Materials cost / Lifetime
	Depreciation per band =
	Annual depreciation / Number of bands
	Total depreciation charge = Sum of depreciation charges (building + equipment)
	Other IC: Transportation costs (chicks and feed)
Production cost PC in DZD/kg	$\sum \frac{charges}{(Kg\ meat\ sold)}$
Gross margin (GM in DZD)	GM = Income – Cost price (PC)

RESULTS AND DISCUSSION

Size of Poultry Houses, Breeding Cycle, Strains Used and Numbers

Cobb500 is the most popular variety among breeders in the region (45.8 %), followed by Arbor Acres (37.3 %); ISA15 is only used by 3.6 % of broiler farmers (Table 3). In the literature, both varieties are characterized by a rapid initial development and competitive breast meat yield at different processing stages (Coneglian *et al.*, 2010). Therefore, these two varieties are considered the most efficient in the world with the lowest feed conversions, namely 1.84 for Cobb 500 and 1.81 for Arbor Acres (Cobb, 2022; Aviagen, 2022).

In the same study area, (Mahmoudi *et al.*, 2019) observed that the most exploited strains were Arbor Acres and ISA15 (in 30.4 % for cases) and Coob500 (in 21.7 % for cases). In a study carried out in the Tizi-Ouzou region, three strains were identified: ISA 15 (used by 78 % of the farmers), ISA Classic and Arbor Acres (Mouhous *et al.*, 2021). These same strains are still the most widely exploited throughout Algeria: Kebdani and Naalamene (2019), Benyounes *et al.* (2013), Lamani (2023). The animal density (9.55 birds/m^2 ± 4.99) and the number of bands per year (3.83 ± 0.67) are relatively low compared to the standards for standard broilers, which are 20 to 25 birds/m^2 and 6.3 to 6.4 bands per year (Guerin, 2007).

Table 3: Strains exploited.

Strains	Frequency	Percentage (%)	Number (subject/band)*
Cobb500	38	45.8	133,900
Arbor Acres	31	37.3	120 100
Cobb500, Arbor acres	9	10.8	31,000
ISA15	3	3.6	30,500
Cobb500, ISA15	2	2.4	6,000
Total	83	100	321,500

* average number of bands per year = 3.83 ± 0.67.

The size of the poultry houses in the 15 municipalities studied varied greatly, from a minimum of 200 m^2 to a maximum of 2,500 m^2, with an average of 453.53 ± 309.45 m^2. The duration of production cycles is considered optimal according to the recommendations in the technical data sheets of the breeds concerned (Aviagen, 2022; Cobb, 2022), with an average of 51.48 ± 6.56 days (see Table 4 for comparison). Sometimes, farmers plan the age of slaughter in order to meet high demand (during Ramadan, for example), without reaching the most profitable average live weight. According to Belaid-Gater *et al.* (2022), a rearing period of 49 days was reported in the Tizi-Ouzou region.

The number of chicks reared per building is 3,871.08 ± 2,476.1. The factors that explain this variability are the surface area of the building and the price of the chick. Fluctuations in market prices have a significant impact on the sustainability of these farms and can therefore lead to the cessation of activity by several breeders or to very variable numbers from one band to another. Similar results (3,849.17 chicks/building) were found by Mouhous *et al.* (2021) in the Tizi-Ouzou region. This result is observed even for breeders whose performance is acceptable. According to (Hubbard, 2015) and (Cobb, 2008), in poultry farming, the key to successful breeding is to adopt the single band, that's to say, to have only one age and one strain per farm in order to respect the "all full - all empty" principle. However, in our study region, farmers commonly use multiple bands. Some of them recommend rearing several batches of the same species at different physiological stages or of different animal species on the same farm. This practice can therefore increase the risk of infection. According to Mahmoudi *et al.* (2019), in the same study region, for economically vulnerable workshops, they should introduce other animal species by diversifying breeding methods (poultry and others) for their financial autonomy.

Table 4: Summary of technical parameters.

	Min *	Max *	Avg *	E- type *	Standards		ISAF15 #
					Cobb 500**	Arbor Acres***	
Breeding cycle (d)	35	60	51.48	6.56	56	56	49
LW at slaughter (kg)	2.0	3.50	2.8 6	0.32	4.64	4.26	2.32
ADG (g/subject/day)	33.33	100	56.50	10	82.1	84	48
CFI (Kg/subject)	4.57	8.48	6.12	1.05	8.55	7.70	5.25
Consumption index (CI)	1.44	3.9	2.18	0.55	1.84	1.81	2.26
Performance index (PI)	149.1	288.74	209.15	32.35	/	/	/

*: own results; **: all-comer broiler raised under good husbandry, feeding and environmental conditions (Cobb, 2022); ***: unsexed broiler (Aviagen, 2022); **Avg:** average; **LW:** live weight; **CFI:** cumulative food intake; **ADG:** average daily gain; **#:** reference (Azzouni *et al.*, 2013).

Zootechnical Performances

Mortality rate (MR): The mortality rates (MR) recorded ranged from 0.83 to 15 % per band in the buildings visited, with an average of 4.24 ± 2.53 %. In developed countries, the mortality rate is necessarily less than or equal to 3 %, as we observed in 47 % of the cases in our study. The quality of the chicks and the strains reared under optimal conditions contribute to high viability rates (Cobb500, ISA15). However, several researchers have reported mortality rates in excess of 7 % on poultry farms in Algeria: 8 to 10 % (Kirouani, 2020) in Béjaïa; 10 % (Lamari, 2023) in the south of Sétif; 13.8% (Mahmoudi *et al.*, 2015) in M'Sila; 9.96% (Mouhous *et al.*, 2021) in Tizi-Ouzou; 9.73% (Kaci et Cheriet, 2013) in Algeria; and 7.5% (Mahmoudi *et al.*, 2017) in M'Sila.

The highest mortality rates in poultry farms in Algeria may be due to the poor quality of farm breeding buildings (risks of heat stress and microbial infections), as well as the lack of skills among farmers and laborers. They may also be due to the high cost of inputs (chicks, raw materials, medicines, and mineral and vitamin supplements), which leads most farmers to neglect the health of their poultry and only call on veterinarians in emergencies.

Food consumption (FC): Per production cycle, feed intake per subject varied between 2.4 and 8.5 kg, with an average of 5.62 ± 1.6 kg/subject (or 110.8 ± 34.78 g/subject/day), a result identical to that of Mahmoudi *et al.* (2017) in the same study region (5.65 kg). In the wilaya of Tizi-Ouzou, Mouhous *et al.* (2021) reported an average feed intake of 102 g/day over an identical rearing period.

Average daily gain (ADG): A total ADG of 56.5 ± 10 g/animal/day was recorded, indicating good weight gain. This result is lower than that of "all-run" chickens of the Cobb500 strain (56 g/animal/day) (Cobb, 2022), as well as that of unsexed chickens from Arbor Acres (75.39 g/animal/day) and close to Lamari (2023) «54.7g/day and 61.94g/day», in two types of breeding carried out in Sétif. This is probably due to the way in which the birds are reared (feeding and environmental conditions, in particular), as 68.3% of farms have traditional rearing buildings, with polystyrene, plastic and breeze-block being the construction materials used. Only 31.7% of hen houses are modern. Under local conditions, Mouhous *et al.* (2021), Mahmoudi *et al.* (2017) and Kaci et Cheriet (2013) reported slightly lower values: 48.76 g/animal/day, 41.5 g/animal/day, and 40,54 g/animal/day, respectively.

Consumption index (CI): The recorded values are equivalent to 1.44 to 3.9, with an average of 2.18 ± 0.55. Our results are better than those of (Mahmoudi *et al.*, 2015) «28», (Mahmoudi *et al.*, 2017) «2.26» (who showed the same values in the same study region) and (Kaci and Cheriet, 2013) with «2,48». Similar results (2.14) are reported by Mouhous *et al.* (2021). Belaid-Gater *et al.* (2022), found a CI of 1.9 in the wilaya of Tizi-Ouzou. Lamari (2023) reported a CI of 1.61 and 1.76 (in two different farms in Setif). Compared to international standards for industrial broilers, the CI value found is less important, 2.18 vs. 1.84 (Cobb, 2022) and 1.81 (Aviagen, 2022). In fact, several factors, at all levels of rearing management, can reduce feed conversion efficiency. In this study, the feed conversion index was negatively affected by the length of the rearing cycle beyond 45 days (CI = 1.91). It was 2.24 at 50 days and 2.35 at 60 days. As mentioned by Kaci et Cheriet (2013), the Algerian poultry industry continues to suffer from farm performance problems, particularly in terms of parameters such as mortality and the lengthening of the production cycle due to a lack of control over feed and disease prevention.

Production index (PI): The production index (PI), determined at 209.15 ± 32.35 (Table 4), is considered lower than standards of (ITAVI, 2015) calculated for standard chickens reared for 35 days (293.9). Our result is close to Mouhous *et al.* (2021), who reported a score of 207.9. Kaci et Cheriet (2013) and Mahmoudi *et al.* (2017) recorded lower scores: 149 and 157.9, respectively. A production

index greater than 150 indicates that the farms have satisfactory technical performance (Mouhous *et al.*, 2021), which is the case for our farms.

Typology of Livestock Farming in the Wilaya of M'Sila

The statistical tool PCA was used to process and interpret the data in order to create different categories of broiler farms. The aim was to identify the different management practices that influence the profitability of these structures. According to the analysis carried out, the first two factorial axes, 1 and 2, explain 47.23 % and 22.57 % of the results respectively, or 69.8 % of the total variability. The first axis of the PCA mainly characterizes the production costs and the selling price. It schematically contrasts farms with high average production costs. The second axis contrasts large farms in terms of the number of employees, the area of buildings and the amount of feed consumed (Figure 2).

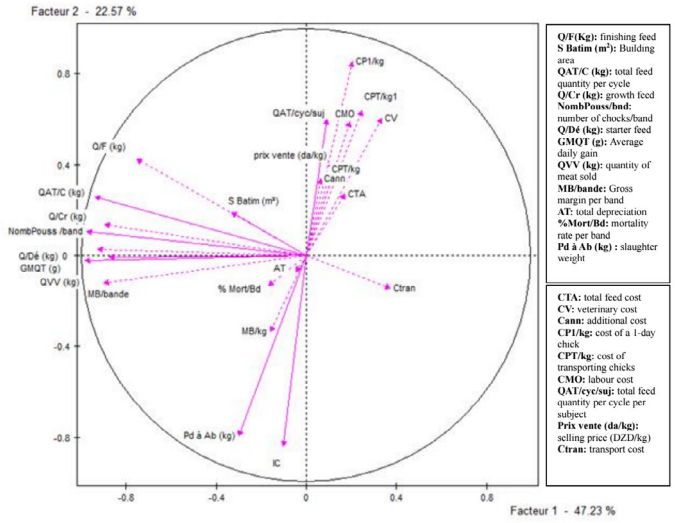

Figure 2: Projection of variables on planes F1 and F2.

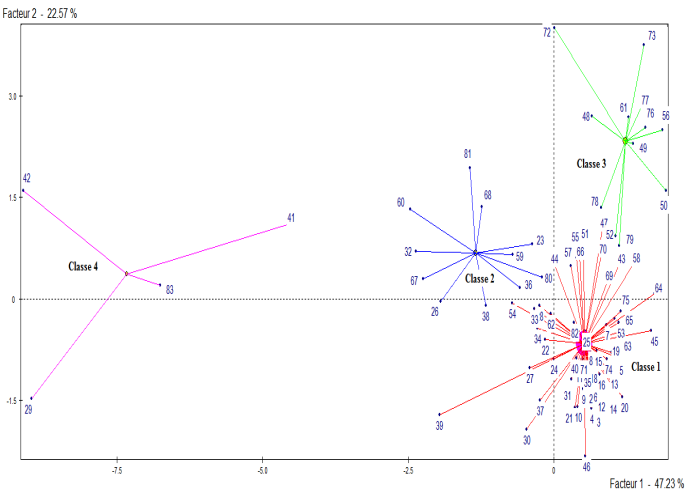

Figure 3: Paragon of the 83 farms grouped according to profitability on plan 1-2 (indicators PCA).

An ascending hierarchical classification made it possible to identify four profitability classes, distinguished by their characteristics and their zootechnical performances (Figure 3 and Table 5).

Comparison of means was performed by one-way analysis of variance (Table 5) for feed cost, chick cost, production cost, gross margin and average daily gain. The difference is highly significant ($P < 0.01$) for almost all parameters except mortality rate, transport costs and additional costs.

Class I: This class, which includes 56 farms (more than 67 % of the total), is characterized by the smallest building area (360.63 m²), an average number of chicks per rearing band of 3,064 and an average total feed consumption of 5.94 kg / chick. These results made it possible to achieve an ideal conversion index (2) with a high live weight at slaughter (2.97 kg), a high daily weight gain (60.19 g/chick) and, consequently, a gross margin of 105.07 DZD/kg of meat (0.7 €/kg of meat or 6,349.68 € per rearing band, assuming that 1€ = 150 DZD).

Class II: It has 11 holdings (13.25 % of the total). The sheds are large, up to 919.64 m², the average number of chicks per band is 5,663.64 and the mortality rate is one of the lowest (3.46 %). The average feed consumption is 6.10 kg/bird/cycle and the gross margin is low, corresponding to 97.09 DZD/kg of meat (0.64 €), which corresponds to 9,960.19 € /band (assuming that 1€ = 150 DZD).

Class III: It has 12 holdings (14.45 % of the total). This class is characterized by a low number of animals per band (2,866.67), a long breeding cycle (55.5 days), high feed consumption (6.99 kg/chick/cycle) with a low average daily gain (41.3 g/chick/day) and a consumption index that is too high (3.10). Although the selling price per live kg of meat is the highest in this class (275 DZD), the gross margin per kg of meat is the lowest (64.06 DZD; 0.426 €), which corresponds to 2,470.05 €/chick (assuming that 1€ = 150 DZD).

Class IV: It brings together four large farms and represents 4.81 % of the total. It is characterized by a large number of birds/band (13,250), a very high live weight at slaughter (3.07 kg), an optimal mortality rate (4.91 %) and an optimal feed conversion ratio (1.97). Also noteworthy are the low economic parameters: cost of the chick on the first day (CP1 = 20.21 DZD), transport costs (TRC = 71.55 DZD), labour costs (LC = 1.98 DZD) and, consequently, the highest profit margin, 138.42 DZD/kg of meat produced (0.92€), which corresponds to 36,484.66 €/band.

Referring to Table 4, we can appreciate that Class 3 includes small workshops with the lowest technical performance.

Table 5: General classes characteristics and their profitability.

Variables	Class 1 (N=56)	Class 2 (N=11)	Class 3 (N=12)	Class 4 (N=04)	Sig
Number of chicks per band	3,064.29±681.55 [a]	5,663.64±1,320.81[b]	2,866.67±811.65[a]	13,250.0±2,362.90[c]	0.000
Breeding cycle (day)	50.18 ± 6.74 [a]	53.36 ± 5.51 [a]	55.50 ± 4.98 [a]	52.5 ± 6.45 [a]	0.108
Building area (m^2)	360.63±111.12[a]	919.64 ± 631.29[c]	406.0 ± 97.95 [a]	615.0 ± 161.14 [b]	0.000
Starter feed (kg)	3,193.30±959.5[a]	5,654.55±1,960.28[b]	2,329.17±1,114.87[a]	17,250.0 ± 2,500.0[c]	0.000
Growth feed (kg)	8,320.54±2,452.39[a]	15,890.91± 5,285.53[b]	8,150.0±3,119.58[a]	34,500.0±5,259.91[c]	0.000
Finishing feed (kg)	6,505.36±3,293.1[a]	13,127.27±5,590[a]	9,716.67±4,157.32[ab]	28,000.0±16,083.11[c]	0.000
Feed (kg/cycle)	18,019.2±4,337.16[a]	34,672.73±9,766.17[b]	20,195.83±7,137.87[a]	79,750 ± 16,337.58 [c]	0.000
TFQ (kg/subject/cycle)	5.94 ±1.02 [a]	6.10 ± 0.94 [ab]	6.99 ± 1.03 [b]	6,02 ± 0.57 [ab]	0.015
Slaughter Weight (kg)	2.97 ± 0.17[bc]	2.81 ± 0.2 [b]	2.28 ± 0.26 [a]	3.07 ± 0.29 [c]	0.000
Selling Price (DZD/kg)	240.89 ± 22.01[a]	245.45±22.52[a]	275.0 ± 42.74[b]	250.0 ±14.14 [a]	0.001
QMS (kg)	9,006.28±2,268.79[a]	15,638.84±3,373.3[b]	6,352.22±1,563.67[a]	40,493.55± 10,073.26[c]	0.000
Sanitary vacuum duration (day)	18.57 ± 6.44 [a]	20 ± 7.74 [ab]	25.0 ± 7.38 [b]	18.75 ± 7.5 [ab]	0.069
MR (% per band)	4.43 ± 2.46 [a]	3.46 ±2.16 [a]	3.87 ±3.46 [a]	4.91 ± 0.96 [a]	0.607
ADG (g/subject/cycle)	60.19 ± 8.06[b]	53.2 ± 5.48 [b]	41.3 ± 4.82 [a]	59.43 ± 11.25 [b]	0.000
CI	2.0 ± 0.36 [a]	2.17 ± 0.35 [a]	3.10 ± 0.6 [b]	1.97 ± 0.31 [a]	0.000
CC1 (DZD/kg)	22.86 ± 4.38 [ab]	24.60 ± 3.55 [b]	26.99 ± 4.28 [b]	20.21 ± 5.85 [a]	0.011
TFC (DZD/kg)	86.51 ± 23.63 [a]	94.72 ± 33.66[a]	145.53 ± 37.72 [b]	71.55 ± 20.92 [a]	0.000
LC (DZD/kg)	3.06 ± 1.66 [a]	2.86 ± 1.71 [a]	6.4 ± 0.7 [b]	1.98 ± 1.06 [a]	0.000
VC (DZD/kg)	5.41 ± 2.63 [b]	3.63 ± 1.01 [ab]	5.16 ± 1.17 [b]	1.64 ± 0.61 [a]	0.004
C-tran (DZD/kg)	2.63 ± 2.29 [a]	2.32 ± 0.59 [a]	3.82 ± 2.36 [a]	2.9 ± 2.32 [a]	0.323
C-year (DZD/kg)	7.73 ± 3.93 [a]	8.36 ± 5.67 [a]	8.01 ± 2.18 [a]	6.75 ± 5.70 [a]	0.915
TD (DZD/kg)	7.58 ± 5.28 [a]	11.83 ± 9.99 [ab]	14.99 ± 8.06 [b]	6.51 ± 4.46 [a]	0.002
TPC (DZD/kg)	135.82 ± 25.47[ab]	148.35 ± 34.33[b]	210.93 ± 42.19[c]	111.57 ± 16.80 [a]	0.000
MB (DZD/kg)	105.07 ± 34.24[bc]	97.09 ± 40.92[ab]	64.06 ± 56.66 [a]	138.42 ± 25.25 [c]	0.003
GM (DZD/band)	952,452.53± 397,508.22 [b]	1,494,028.68± 625,521.46 [c]	370,507.81 ± 279,819.01 [a]	5,472,700.28 ± 1,136,429.20 [d]	0.000

TFQ: total feed quantity; **QMS:** quantity of meat sold; **MR:** mortality rate; **CI:** consumption index; **CC1:** cost of a 1day old chick; **TFC:** total feed cost; **LC:** labour cost; **VC:** veterinary cost; **C-tran:** transport cost; **C-ann:** additional costs; **TD:** total depreciation; **TPC:** total production cost; **GM:** gross margin.

In light of the survey results and statements from farmers, the weaknesses attributed to this group can be summarized as follows:

- Livestock buildings: Limited financial resources and difficulties in accessing subsidies under the agricultural renewal program hinder farmers' ability to modernize their buildings. In addition, the materials used to construct these buildings are of poor quality on 45% of farms (plastic greenhouses), which has an impact on environmental quality and animal welfare.
- Level of education: 31.73% of the workforce has never been to school; 41.46% has primary education; 21.94% has middle and secondary education, and only 4.87% has a university degree. Broiler chicken farmers show no interest in training their employees or improving their professional skills.
- The length of the sanitary break is too long (25 to 30 days), which probably contributes to the reduction in the number of flocks per year and therefore to the financial situation of farmers.

In PCA, there is a clear positive correlation between profitability and the number of animals; as shown in Table 5 and Figure 4, the large class IV holdings, which have remarkable performances and production costs, achieve a significant profitability (138.42 ± 25.25 DZD/kg). This result is opposite to that of class III farms (which have the lowest number and gross margins). Khan and Afzal, (2018), Dotas *et al.* (2021) presented similar results, proving that large farms perform better than medium and small farms. Kaci et Kheffache (2016) showed that farmers with the lowest production costs have the best technical performance and the highest net margins.

According to the results of Szőllősi *et al.* (2014), the length of the broiler production cycle has a significant effect on production and economic performance. However, in our

study, the rearing period is almost similar in all four classes (51.48 ± 6.56 days). Gross margin per band is positively influenced by farm size (number of chicks) and the differences between classes are highly significant (P = 0.000). Similar results were obtained by Khan and Afzal (2018). However, Mouhous *et al.* (2021) found a lower value of gross margin per kg (€0.17) compared to our results (€0.66).

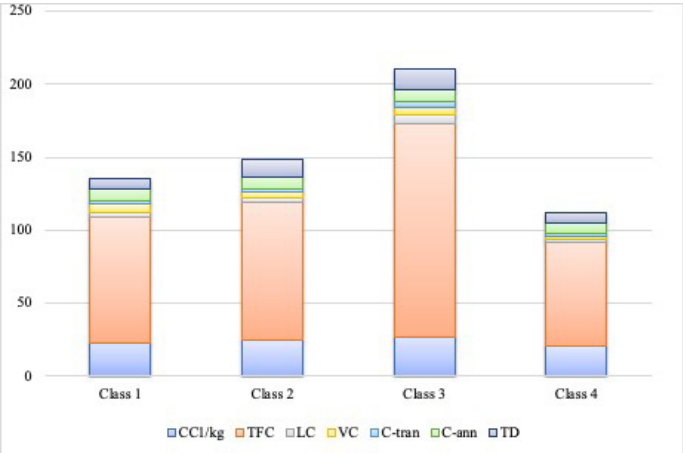

Figure 4: Total production costs for the four classes (class 4 with the best result).

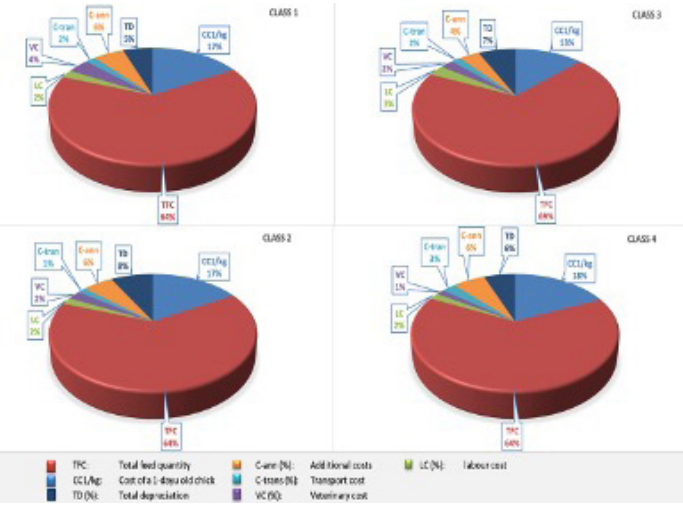

Figure 5: Production cost expenditure items in the different class.

Cost of Production Expenditure Items

Figure 5 illustrates the various components that comprise the cost of production. Feed is the main expense in categories I, II and IV, accounting for 64 % of costs. In category III, however, feed accounts for 69 % of production costs, which explains why farms in this category are less profitable. All of the farms in the study region are free-range and purchase feed from local manufacturing units, which may explain why the proportion of feed in total production costs remains consistent. The second largest expense after feed is the purchase of one-day-old chicks, accounting for 17 % of costs in categories I and II and 18 % in category IV. Therefore, the cost of feed and day-old chicks alone accounts for over 80 % of the total production cost. Mouhous *et al.* (2021) reported that feed was the most significant expenditure item, accounting for 68 % of production costs. The purchase of chicks accounted for 20.5 % of total expenditure.

CONCLUSION AND RECOMMANDATION

The study of technical and economic characteristics of broiler farms in the wilaya of M'Sila (Algeria) for the period 2022-2023 showed that the criterion for profitable farming is the mastery of growth management programs, in particular optimal feed conversion, high viability rate, and animal density adapted to the capacity of the houses. These factors make it possible to produce broilers that meet these specifications (strain standards) and increase the profitability of the farm. The large class IV farms, which achieved the best results in the study, may lead to the conclusion that all broiler breeders are called upon to modernize the structure of their houses and their breeding techniques. Modernization means that subsidies are needed to renovate poultry farming buildings, infrastructure and equipment, as well as agricultural machinery, in line with new technologies. From a technical standpoint, particular attention should be paid to the professional and educational integration of the workforce, as well as to their training and supervision, to ensure they are competent in all aspects of livestock farming. From an economic perspective, it is crucial to promote the use of local food sources (including by-products) in livestock feed. This can be achieved by increasing fodder crop production and promoting the development of intensive organic poultry farms. This type of facility is particularly relevant in Algeria, where the climate is favourable. Creating units to treat and recycle animal and plant by-products from the agri-food industry would also be a significant step forward. These measures would reduce the proportion of the 'feed' item in total production costs, thereby increasing profits, reducing the volume of imports, and alleviating the financial burden on the global market.

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As part of the investigation process, we made a verbal commitment to farmers and farm owners that we would not disclose their identities and would treat the information collected anonymously.

NOVELTY STATEMENTS

In the M'Sila region, broiler farms were ranked according to their zootechnical and economic performance.

AUTHOR'S CONTRIBUTIONS

Yamouna Bara: study design, fieldwork, drafting and editing of the manuscript.
Abdelhamid Baa: statistical data collection and analysis, also participate in manuscript drafting.
Abdennour Bir: statistical data analysis.

All authors approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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