

Laying hen house characteristics and health management practices in Algeria

Características de los gallineros ponedores y prácticas de gestión sanitaria en Argelia

Yacine KASMI^{1,2,3} , Nouzha HELEILI^{2, 4*} , Zohra Ahmed GAID¹ , Brahim HAMAD^{3,5} ,
Leyla HADEF^{3,5} , Manel MERRADI^{2,6} , Zahra ROUABAH² 

¹ University of Batna 1, Institute of Veterinary Sciences and Agronomic Sciences. Batna 05000, Algeria

² University of Batna 1, Institute of Veterinary Sciences and Agronomic Sciences, Laboratory of Health, Animal Production and Environment (ESPA). Batna 05000, Algeria

³ University of El Oued, Faculty of Natural and Life Sciences, Department of Agronomy. El Oued 39000, Algeria

⁴ University of Batna 1, Institute of Veterinary Sciences and Agronomic Sciences, Department of Veterinary Sciences. Batna 05000, Algeria

⁵ University of Tiaret, Institute of Veterinary Sciences, Laboratory of Hygiene and Animal Pathology. Tiaret 14000, Algeria

⁶ University of Batna 2, Faculty of Natural and Life Sciences, Department of Microbiology and Biochemistry. Batna 05078, Algeria

*Correspondence author: heleili.nouzha@gmail.com / nouzha.heleili@univ-batna.dz

ABSTRACT

Considering the importance of commercial laying hen farms in the egg production sector in Algeria. This study aimed to describe the laying hen houses and health management practices used in high-density poultry farms. Between 2024 and 2025 (January and April), a cross-sectional survey was carried out in 144 commercial farms in the Batna Province, Algeria, through structured questionnaires with the help of oral interviews. Most laying barns (93.75 %) were constructed using non-insulating materials, and the average space per laying hen ranged from 424.28 to 476.00 cm²/hens. In terms of farm sizes, surveillance operations of feed, droppings, and equipment were statistically associated with farm size ($P < 0.001$) and practiced by all large-scale farms with more than 40,000 laying hens (100 %). The main causes of mortality were infectious diseases (79.86 %), followed by accidents in cages (16.67 %) and cannibalism (3.47 %). A quarter of laying hen farms reported disease outbreaks, of which viral diseases were the most prevalent (61.12 %). Disease prevalence was highest in farms with less than 12,000 laying hens and farms with 12,000-40,000 laying hens (32.43 % and 23.47 %, respectively). This study revealed that laying barns did not comply with standard housing requirements and that health management practices were deficient on small and medium-sized farms (less than 40,000 laying hens), which could compromise the health and production performance of laying hen flocks. Obtaining a better understanding of these aspects in an Algerian context is useful for targeting inventions to improve laying hen houses, health management, and disease prevention.

Key words: Algeria; health management; laying hen; practices.

RESUMEN

Considerando la importancia de las granjas comerciales de gallinas ponedoras en el sector de la producción de huevos en Argelia. Este estudio tuvo como objetivo describir los gallineros de gallinas ponedoras y las prácticas de gestión sanitaria utilizadas en granjas avícolas de alta densidad. Entre 2024 y 2025 (enero y abril), se llevó a cabo una encuesta transversal en 144 granjas comerciales en la provincia de Batna, Argelia, a través de cuestionarios estructurados con la ayuda de entrevistas orales. La mayoría de los gallineros de ponedoras (93,75 %) se construyeron con materiales no aislantes, y el espacio promedio por gallina ponedora osciló entre 424,28 y 476,00 cm²/gallina. En términos de tamaños de granja, las operaciones de vigilancia de alimentos, excrementos y equipos se asociaron estadísticamente con el tamaño de la granja ($P < 0,001$) y fueron practicadas por todas las granjas a gran escala con más de 40.000 gallinas ponedoras (100%). Las principales causas de mortalidad fueron las enfermedades infecciosas (79,86 %), seguidas de los accidentes en jaulas (16,67 %) y el canibalismo (3,47 %). Una cuarta parte de las granjas de gallinas ponedoras reportaron brotes de enfermedades, de las cuales las enfermedades virales fueron las más prevalentes (61,12 %). La prevalencia de enfermedades fue más alta en granjas con menos de 12.000 gallinas ponedoras y granjas con 12.000 - 40.000 gallinas ponedoras (32,43 % y 23,47 %, respectivamente). Este estudio reveló que los gallineros de ponedoras no cumplían con los requisitos estándar de alojamiento y que las prácticas de gestión sanitaria eran deficientes en las granjas pequeñas y medianas (menos de 40.000 gallinas ponedoras), lo que podría comprometer la salud y el rendimiento productivo de las bandadas de gallinas ponedoras. Obtener una mejor comprensión de estos aspectos en un contexto argelino es útil para orientar las invenciones para mejorar los gallineros de ponedoras, la gestión sanitaria y la prevención de enfermedades.

Palabras clave: Argelia; gestión sanitaria; gallinas ponedoras; prácticas.

INTRODUCTION

Eggs from laying hens (*Gallus gallus domesticus*) are still considered one of the most consumed animal-source foods in the world due to their composition, which features richness in proteins, essential amino acids, cholesterol, monounsaturated fatty acids, micronutrients, and vitamins [1].

The growing demand for eggs has led to an increase in intensive production systems, where laying hen housing is a central determinant of productivity and welfare. To develop minimum standards of welfare, international regulations were also introduced, especially in space assignment given to each bird [2, 3].

Despite these interventions, contemporary intensive egg production systems do not necessarily promote the health of laying hen flocks. Poor nutrition, hygiene, and inadequate feeding conditions, as well as limited space, have been linked to deteriorating health outcomes [4].

Simultaneously, the inclination towards larger flock sizes has contributed to making health management a more complex task, thereby increasing the risk of an outbreak and lost production [5].

Several studies have emphasized that the characteristics of laying hen houses [6, 7] and management of health practices contribute significantly to the productivity and sustainability of laying hen flocks [8, 9].

In this regard, it is essential to analyze the production settings in the region to determine the risk factors and focus on their mitigation. In Algeria, there is a dearth of research concerning the laying hen housing conditions. The available literature so far reviewed only a small sample of 10 poultry sheds, which was not enough to describe the sector. As far as we know, there are no in-depth studies conducted on the health management practices in commercial laying farms in Algeria [10].

This knowledge gap is the subject of the present research, in which the structural features of laying hen houses are provided, and (ii) the health management practices in a representative sample of the commercial farms located in a high-density poultry producing area of Algeria. This work will provide information to guide specific activities that will enhance flock health, welfare, and productivity in the national egg production industry by creating baseline data.

MATERIAL AND METHODS

Ethical approval

All procedures were following the guidelines of the Scientific Council of the Institute of Veterinary Sciences and Agricultural Sciences, University of Batna 1 in Algeria, granted ethical approval for this research.

Study location

A cross-sectional study was conducted in laying hen farms from January 2024 to April 2025 in the province of Batna (Algeria). This study site was the leading producer of table eggs for twelve years (2000-2012) in Algeria [11]. This province is

located in the northeast of Algeria, between the 4° and 7° of East longitude and 35° and 36° of North latitude, and is characterized by a semiarid climate [12].

Sampling, survey and data collection

The study was conducted in nineteen (19) municipalities, including Bitam, Merouana, Ouyoun El Assafir, Aïn Djasser, Ouled Sellam, Aïn Yagout, Rahbat, Lemcen, Ksar Belezma, Oued El Ma, Talkhemt, Ouled Aouf, Hidoussa, Ouled Fadel, Zana El Beida, El Hassi, Lazrou, Aïn Touta and Seriana during the period from January 2024 to April 2025. A list of commercial laying hen farmers in these regions was created by compiling farm lists from municipal agricultural departments and local veterinarians.

Sample size was estimated using the sampling technique of Yamane [13], according to the following formula:

$$n = \frac{N}{1 + N(e)^2}$$

(n: sample size; N: population size; e: margin of error).

In this study, the population size (N) represents the number of operational laying hen farms estimated at 225 farms, and e = 0.05 (5 %). In total, 144 laying hen farms were included in this study based on the consent of their owners to participate in the study.

Data was collected using questionnaires distributed to farmers through oral interviews. The questionnaire consisted of closed questions and open questions. It had three sections: Section A included questions on laying hen farms characteristics, such as age of farmer, education level, experience, strain and flock size; section B included questions on characteristics of laying hen houses, such as age of barn, construction materials, equipment, number of barns per farm and number of laying hens per cage; section C included questions on management health practices, such as surveillance operations, veterinarian visits, mortality causes, as well as pathologies.

Density for cage-laying hens was calculated by dividing the number of laying hens per cage by the cage area. Density measurement was dependent on the farmer's permission to access the shed and the number of cage measurements allowed. The primary diseases were only collected from the veterinarians monitoring the laying hen flocks.

Laying hen farms were divided into three groups according to their size, based on commonly used battery modules [14, 15]. Group 01 corresponds to farms with less than 12,000 laying hens; Group 02 corresponds to farms with a size between 12,000 and 40,000 laying hens; and Group 03 corresponds to farms with more than 40,000 laying hens.

Statistical analysis

The frequency of the different laying hen characteristics was calculated using descriptive statistics in SPSS version 27.0 (Statistical Package for the Social Sciences). Results are presented using the number and percentage for categorical variables.

The stocking density and barn size data were subjected to analysis of variance (ANOVA) to determine any significant statistical differences between the different farm sizes. Significant differences were identified at P -value ≤ 0.05 . Pearson's chi-square (χ^2) test with calculation of P was used to compare categorical variables between groups of farm sizes. To estimate the strength of the association between categorical variables and farm sizes, Cramer's V for categorical variables (with more than two possible answers) were used. P -value ≤ 0.05 is considered a statistically significant difference.

RESULTS AND DISCUSSION

General characteristics of laying hen farms

TABLE I provides a summary of the main features of the investigated by laying hen farms. Most farmers were between 40 and 60 years old (79.86 %) and had a middle school education (73.61 %), indicating that mature, reasonably educated individuals primarily lead the sector. Over 10 years of experience in farming was reported in more than half (52.08 %), indicating that a relatively stable workforce exists with practical knowledge. However, 92.36 % of the total population ($N = 1,943$) had not been trained in poultry farming formally, which poses a severe technical capacity deficit. The results are quite consistent with the socio-professional profiles of poultry farmers present in the M'sila region in Algeria [16].

TABLE I

Overview of laying hen farms in the study region

Variable	Frequency (n)	Percentage (%)
Age		
25-39 years	6	4.17
40-60 years	115	79.86
More than 60 years	23	15.97
Education level		
Primary	11	7.64
Middle	106	73.61
Secondary	24	16.67
University	3	2.08
Experience		
Less than 5 years	18	12.5
5-10 years	51	35.42
More than 10 years	75	52.08
Training		
Yes	11	7.64
No	133	92.36
Strain		
Hy Line Brown	38	26.39
ISA Brown	95	65.97
Hy Line White	11	7.64
Production type		
Commercial laying hen farms	144	100
Laying hens and other poultry production	0	0.00

In terms of genetic stock, the most common stock was that of the ISA Brown (65.97 %), then Hy-Line Brown (26.39 %) and then Hy-Line White (7.64 %). The popularity of the ISA Brown could have been due to its stable egg production and excellent egg quality, which the commercial operations have preferred. This dependence on exported hybrid breeds mirrored the larger pattern in Algeria's poultry industry, which is dominated by modern intensive systems constructed around commercial breeds used worldwide [16, 17].

The survey carried out on all farms revealed that they are involved in the commercial production of table eggs, which is the main source of earnings in these businesses. Such homogenization of purpose in production highlights the economic significance of egg production in the area and the commercial inclination of the industry, and also offers a clear background against which later results on housing and health management practices can be interpreted.

Housing characteristics

Barn description

TABLE II summarizes the structural features of the surveyed laying hen barns. Over 52.08 % of the barns were five to ten years old, with an additional 44.44 % aged ten to twenty years. The roof featured a steel-framed tiling with fibre-cement corrugated sheets, zinc panels or sandwich panels on most barns. Most of the walls were made of cemented blocks of concrete (47.92 %) or bricks (45.83 %). The percentage of farms using insulated construction materials (prefabricated wall panels, insulated walls made of double-brick or sandwich panels) was only a small fraction (6.25%), and a feature exclusive to large-scale poultry businesses [15].

In general, most of the farms (93.75 %) had a thermal insulation-free barn, whether a roof or walls, which significantly reduced the possibility of temperature control. All farms had universally concrete flooring. Sites differed in window number and size, although all barns had cooling pads and exhaust fans, which were turned on to full capacity under conditions of high temperatures, especially in summer. The management of manure was done mechanically; it either employed manure removal scrapers (45.83 %) or the belt systems (54.17 %), which transferred the waste out of the housing facilities.

TABLE II

A description of barn characteristics in the commercial laying hen farms study region

Variable	Frequency (n)	Percentage (%)
Age		
Less than 5 years	4	2.79
05-10 years	75	52.08
10-20 years	64	44.44
More than 20 years	1	0.69
Wall construction materials		
Block wall	69	47.92
Bricks	66	45.83
Prefabricated wall panel	5	3.47
Double brick walls with insulation	4	2.78
Floor construction materials		
Concrete	144	100.00
Other materials	0	0.00
Roofing construction materials		
Zinc roof	58	40.28
Fibre cement corrugated	77	53.47
Sandwich panels	9	6.25
Equipment		
Exhaust fans		
Yes	144	100
No	00	00
Cooling pads		
Yes	144	100
No	0	0.00
Manure scraper		
manure removal scrapers	66	45.83
manure removal belts	78	54.17

Such results suggest that almost half of the barns (45.13 %) were more than 10 years old, and they had not been renovated. The prevalence of low-insulation building materials (93.75 %) further weakened the control of ambient temperatures. These inadequacies are extremely dangerous to the health, welfare, and productivity of the flock since they cause restriction of the ability to sustain a consistent internal environment. Considering these findings, the purpose of renovating the barn and enforcing compliance with the construction standards can be considered an urgent need to optimize the housing conditions. The poultry houses will need to be designed to consider the building's geometry, the correct location of windows and ventilation systems to facilitate efficient air circulation, and to control the temperature [18, 19]. In fact, the impact of structural design of laying hen houses on the indoor environment is quite significant, and this directly impacts the flock performance and biosecurity results [20, 21].

Barn size and stocking density

According to TABLE III, the size categories of farms did show a significant difference in the number of laying hens per barn ($P < 0.001$). There was, however, no significant difference in the area of the cage among the various groups of farm sizes. The median flock size per barn was highest in farms with over 40,000 hens, then in 12,000-40,000, and in less than 12,000 hens.

Stocking density was 360–540 cm² per hen with four to seven birds per cage. Such space show that none of the flocks sampled were kept in accordance with European Union standards, where at least 550 cm²/hen in unenriched cage systems (Directive 1999/74/EC, recommended in 2003) and 750 cm²/hen in furnished cage systems are required by European legislation since 2012 [2].

Economic factors have probably caused the high stocking rates used in this experiment because the farmers usually want to achieve the optimal productivity and profitability rates on a per-unit area basis [22]. However, the literature has shown that the density of stocking has a direct impact on the egg-raising rate and the welfare of hens [23, 24]. Interestingly, despite previous battery cage research indicating a tolerable space distribution of 300-650 cm²/hen, it can be noted that at least 736.3 cm²/hen would be needed to maintain optimal egg production in a battery cage [25].

Taken together, these results highlight a severe discrepancy between the existing housing habits and the set welfare norms. Continuous application of high-density systems not only leads to the possible deterioration of animal welfare, but it can also have negative impacts on long-term productivity and egg quality. When it comes to achieving sustainable production results in keeping with global welfare standards, it will thus be necessary to address the issue of stocking density in Algerian laying hen farms.

Health management

TABLE IV sums up the practices of animal health management in the laying hen farms in Batna province. Farm size was strongly correlated with veterinary visits ($\chi^2 = 110.365$, $P = 0.001$), droppings monitoring ($\chi^2 = 30.154$, $P = 0.001$), equipment monitoring ($\chi^2 = 11.189$, $P = 0.004$), mortality investigation ($\chi^2 = 11.121$, $P = 0.025$) and feed monitoring ($\chi^2 = 9.180$, $P = 0.010$). These findings suggest that there are significant differences in key health management practices among farms of varying capacities.

TABLE III

A description of the housing characteristics of laying hens in the study region

Variable	Farm size			P-value
	Less than 12000 Mean \pm SD	12000 - 40000 Mean \pm SD	More than 40000 Mean \pm SD	
Hens/barn	8727.03 \pm 1885.27	17420.41 \pm 2718.74	29777.78 \pm 15039.76	< 0.001
Cage area (cm ² /hens)	424.28 \pm 54.55	427.07 \pm 47.48	476.00 \pm 39.75	0.116

One of the most important differences was seen in farm sizes: all the farms that had over 40,000 hens were always adopting veterinary oversight, equipment and feed checks, and inquiries into deaths (100 %). On smaller farms, in contrast, there were inconsistencies related to the application of these measures. Such distinctions must be, probably, indicative of the technical capacity, financial power, and compliance with standardized health management practices [26].

In total, there was 100 % prevalence of routine health surveillance. However, only 51.39 % of farms investigated feed distribution, 24.31 % of farms evaluated droppings, 13.19 % of the farms evaluated flock behaviour, and 50 % of farms evaluated equipment functionality. Only a minor fraction of the farmers (95.14 %) requested veterinary help proactively- that is, only when faced with a health problem, decreased production, decreased feed consumption, or an open outbreak of the disease. A small number (4.86 %) hired an outsourced veterinarian who made weekly prophylactic visits. This underscoring tendency to rely on passive veterinary services indicates a structural vulnerability in preventive health care in the poultry sector of the region.

The causes of mortality also differed, with the size of the farm ($P = 0.025$). At large farms (> 40,000 hens), the mortality was solely of a disease-related nature (100 %). Besides, in smaller farm sizes diseases also remained the major cause (84.69 % and 62.16 %, respectively), but accidents within cages (12.24 % and 32.43 %) and cannibalism (3.06 % and 5.41 %) contributed to secondary losses. Such patterns suggest that smaller operations may lack structural protection, proper oversight, and stringent biosecurity measures, thereby making them vulnerable to injury and behavioral vices, as well as the risk of infectious diseases [8, 27].

Infectious disease was the leading cause of death in all the farms (79.86 %), cage-related accidents (16.67 %) and cannibalism (3.47 %) came second and third, respectively. The etiological analysis has shown that most deaths were caused by infectious diseases, which supports the results of Muñoz-Gómez et al. [28]. This pattern of death suggests that there is inadequate biosecurity infrastructure, as well as irregular prophylaxis.

The main pathologies reported by veterinarians were Infectious Bronchitis (30.56 %, $n = 11$), Mycoplasmosis (16.67 %, $n = 6$), Colibacillosis (11.11 %, $n = 4$), Coccidiosis (11.11 %, $n = 4$),

TABLE IV
Health management of laying hen flocks in the study region

Factors	Less than 12.000 n (%)	Farm size 12.000-40.000 n (%)	More than 40000 Mean ± SD	Total n (%)	χ^2	P- value	Cramer's Values
Surveillance operations							
Behaviour of laying hens							
Yes	2 (5.41)	14 (14.29)	3 (33.33)	19 (13.19)	5.249	0.07	0.191
No	35 (94.59)	84 (85.71)	6 (66.67)	125 (86.81)			
Feed distributed							
Yes	17 (45.95)	48 (48.98)	9 (100.00)	74 (51.39)	9.180	0.010	0.252
No	20 (54.05)	50 (51.02)	0 (0.00)	70 (48.61)			
Health							
Yes	37 (100.00)	98 (100.00)	9 (100.00)	144 (100.00)	/	/	/
No	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)			
Dropping state							
Yes	6 (16.22)	20 (20.41)	9 (100.00)	35 (24.31)	30.154	< 0.001	0.458
No	31 (83.78)	78 (79.59)	0 (0.00)	109 (75.69)			
Equipment operation							
Yes	14 (37.84)	49 (50.00)	9 (100.00)	72 (50.00)	11.189	0.004	0.279
No	23 (62.16)	49 (50.00)	0 (0.00)	72 (50.00)			
Veterinarian visits							
At least one visit per week	0 (0.00)	0 (0.00)	7 (77.78)	7 (4.86)	110.365	< 0.001	0.875
In case of necessity	37 (100.00)	98 (100.00)	2 (22.22)	137 (95.14)			
Causes of mortality							
Diseases	23 (62.16)	83 (84.69)	9 (100.00)	115 (79.86)	11.121	0.025	0.197
Accident in the cage	12 (32.43)	12 (12.24)	0 (0.00)	24 (16.67)			
Cannibalism	2 (5.41)	3 (3.06)	0 (0.00)	5 (3.47)			
Pathologies							
Mycoplasmosis	2 (16.67)	4 (17.39)	0 (0.00)	6 (16.67)	8.280	0.602	0.339
Colibacillosis	2 (16.67)	2 (8.70)	0 (0.00)	4 (11.11)			
Coccidiosis	2 (16.67)	2 (8.70)	0 (0.00)	4 (11.11)			
Infectious bronchitis	4 (33.33)	7 (30.43)	0 (0.00)	11 (30.56)			
Newcastle	1 (8.33)	3 (13.04)	1 (11.11)	5 (13.89)			
Avian influenza	1 (8.33)	5 (21.74)	0 (0.00)	6 (16.67)			

Newcastle (13.89 %, n = 5), and Avian Influenza (16.67 %, n = 6). This is in consistent with the findings of several epidemiological investigations in Algerian poultry farms who reported a high seroprevalence of infectious bronchitis [29], a high prevalence of *Mycoplasma synoviae* (MS) and *Mycoplasma gallisepticum* in poultry farms in the area of Batna [30, 31], Colibacillosis [32, 33, 34], a high prevalence of coccidiosis [35, 36], Newcastle disease [37, 38] and avian influenza [39, 40].

Epidemiological diagnosis showed that viral diseases were predominant (61.12 %), bacterial diseases (38.88 %), and no fungal, parasitic or nutritional disorders were reported. Such a high prevalence of the viral disease indicates insufficient sanitary protection, a low level of hygiene standards, and failures in the vaccination programmes [41, 42, 43, 44]. Indicatively, when diseases were actively reported, it was a quarter of the farms (25 % n = 36), indicating the lack of system health defenses in both preventive and reactive health management models.

Taken together, these results indicate a two-sided issue: despite better representation of larger farms in terms of compliance with veterinary monitoring and surveillance measures, both large-scale and small-scale activities can be exposed to pressures of infectious diseases due to the lack of full biosecurity and uneven prophylaxis. These shortcomings are critical not only for enhancing the health and productivity of flocks but also for addressing community health concerns associated with zoonotic pathogens in Algeria's growing poultry industry.

CONCLUSIONS

To some extent, this research fills the gap in the literature that discusses laying hen houses and health management practices of laying hen flocks in commercial laying hen farms in Algeria. It was discovered that most of the barns fail to fulfil building standards, which makes it hard to monitor the ambient factors within the barns. Moreover, this study also indicates a very high density of stocking. When it comes to a comparison of farm sizes, all farms with over 40,000 laying hens practised daily surveillance operations, despite the lack of laying hen behaviour. Nevertheless, laying hen farms containing fewer laying hens fail to satisfy good daily surveillance operations. Diseases cause the greatest mortality of all farm sizes. Moreover, mortality in the lower farm sizes was also caused by accidents and cannibalism. The most common pathologies were viral diseases, followed by bacterial diseases.

Improving housing design, enforcing minimum welfare standards, and strengthening health management are urgent priorities. Targeted technical support while building, financial incentives for barn renovation and access to bank credits, and the development of standardized flock health plans, such as the development of a health plan of laying hen flocks to encompass vaccination, hygiene and biosecurity practices, could significantly reduce disease burden and enhance productivity. Future research should provide context-specific recommendations to align production practices with both animal welfare and economic sustainability.

Conflict of interest statement

The authors declare no conflicts of interest.

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