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Characterization of the Systems in Use in Laying Hens Farming under Semi-Arid Climate, Wilaya of Batna, Algeria

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Abstract: The region of Batna north-eastern Algeria, with a semi-arid climate, is a leader in egg production with 23% of laying hens nationwide. Despite the intensive nature of the sector, the assessment of atmospheric emissions from these farms remains unclear or even non-existant. The estimation of these emissions begins with the realization of a typology of local breeding systems of laying hens in cages. With regard to the subject, a survey was conducted in 2017 and it concerned 46 buildings in the region. This categorization lists three sections the building and its equipments, the parameters and the practices of breeding.The study led to distinguish three classes of livestock systems. The first is a minority, but defines a powerful system and respectful of the usual production norms. The second class makes the transition between the two. The third class, characterized by small farms and modest equipment, represents more than half of the farms in the region. It is also the one that contributes the most to the generation of polluting emissions. We came to the conclusion that, in order to reduce these emissions inside the poultry buildings and limit their out ward movements, measures should be taken in terms of equipments financing. These measures concerne not only equipment necessary for excrements disposal but also for air conditioning of premises.

Key words: Laying Hens · Rearing System · Typology · Semi-Arid · Polluting Emissions

INTRODUCTION

Livestock buildings are housing systems for a specific category of animals, with distinctive design, equipment and management that determine their environmental performance [1] and emissions that can let out Atapattu, Senaratna and Belpagodagamage [2].The specification of livestock systems for the purpose of assessing or reducing emissions is defined through a description of the building design, that of the manure evacuation systems and the places where they are stored and also through the description of the internal climate and the means of its control. Food composition, light management and husbandry practices also contribute to the determination of livestock systems[1, 3] as well as the knowledge of the ventilation rate around the emission's sources [4- 6]. All these factors directly related to housing and its management, determine the general conditions for the formation and emission of pollutants in animal housing. These factors influence the variation in temperature and humidity production [3], two important parameters in the generation of many pollutants in the indoor air of buildings [7, 8].

The emissions inventory for an environmental assessment requires a typology of livestock systems. Such method remains vague or even non-existent in the poultry sector in Algeria, despite its importance. Indeed, the last two decades bear witness to an important evolution in poultry farming in Algeria [9]. Such progress has already taken place in most in African countries [10] alike and in developing countries [11]. Poultry is the largest species of animal husbandry in the world [12], but in these regions, 80% of poultry is found in traditional production systems [13]. In Algeria, Intensification has spread throughout the country, with a high concentration around northern cities [14, 15]. Data from the General Census of Agriculture [16] indicated that 58% of the farms and 68% of the total number of subjects are located in 13 departments located in the North of the country. If laying hens farms are taken into consideration, this

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concentration in space is even more significant; the department of Batna, the region of our study, occupies the first place with 7% of the farms and 23% of national production of eggs for one of its communes [16, 17]. The last census count nearly 1111 farms in 2011 [18] and 1708 farms in 2017. It should be noted that this prosperity is not the same in all the municipalities in the Batna region [19].

This article provides information on breeding hen systems in the Batna region of northeastern Algeria, as part of a pollutant assessment process. Thus, we proceeded to the typology of the systems, emphasizing their specificities if they exist. The characterization will be reported through the points developed in this article, in particular by describing livestock buildings, equipment and local practices of livestock management.

MATERIALS AND METHODS

Description of the Study Area: The wilaya of Batna, study area, is located in eastern Algeria (6°11 'East, 35°33' North). Most of its area, 12,038.76 km2, lies at the junction of the Tellien Atlas to the north and the Saharan Atlas to the south, thus determining its semi-arid climate: a hot dry summer and a cold dry winter. The annual rainfall is 150 to 200 mm / year and the average annual temperature is 15.6°C with low levels of humidity.The lowest temperatures are recorded from January to March, where they vary between - 5°C and 18°C, in July, the warmest month ; they rise up to 36.44°C in the course of the day and 18.48°C at night, thus presenting a very wide thermal range.

The Spatial Distribution of Laying Hen Buildings in the Wilaya of Batna: With 1045 buildings officially listed in 2017, the laying hen sector is dominant, representing 53% of the poultry sector in the Batna region. (Figure 1) shows the spatial distribution of these buildings.Their distribution is heterogeneous, with a high concentration in the northern, central and eastern boundaries of the region, moderately in the West and weakly in the Southeast. The Merouana daira has a monopoly on the production of consumption eggs with a capacity of more than 3 million hens in 2017, representing 35% of this sector, followed by the daira of Ain-Touta (1 million subjects) which has occupied the position of the leader until 2008 [19] and the third place, is occupied by the daïra of N'Gaous (eight hundred thousand subjects).

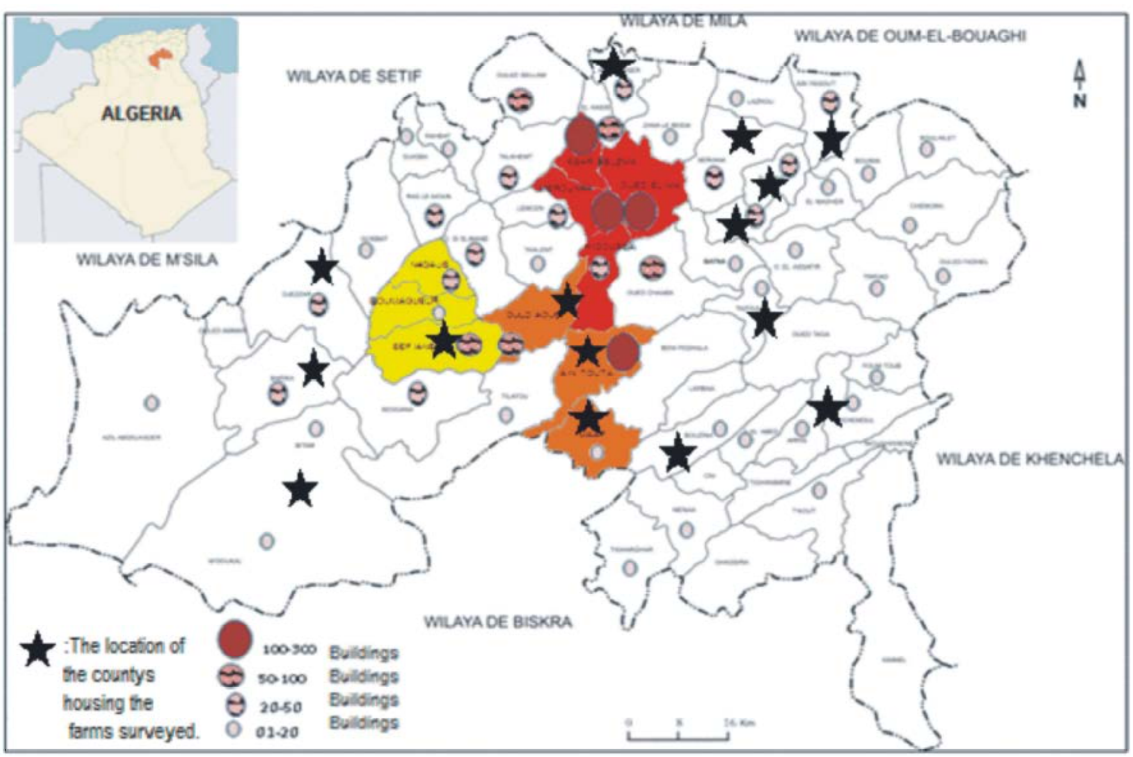

Fig. 1: The spatial distribution of laying hen buildings in the wilaya of Batna and the location of the countys housing the farms surveyed.

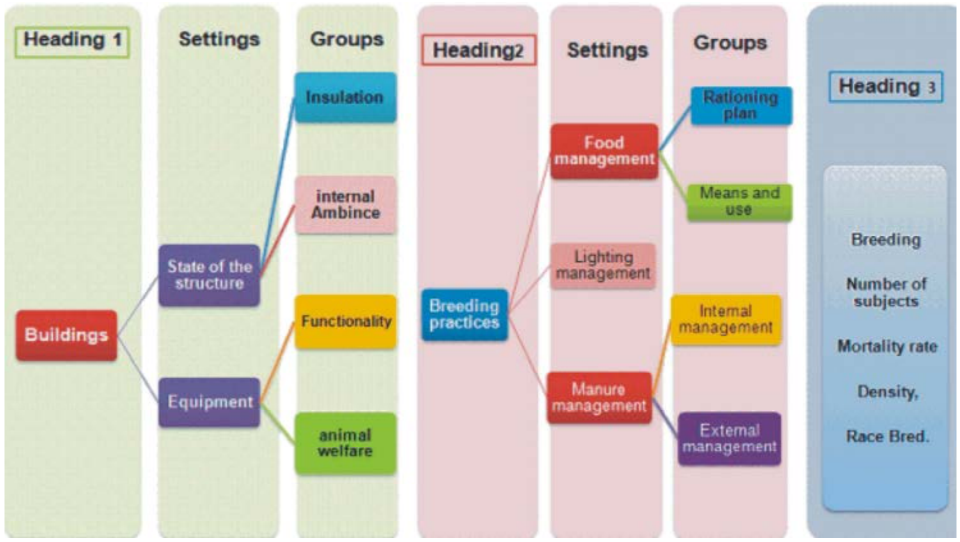

Fig. 2: The main topics covered by the survey questionnaire.

Location of the Buildings Concerned by the Investigation: In this study, the majority of the surveyed buildings are in municipalities with a tradition of poultry farming; occupying the rank of leader during the period ranging from 1990 to 2009 [19]. These are the communes of Ain Yagout, Fesdis, Djerma, Ain-Touta, Ouled-Aouf, Sefiane, Ain-Djasser, Sériana, Mafa, Arris, Bouzzina, Tazoulte, Barika,Bitam, M'doukel and El-djazzar (Figure 1). The major criterion adoped has been the prevalence of buildings with a tradition of raising laying hens in cages. The choice of our investigation is focused on farms distributed throughout the wilaya.

Presentation of the Questionnaire Used: The questionnaire used in the survey was intended to bring out the local systems of breeding caged laying hems reported on keeping laying hens caged local systems. It seeks to characterize and understand their workings. The assumption, of demonstrating the influence of the specificity of these farms (weather conditions and types of systems), if it exists, the nature and intensity of ammonia emissions and particles. It will be used to best describe:

- The conditions of the general atmosphere which animals and their droppings are subjected.
- The breeding parameters (animals)
- The breeding practices that may have a direct impact on emissions.

The Structure of the Questionnaire Is Based on Three Headings: construction, farming and practices. It comprises eighteen main questions, each one containing a number of details used to describe essentially the areas covered by the survey and regrouped by the three above headings (Figure 2).

Through these headings, we our aim is to identify the points that describe the situation of breeding systems of laying hens and proceed to the determination of their typology. The questionnaire covers:

The Description of the Buildings: This part describes the buildings, through the development of the following parameters:

- The state of the structure: We will focus on the effectiveness of the insulation and the internal environment of the buildings.
- Equipment: for this point we will focus on the functionality of these and their role in animal welfare.

The Description of Breeding Practices: This part concerns the description of the different tasks carried out at the level of the livestock building. It is used to identify the management that can have a direct impact on emissions. It's about:

- Food management procedures; through the rationing plan and the means used in the management.
- Manure management procedures inside and outside the building: means and evacuation methods, as well as their destination once they leave the buildings (sale or personal use).
- Lighting management methods: means and program used.

The Description of the Breeding (Animals): This part concerns the animals: The elements described are: the number of subjects, the mortality rate, the surface density and race.

Data Collection Methods: The survey covered 46 buildings spread over the sixteen municipalities mentioned above. It was carried taking place from November 2016 to December 2017.

Part of the questionnaire is directly intended to the farmers and concerns the methods of poultry farming. One of the objectives of the survey questionnaire is to characterize and understand the management strategies of farm buildings by breeders. Their seniority and experience of these will provide information on the general state of the industry in the study area. This first part, also carries out the inventory of the equipment of the building and the state of the latter.

The other part is achieved by the investigator himself, by simple field observation (location of the building, sunniness, neighborhood). A number of information, require measurements on site (size of windows, dimensions of the building), if suitable answer caeit be given by the farmer or his employees.

Statistical Analysis: In order to describe and classify the laying hen systems of the region in groups, the data collected have been the subject of multivariate statistical studies, these methods lend themselves to Data Reduction or Structural Simplification [20]. Multivariate analysis includes methods that are generally descriptive. In our study, these are factorial analyzes developed by the free software R version 3.2.5 with the ade4 package, using the scripts: Principal Component Analysis (PCA) and Hierarchical Ascending Classification (CAH). A principal component analysis of the variables is an optimal planar representation of the data [21]. Its fundamental purpose is to describe the variation of a set of correlated variables, Brian [22]. The main components can be entries in a Johnson and Wichern [20] cluster analysis, clustering is a hierarchical classification that provides a lot of information related to classification [21].

We have also introduced qualitative variables in terms of additional variables, which allows us to reinforce the interpretation of the axes [23] and to provide a complementary view on the conditions of the laying hen industry in the region.

RESULTS

Description of the Breeding Systems of Laying Hens in Cages Used in the Region of Batna: The parameters of the buildings as structures, those of the breeding practices, as well as the breeding parameters, collected during the investigation, were analyzed by (PCA). The two main components (PC) (Figure 3) and (Table 1) accounted for 39.17% of the total data variance, with (PC1) representing 29.20% and (PC2) representing 9.97%.

Effectifdébut: Hens number, NBRCage: Cages number, Quantitéali.j: Quantity of food distributed / day, LBAT: Buildings length, surfacem2: Building surfaces, SurfHumid: Total area of humidifiers, LBtr: Battery length, NbAmpl: Number of bulbs, QuantiteFie: Quantity of droppings, NbExtr: Number of extractors, qt_alim.poule.j: Daily food ration, HBAT: Building height,lBAT: Building width,Hampl: Height of bulbs/soil, tauxdemortalité: Mortality rate, Frequence: Frequency of food distribution/day, Espace.poule: Space available per hen, surfacecage: Surface of the cage, NBRang: Number of rows of bulbs, X.surfaceF: Total area of windows.

The correlation circle (Figure 3) showed that ten variables are strongly and positively correlated to the first axis (PC1). Among these, 8 list the equipment that controls the internal environment of the building, that is the surface of the humidifiers, the number of extractors and the number of bulbs, which are strongly correlated to the length of the batteries, that of the building as well as to its surface. This block of variables is also correlated to the amount of food distributed per day and the amount of droppings evacuated from the building. Together, the 2 remaining parameters, constitute the largest contribution to this axis, as well as the highest correlation, that is the number of cages and the number of hens. From these observations, it seems clear, that the first axis (PC1) describes the building equipment that is directly related to the scale of the structure and the size of the farm.

At the same time, the correlation circle shown in (Figure 3) and the (Table 1) shows the top ten variables that contribute to the construction of the second axis (PC2). For the reading of this axis, we grouped our observations into three observations. First, it concerns the daily food ration per hen, main contribution to this axis, which is negatively correlated to the frequency of food distribution and the surface of the cage, both of them being strongly correlated.

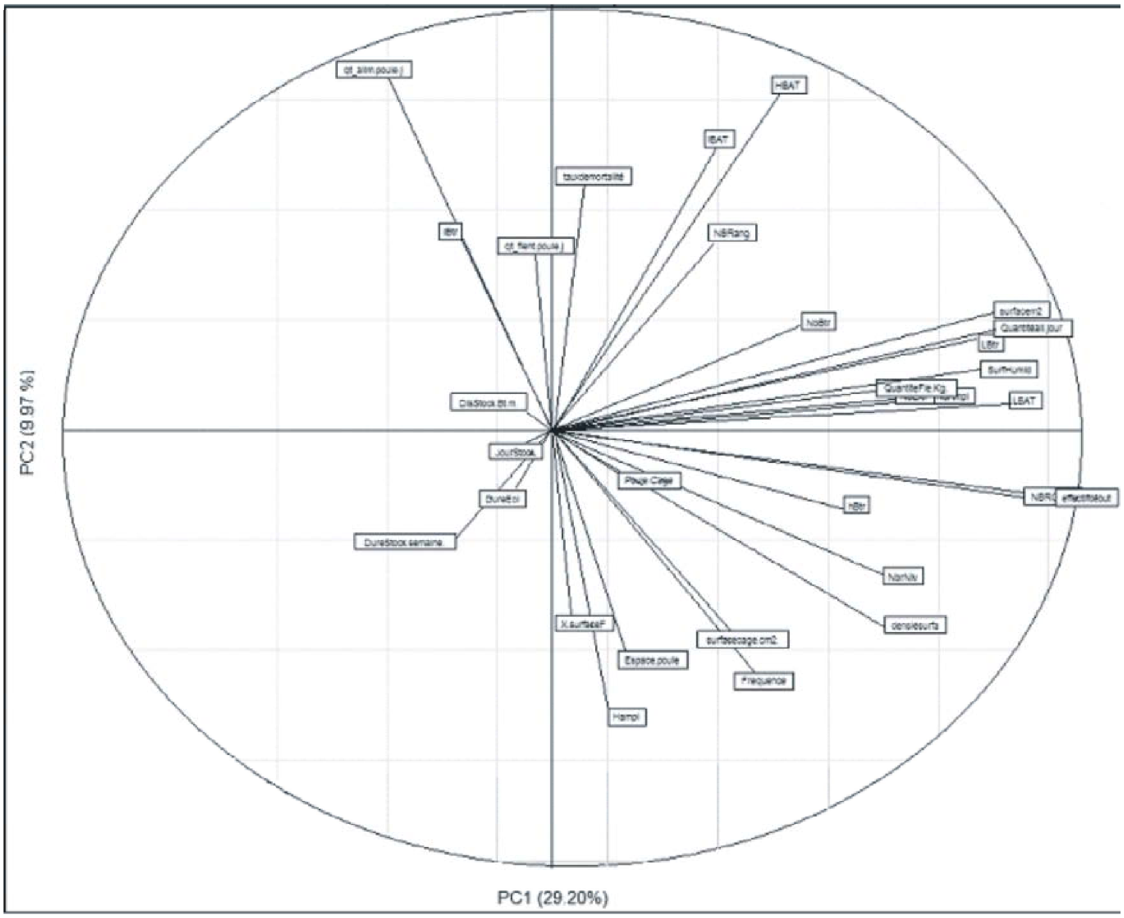

Fig. 3: Correlation circle obtained from the principal component analysis (PCA) on the characteristics of the laying hen systems in the region of Batna.

Table 1: Main variables contributing to the construction of the first two axes.

Variables represented by Axis1(%)	Contribution to the first axis (%)	Variables represented by Axis 2(%)	Contribution to the second axis (%)
hen number	10.37864	Daily food ration (g/hen/ day)	13.84391
Cages number	9.10269	Building height(m)	12.70715
Quantity of food distributed / day (kg)	8.39679	Building width (m)	9.04694
Buildings length (m)	8.13972	Height of bulbs/soil (m)	8.77541
Building surfaces (m^2)	8.00187	Mortality rate (%)	6.88069
Total area of humidifiers (m^2)	7.58527	Frequency of food distribution /day	6.71097
Battery length (m)	6.98275	Space available per hen (cm^2)	5.63553
Number of bulbs	5.82375	Surface of the cage (cm^2)	4.67860
Quantity of droppings (Kg).	4.82445	Number of rows of bulbs	4.16057
Number of extractors	4.77099	Total area of windows(%)	3.97991

On the other hand, the mortality rate is negatively correlated to the available space per hen and per cage.Finally, this axis shows us that the height and the width of the building as well as the number of rows of bulbs are correlated positively with each other but negatively with the height (position) of the bulbs with respect to the ground and the percentage of the total surface of the windows,both of them being strongly correlated.From these observations, we can easily conclude that the second axis gives us information about the breeding practices in terms of food management and lighting, animal welfare and building design.

Typology of the Laying Hen Systems in the Region: In order to identify the various classes of buildings sampled and from there, the typology of the laying hen systems in

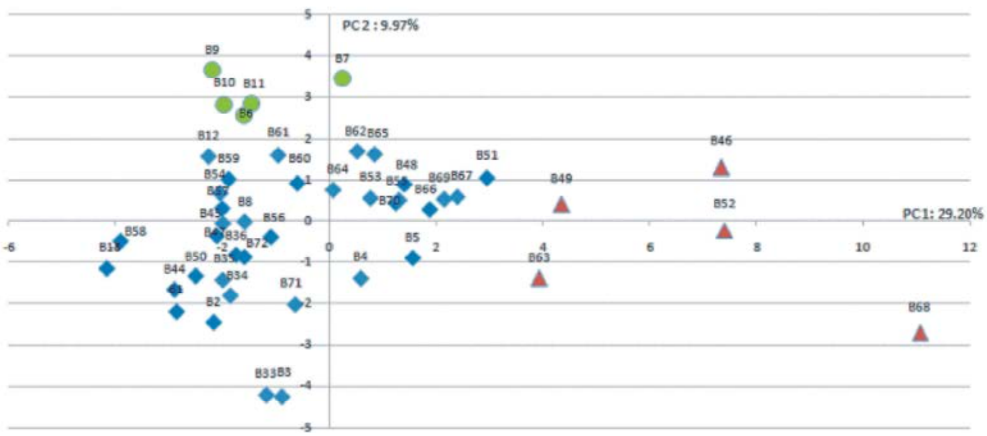

Fig. 4: Projection of laying hen systems in the space of the first two main components.
B (1-68): sampled buildings with their corresponding numbers

the region, we performed two (PCA) and (CAH) analysis. We will start with the presentation of the results of the (PCA), followed by the results of the (CAH) combined with descriptive statistics applied to the resulting groups.

The projection of the buildings on the factorial plan (Figure 4) makes it possible to distinguish two groups of buildings, which seem to dictate the trend of the axes.

For the first axis of this plan (PC1), we have noticed that the buildings located on the right of (Figure 4), stand out from the cloud of points representing the distribution of individuals (buildings).These are buildings (B68, B52, B46, B49 and B63). Given the relationships between the coordinates of the individuals and those of the variables, it turns out that, along the axis 1, on the side of the positive coordinates, we find the well-equipped buildings with large numbers of hensand imposing structures.A second group of buildings detaches itself at the top of the vertical axis (PC2) (Figure 4), these are buildings (B6, B7, B9, B10 and B11). Knowing that the second axis (PC2) informs about animal welfare, it turns out that these buildings are small farms with an average of 3500 subject, an average space of 404cm^2 available per hen and a high mortality rate 13.63%. Knowing that this axis also provides information on livestock farming practices in terms of food and lighting management, it has been found that these livestock systems distribute the largest food ration per hen per day (204 g /hen /day) and do not use natural lighting (0 windows).The rest of the buildings have intermediate characteristics between those of the first group represented by the first axis and characteristics of the third group represented by the second axis.

A (CAH) was used to identify the different existing systems available in the region, using the variance explained by the PCA's 31 axes. The result is a distribution in three classes (Figure 5). In order to detect the differences between the rearing systems represented by these three classes, we carried out descriptive statistics on each group. The results are presented in order to develop, separately, the characteristics of each one. The variables taken into consideration are only the ones contributing to the formation of the first and second axes (Table 2).

A first class of buildings constitutes 13.04% of our sample. It is characterized by farms with an average of 18600 subjects housed in structures of more than 1000 m^2 equipped with 4 batteries of an average length of 76.33m with more than 3700 cages. Large investments are made in the equipment that conditions the internal environment of these buildings; we can count on average, 8 extractors and an area of humidifiers of 46m^2 per building. The number of bulbs is 64, for a lighting duration of 14h.This class provides 501 cm^2 of space per hen, a daily food ration of 87g per hen and it has the lowest mortality rate in our sample, 8.58%.The individuals of this first class of breeding system, are the same as those of the first group, designated by the PCA, except for the individual B67.

The second class of buildings constitutes 30.43% of our sample. It has an average of 9014 subjects, housed in structures of more than 700 m^2. The average length of the 3 batteries that equip each of these buildings is 52 m, providing an average of 1946 cages.

The equipment that manages the prevailing atmosphere inside these buildings consists in an average number of 4 extractors and the area of humidifiers do not exceed 19.27 m^2 per building. The number of bulbs is 50, for a duration of lighting of 16h.This class provides 430 cm^2 of space per hen for a daily feed of 98.29 g per hen and it has the highest mortality rate in our sample at

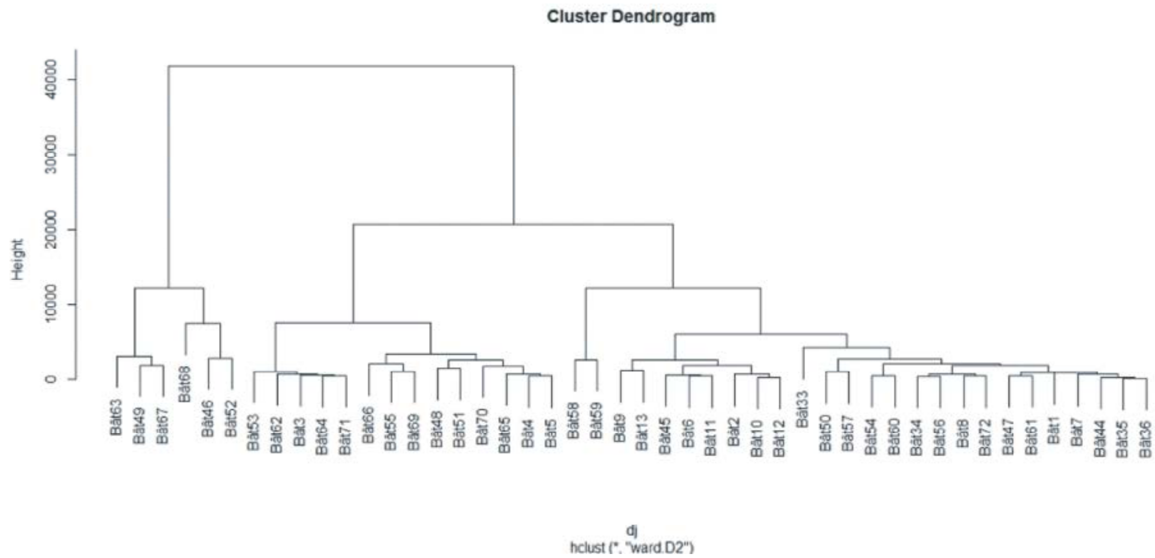

Fig. 5: Hierarchical tree representing the distribution of the three classes of laying hen systems in the region Batna. B (1-68):sampled buildings with their corresponding numbers.

Table 2: Main characteristics of the three classes of laying hen systems in the region of Batna. SD: Standard deviation.

	First class		Second class		Third class	
Variables	Average	SD	Average	SD	Average	SD
Hen number	18600	4138	9014	1622	4267	1030
Building surface (m^2)	1020	197,3	743,5	187,8	524,7	133,7
Batteries number	4	0,516	3	0,36	3	0,614
Batterylength(m)	76,33	17,28	55,43	12,94	41,02	6,53
Cages number	3713	1635	1946	433	995	303,1
Number of extractors	8	3,71	4	1,657	4	1,848
Total area of humidifiers (m^2)	46	31,4	19,27	11,06	12	8,25
Number of bulbs	64	27,7	50	11,14	39	9,78
Lighting duration (h)	14	1,366	16	2,586	15	1,233
Daily food ration per hen (g)	86,83	21,26	98,29	18,29	128,12	46,11
Space available per hen (c m^2)	501,0	202,8	430,6	70,4	475,4	183,4
Mortality rate (%)	8,58	4,18	11,10	4,79	9,831	4,180

11.10%.Individuals in this second class of livestock system belong to the PCA group of buildings with intermediate characteristics, although these have not been clearly defined.

The third class of buildings is the largest of our sample with 56.52%, has on average 4267 subjects, housed in structures of 524.7 m^2. The buildings in this class have 3 batteries with an average length of 32.84 m, providing more than 995 cages. The internal environment of these buildings is governed by an average number of 4 extractors and a surface area of humidifiers of 12 m^2 per building. The number of bulbs is 39, for a lighting time of 15h.This class provides 475.4 cm^2 of space per hen for a daily food ration of 128.12 g per hen and has a mortality rate of 9.83%.This third class of breeding system encompasses all the individuals in the third group designated by the (PCA) and therefore has their characteristics.

In order to deepen the interpretation of the factorial axes, we proceeded to the introduction of qualitative variables in terms of additional variables (Figure 6).

This figure reveals the contribution of the variables describing the management of manure to the interpretation of the first axis; thus, along this axis, along the positive coordinates, we find buildings with a pit and using an automatic scraping for the collection of droppings, with a frequency of evacuation once a week. In contrast, individuals that form the second axis do not have a pit and use manual scraping of droppings with a frequency of evacuation per day. These observations strengthen the fact that, buildings well represented by the first axis deploy significant investments in equipment.

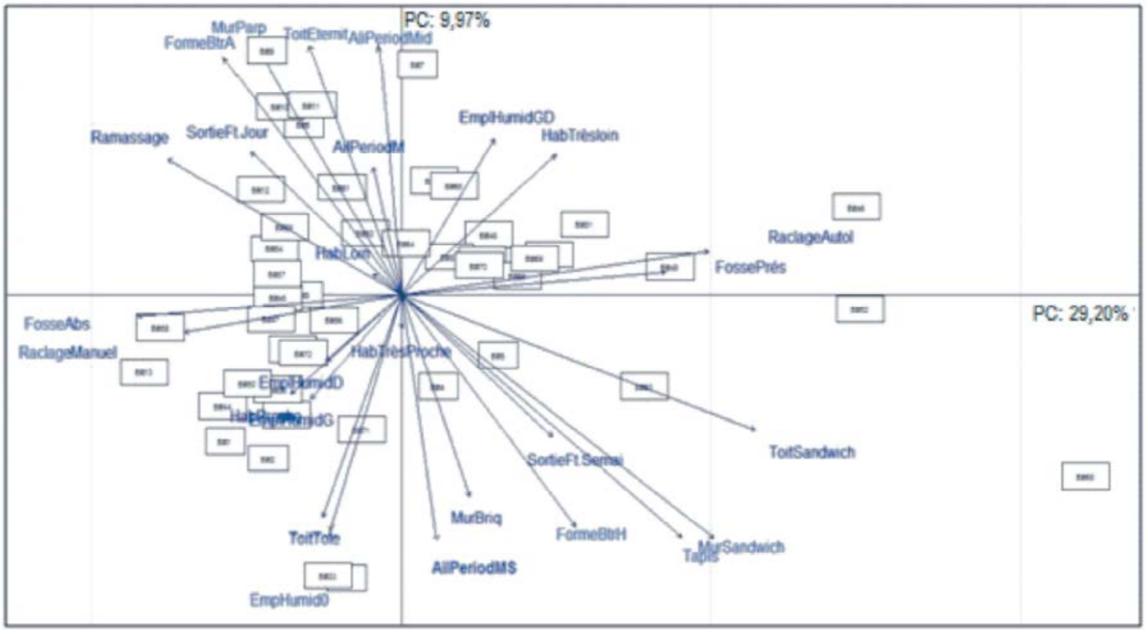

Fig. 6: Projection of illustrative qualitative variables in terms of the first two axes.

The legend only picks up the variables with the largest contributions to the axes. B (1-68): sampled buildings with their corresponding numbers, MurParp: walls in parpaing, ToitEternit: Eternit roof, AliPeriodM: food served in the morning, AliPeriodMS: food served in the morning and evening, RaclageAuto: automatic scraping, RaclageManuel: manual scraping, Fossepré: pit presence, FosseAbs: absence of pit.

At the same time, this figure reveals that the buildings that contribute the most to the construction of the second axis are built with cinder blocks and have an Eternit roof, which again emphasizes the modest aspect of the livestock systems represented by the second axis.It should be noted that these same systems distribute the food once a day, in the morning, unlike the first group of buildings which distribute it twice a day, morning and evening.

DISCUSSIONS

It is widely considered that building standards for livestock buildings are based on band size [24, 26]. This aspect is confirmed with the result of the PCA and that of CAH; they show that the highest numbers on hensare housed in larger structures and whereas the lowest numbersbeing housed in the most modest buildings in the area, concerned by our study, specifying that the latter group represents more than half of the laying hen farms in the region with 56.52%. The length of the buildings in our region vary from 30 to 100 m, with a number of hens ranging from 1800 to 25600 subjects. The national average varies between 40 and 54 m for a population ranging from 2,400 to more than 10000 hens [27]. It is 120m for a total of 30500 hens [28] and exceeds 140m for a population of more than 200000 hens [29, 30].

In addition, the surface area of building must meet the birds' environmental requirements and needs as regards the internal ambiance on the poultry [24, 31]. Their width is directly related to the possibilities of good ventilation: the wider the building is, the more means of aeration are provided for [15]. Thus, the largest structures in our sample are the best equipped in terms of extractors, humidifiers and bulbs.

The projection of the additional qualitative variables, reveals that the buildings that contribute to the construction of the second axis are built in cinder block and have Eternit roofs. These materials are cheap, but produce a bad insulation [27], thus hindering the effectiveness of ventilation. Knowing that gaseous losses in buildings, particularly those of nitrogen, are among others, related to the air conditioning of places and the modes of housing [32, 33] one can deduce that this type of structure contributes to polluting emissions.

It was reported that the daily ration of food varies between 56 to 150g, its increase is done gradually according to the age of the hens [34.35], taking into account its energy-giving value [36, 37] and its physical form (granulometry) [38]. In our study the results showed that the average daily ration varies between 87 and 128g /hen /day. It can reach 204g /hen /day if we consider the farming systems that contribute to the construction of the second axis of our factorial analysis. These same systems distribute the food only once a day, in the morning. On the other hand, the breeding systems belonging to the first group adopt a frequency of twice a day; morning and evening. It should be noted that the handling of the food during meals (preparation or distribution of rations) would be responsible for some of the dust emissions inside the building [37]. This leads us to believe that the systems of the first group are likely to emit more particles.

Lighting is very carefully controlled to maximize productivity [25, 39]. It is a powerful exogenous factor in the control of many physiological and behavioural processes [40]. At laying age, 16 hours of light per day are recommended [25] recommends from 11 to 14 hours/day. The breeding systems of the region adopt this principle and illuminate the buildings between 14 and 16h.

In this study, two farming systems are opposed in their management of dejections. Inthe first group, the buildings have pits and use automatic scrapers for the collection of waste; the evacuation is generally done once a week. The second group designated by the rearing systems belonging to the third class, do not have a pit and use manual scraping of the dejections, which forces them to evacuate them once a day.It is recognized that the frequency of disposal of the dejections and the duration of their presence in the building, influences the evolution of their nitrogen and moisture contents, which determines the NH3 emissions [41]. Moreover,the characteristics of the droppings depend on the practices of breeding and the type of building even if the same species are concerned [42].This leads us to say that the farming systems of the first group emit more ammonia inside the buildings and that the other systems move these emanations outside the buildings, where the droppings are subjected to the storage conditions [43].

The farms sampled have a real capacity that varies between 1800 and 25600 subjects, the average size of the groups defined after analysis varies from 3500 to 18600. In these farming systems, the hens are housed in conventional cages and have an average space which varies from 404 cm^2 to 501 cm^2 per hen. The required space for laying hens is at least 750 cm^2 / hen of the cage area [44] recommends 550 cm^2 minimum, to allow a goodventilation of the building to avoid mortalities by hyperthermia. But spaces between 329 cm^2 and 516 cm^2 have been mentioned in the literature, in research work on the subject conducted under conditions of production [29, 45, 46]. It seems clear that the hens of the breeding systems of the Batna region do not benefit from spaces that comply with the standards. Nevertheless, they follow the general trend of conditions of production of laying hens in cages.

The impact of different types of cages on well-being, health, zootechnical performance, egg quality is widely demonstrated [47]. Indeed, overcrowding has serious consequences for weight growth and the incidence of toxic pathologies and emissions such as NH_3[25]. This is reflected in the high mortality rates recorded on the farms in the region; they vary between 8.58 and 13.63% against 0.8 and 1.5% [48] 7% [49] and 22% [50]. On the other hand, the results show that the average mortality rates of the three groups defined by the factor analysis, decrease as the available space area per hen increases.Moreover, the breed raised in the region of our study, is for 95% "Isa Brown", the remaining 5% uses the race "LOHMANN".

CONCLUSION

The Willaya of Batna, a region with a semi-arid climate, is the largest egg-producing region, in our country with 23% of the national production. In this study, we sought to identify and characterize layer hen production systems in the region, describing livestock buildings and their equipment and highlighting the impact of local practices on intensity and the nature of emissions, including ammonia and particles. The result is a typology in three classes, as follows:

- The first class, defines a breeding system characterized by imposing structures, well equipped with large numbers of hens, complying with the usual production standards and having the lowest mortality rate in the region, but still high (8, 58%). On the other hand, this category of systems represents only a minority of existing systems in the region.
- In contrast, the rearing system described in Class 3 is characterized by limited investments, especially when the size of the farm and the size of the buildings are concerned. The equipment is modest or nonexistent when it comes to managing manure. Due to lack of resources, livestock farming practices are non-compliant and have the particularity of displacing polluting emissions outside the buildings. It should be noted that this third class constitutes more than half of the farms in the region.
- Class 2 defines a breeding system with intermediate characteristics between the two classes mentioned above. Nevertheless, this class of livestock shows the highest mortality rate in the region (11.10%), probably because of the smallest available space per hen in the region.

Thus, we can conclude that the heterogeneity prevailing in breeding practices, because of the differences in equipment and their use, is at the root of the three classes of livestock systems in the region.

REFERENCES

1. VERA, 2011. Test Protocol for Livestock Housing and Management Systems, DK-2920 Charlottenlund Denmark, Version 2: 29-08.
2. Atapattu, D., Senaratna and U.D. Belpagodagamage, 2008. Comparison of Ammonia Emission Rates from Three Types of Broiler Litters, Environment, Well-Being and Behavior. Poultry Science, (87): 2436-2440.
3. Pedersen, S. and K. Sällvik, 2002. Climatization of Animal Houses Heat and moisture production at animal and house levels, 4th Report of Working Group, Research Centre Bygholm, Danish Institute of Agricultural Sciences, P.O Box 536, DK-8700 Horsens, Denmark.
4. Yongxing, C., X. Hongwei, L. Hong and T. Shepherd, 2012. Comparison of Ammonia Emissions from Poultry Houses Based on Diurnal Integration vs. Daily Means of Gas Concentration and Building Ventilation Rate, An ASABE Conference Presentation. Paper Number: ILES 12-0965.
5. Calvet, S., M. Cambra-Lopez, V. Blanes-Vidal, F. Estellés and A.G. Torres, 2010. Ventilation rates in mechanically-ventilated comercial poultry buildings in southern Europe: Mesurement systemdevelopment and uncertainty analysis. Biosystems Engineering, 106 (4): 423-432.
6. Kenneth, D., F.E. Wheeler, R.S. Gates, H. Xin, P.A. Topper, J. Smith Zajaczkowski, Y. Liang, A.J. Heber and L.D. Jacobson, 2002. Quality Assured Measurements of Livestock Building Emissions: Part 4. Building Ventilation Rate. Air and Waste Management Association Conference December, 2002 San Francisco CA.
7. Coufal, C.D., C. Chavez, P.R. Niemyer and J.B. Carey, 2006. Nitrogen emissions from broilers measured by mass balance over eighteen consecutive flocks. World's Poultry Science Journal, 85: 384-391.
8. Al Homidan, A., J.F. Robertson and A.M. Petchey, 2003. Review of the effect of ammonia and dust concentrations on broiler performance World's. Poultry Science Journal, 59(3): 340-349.
9. Khenenou, T., M. Bougherara, M. Melizi and R. Lamraoui, 2017. Histomorphological Study of the Bursae of Fabricius of Broiler Chickens during Gumboro Disease in Algeria Area. Global Veterinaria, 18 (2): 132-136.
10. Nebiyu, Y.N., B. Tamir and A. Mengistu, 2018. Marketing of Exotic Chicken Products and Constraints under Small Scale Intensive Urban Poultry Production in Addis Ababa. World Journal of Agricultural Sciences, 14(1): 17-24.
11. Serbessa, T.A. and T.T. Tucho, 2017. Review on Newcastle Disease in Poultry and its Public Health Importance. British Journal of Poultry Sciences, 6(2): 29-39.
12. Moreda, E., S. Hareppal, A. Johansson, T. Sisaye and Z. Sahile, 2013. Characteristics of Indigenous Chicken Production System in South West and South Part of Ethiopia. British Journal of Poultry Sciences, 2(3): 25-32.
13. Weyuma, H., H. Singh and M. Megersa, 2015. Studies on Management Practices and Constraints of Back Yard Chicken Production in Selected Rural Areas of Bishoftu. British Journal of Poultry Sciences, 4(1): 01-11.
14. Youbi, I., 2009. Conduite de l'élevage avicole cas de la poule pondeuse dans la région de Ouèd-Souf. M.S. thesis, Kasedi Merbeh Ouargla University, Algeria.
15. Djerou, Z., 2006. Influence des conditions d'élevage sur les performances chez le poulet de chair. M.S. thesis, Mentouri Constantine University, Algeria.
16. National Census of Agriculture, 2003. Ministry of Agriculture and Rural Development, Algeria.
17. Benkredda, 2012. The poultry industry in Algeria. DZ Agro forum of Algerian Agronomists. https://www.dzagro.net/forums/viewtopic.
18. Nouad, M.A., 2011. Etude technico-économique de projets de valorisation/gestion de déchets liés à la filière avicole en Algérie. Expertise valorisation des sous Produits et Déchets Avicoles, (2): 58.
19. Bouzeriba, L., 2011. Contribution à la caractérisation de la pollution atmosphérique émise par les élevages avicole en bâtiment dans la wilaya de Batna (cas de la poussière et l'ammoniac), M.S. thesis, Batna 1 University, Alegria.
20. Johnson, R.A. and D.W. Wichern, 2007. Statistical Analysis -61h ed. Includes index. Pearson Education, pp: 430-454.

21. Murtagh, F., 2005. Correspondence Analysis and Data Coding with Java and R. ISBN 1-58488-528-9, pp: 9-13
22. Brian, S.E., 2005. An R and S-PLUS Companion to Multivariate Analysis. Springer-Verlag London Limited, pp: 41-61.
23. Escofier, B. and J. Pagès, 008. Analyses Factorielles simples et multiples objectifs, méthodes et interprétation. 4th edition Dunod, Paris, pp: 27-28.
24. Dayon, J.F. and B. Arbelot, 1997. Guide d'élevage des volailles au Sénégal. DIREL Dakar Sénégal, pp: 4-14.
25. ITAVI, 2009. Guide D'élevage Aviculture Fermier: Quelques repères pour les éleveurs professionnels commercialisant en circuits courts. Editions ITAVI - PARIS 1er trimestre 2009 1ère édition, pp: 31.
26. Mahmoudi, N., H. Yakhlef and A. Thewis, 2O15. Caractérisation technico-socio-professionnelle des exploitations avicoles en zone steppique (wilaya de M'sila, Algérie). Cahiers Agricultures, 24(3): 161-169.
27. Rahan, M., 2016, La poule pondeuse: Œufs de consommation, synthèse, ITEL: institut technique des élevages. Ministry of Agriculture and Rural Development, Algiers.
28. Priscilla, A.P., T.Y.J. Ribeiro, D.D. De Oliveira, G.A.E.S. Ferraz and D. Lourençoni., 2016. Spacial Illuminances Variability And Energy Consumption In Aviaries for laying hens equiped with compact fluorescent lamps and light emitting diode. Eng. Agríc., Jaboticabal, 36(6): 962-971.
29. Zhao, Y.T., A. Shepherd, J.C. Swanson, J.A. Mench, D.M. Karcher and H. Xin, 2015. Comparative evaluation of three egg production systems: Housing characteristics and management practices, Poultry Science, 94: 475-484.
30. Chai, L., J.Q. Ni, C.A. Diehl, I. Kilic, A.J. Heber and Y. Chen, 2012. Ventilation rates in large commercial layer hen houses with two-year continuous monitoring. British Poultry Science, 53(1): 19-31.
31. Alloui, N., M.M. Alloui, O. Bennoune and S. Bouhentala, 2013. Effect of Ventilation and Atmospheric Ammonia on the Health and Performance of Broiler Chickens in Summer. Journal World's Poult, 3(2): 54-56.
32. Robin, P., P.A. de Oliveira and C. Kermarrec, 1999. Production d'ammoniac de protoxyde d'azote et d'eau par différentes litières de porc durant la phase de croissance. in Pocrine Research Days in France, pp: 111-116.
33. CORPEN, 2003. Estimation des rejets d'azote - phosphore - potassium - cuivre et zinc des porcs. Influence de la conduite alimentaire et du mode de logement des animaux sur la nature et la gestion des déjections produites, pp: 44.
34. Larbier, M. and B. Leclercq, 1992, Nutrition et alimentation des volailles. Editeur Inra Editions Quae, 1992-355, pp: 212-217.
35. Roch, G., C. Couture and M. Boulianne, 2013, Guide d'élevage de volailles de Basse-cour, Eqcma: version complète, pp: 14-16.
36. Ghmirou, Y., 2016. Techniques de conduite des elevages de poules pondeuses d'œufs de consommaton, Aviculture au Maroc. Source: www.avicultureaumaroc.com.
37. Cambra-López, M., 2001. Control of particulate matter emissions from poultry and pig houses. Ph.D. Thesis, Plitecnica Valancia University.
38. Ndelekwute, E.K. and G.E. Enyenihi, 2018. Negro Pepper (Xylopia ethiopica) in Feed is Antibacterial and Can Improve Broiler Chickens Productivity. British Journal of Poultry Sciences, 7(1): 10-15.
39. Duncan. Ian J.H., 2010, Lighting and its Effects on the Welfare of Broiler Chickens, BC Organic Grower, 13(4): 14-23.
40. Olanrewaju, H.A., J.P. Thaxton, W.A. Dozier, J. Purswell, W.B. Roush and S.L. Branton, 2006, A Review of Lighting Programs for Broiler Production, International Journal of Poultry Science, 5(4): 301-308.
41. Peigne, P., 2003. Methodology for assessing agricultural practices on air quality Usingagri-environmental indicators, PhD thesis, at INRA Colmar, France.
42. Peyraud, J.L., P. Cellier, C. Donnars and O. Réchauchère, 2012. Nitrogen flows linked to farms Reduce losses, restore balances. Synthesis of the collective scientific report, INRA, Colloque le 19 Janvier 2012 à Paris.
43. Béline, F., 1998. Étude des transferts d'azote par nitrification/dénitrification (N2, N2O, NH3) au cours du traitement aérobie et du stockage du lisier de porc. Essais avec 15N. PhD thesis, Perpignan University, France.
44. Englmaierová, M.E., V. Tùmová, M. Charvátová and Skøivan, 2014. Effects of laying hens housing system on laying performance, egg quality characteristics and egg microbial contamination. Czech J. Anim. Sci., 59(8): 345-352

45. Guo, Y.Y., Z.G. Song, H.C. Jiao and Q.Q. Song, 2012. The effect of group size and stocking density on the welfare and performance of hens housed in furnished cages during summer Lin. Animal Welfare, (21): 41-49.
46. Gutiérrez-Zapata, D. María, L.G.V. Fernando and M.F. Cerón-Muñoz, 2016. Semiparametric Modeling of Daily Ammonia Levels in Naturally Ventilated Caged-Egg. journal. pone, 11(1): 147-135.
47. Guinebretière, M., G. Guillaume, L. Bignon, S. Conan, G. Audebet, D. Huonnic, A. HuneauSalaün and V. Michel, 2011. Aménagement des cages pour poules pondeuses: impacts économiques, sanitaires, zootechniques et sur le bien-être animal, revue: Innovations Agronomiques, 17: 199-211.
48. Pereira, D.F., M.M. Vale, B.R. Zevolli and D.D. Salgado, 2010. Estimating Mortality in Laying Hens as the Environmental Temperature Increases. Brazilian Journal of Poultry Science, 12(4): 265-271.
49. Leenstra, F., V. Maurer, F. Galea, M. Bestman and Z. Amsler-Kepalaite, 2014. Laying hen performance in different production systems; why do they differ and how to close the gap. European Poultry Science, 78: ISSN 1612-9199.
50. Weeks, C.A. and G.C. Coles, 2011. Managing health risks in free-range laying hens is a Morrisons Farming Program publication.