The multivariate statistics applied to the characterization of backyard poultry production in Cienfuegos province

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The multifactorial characterization of the backyard poultry production systems was conducted in the eight municipalities of Cienfuegos province. One hundred seventy five rearing backyards randomly selected were used, for a reliability of 95 %, proportionally distributed in each municipality. In a transversal observational design with surveys, 17 social, 32 husbandry and 27 epizootiolocal variables were identified. The people inquired are described with an average age of 45 years, male sex predominating (62.90 %) and finished high education (66.9 %). Four husbandry components and five epizootiological ones characterizing the backyard poultry production in Cienfuegos province were identified, with variance explained from 72.90 and 67.22 %, respectively. The components of higher variability for the husbandry and epizootiological were: elements of the productivity, feeding oportunities, bioprotection and ectoparasitosis that explained 50.6 and 40.5% of the total variances. The indicators created: husbandry and epizootiological capacity showed low performance, without differences between the municipalities. Considering the methodology used and the results for strategies in the development of alternative of backyard poultry activity is recommended.

Key words: *backyard poultry rearing, alternative, principal components, epizootiology, husbandry.*

Animal production at family scale has extended during the last years as an important alternative to satisfy the nutritional demands in both rural and urban areas. It is an option for the feeding safety in developing countries. The possibility of solving certain situations related with feeding through animal production at small scale and on the basis on locally available inputs has been stated (FAO 2002).

Unspecialized or backyard poultry rearing (Henson 1992 and Rodríguez *et al*. 1996) is a protein source of high biological value. According to calculations of FAO (2005), the backyard of the house, in the open air, represents up to 70 % of the total egg and meat production in countries of low incomes and lack of feeds.

Poultry rearing at family scale has been urged in Cuba and has brought about the formation of new stocks with accepted production level and high resistance to adverse environmental conditions. In this context, non-conventional local raw materials have been assessed for the proper feeding and management and health systems of this type of rearing (Fraga 1997 and Madrazo *et al*.2006).

The knowledge of rural and backyard poultry production is very limited. That is why, understanding this problem is very difficult due to the lack of objective information to suggest advices to overcome the limitations of its development (Valencia *et al*. 2007).

In Cienfuegos province, during the last years, backyard poultry rearing has notably increased the number of anima. Reportedly, it reaches the 275 producers (EAC-UECAN 2010). Family or backyard poultry rearing, as production system, includes multiple sub-systems, where the social, husbandry and epizootiological components are fundamental.

Nevertheless, integral studies of this system under exploitation that facilitate the introduction of new technologies, the improvement of those already existing and the mitigation or elimination of problems affecting the backyard poultry rearing are scarce. The absence, in the corresponding institutions, of a proper database that allows characterizing this production system from the multifactorial point of view is also a limitation.

The backyard poultry rearing at municipality level in Cienfuegos province is characterized in this study. It is also pretended to establish variables to understand its complexity from the application of multivariate statistics by means of surveys.

Materials and Methods

A random sample of the 275 backyard poultry rearing systems distributed in the eight municipalities of Cienfuegos province (EAC UECAN 2010) was taken, according to stratified transversal sample design. The estimation of the sample size was carried out considering the probabilistic representativeness of 0.5, for a maximum error permitted of 0.05 and reliability of 95 %, according to Cochran (1980). The distribution of the backyards to be assessed was conducted proportionally and randomly for each municipality: 49 in Cienfuegos (CFG), 38 in Palmira (PAL), 14 in Cruces (CRU), 15 in Lajas (LAJ), 12 in Aguada (AGU), 13 in Rodas (ROD), 14 in Abreus (ABR) and 20 in

Cumanayagua (CYG).

The questionnaires representing the variables to be studied in the poultry systems were elaborated by poultry specialists. The variables interpretation was considered, according to its main objective to fulfill in the system: social, husbandry and epizootiological. Table 1 shows the indicators of each variable, classified as nominal (N), ordinal (O) or numerical (M).

A descriptive analysis of the social variables was conducted to obtain a representation of the sample studied. The categorical principal components analysis (CAPTCA) was applied to the husbandry and epizootiological aspects. The variables without correlation and minimum or zero variance were excluded from the analysis. Maximizing the highest amount of components or dimensions for the husbandry and epizootiological aspects was taken into account, whenever the eigen values were higher than

Table 1. Indicators according to classification and variable studied

Nº	Social	Husbandry	Epizootiological
1	Age of the interviewed (M)	Predominating breed (N)	Water source supply (O)
2	Sex (N)	Main purpose (N)	Hygiene state of the place (O)
3	Family size (M)	Rearing system (N)	Cleaning frequency of the feeders (M)
4	Finished education (O)	Birds stocking rate/m² (M)	Cleaning frequency of the drinkers (M)
5	Knowledgment about the poultry activity (O)	Materials used when constructing the facilities (N)	Cleaning frequency of the place (M)
6	Received training (N)	Types of feeder (N)	Disinfection conduction (N)
7	Experience on poultry activity (M)	Types of drinkers (N)	Insect removal (N)
8	Attention to the system (N)	Use of artificial light (N)	Desratization conduction (N)
9	Freelancers (M)	Primary statistical control (N)	Health habilitation conduction (N)
10	Persons working on a regular salary basis (M)	Lot composition this day (M)	Quality of veterinary attention (O)
11	Labor occupation (N)	Females/males proportion (M)	Type of veterinary attention (N)
12	Initiative to start the rearing (N)	Eggs per bird (M)	Most common disease (N)
13	Farm owner (N)	Destination of the egg production (N)	Knowledge about the avian flu (N)
14	Primary cattle rearing activity (N)	Trimestral meat production (M)	Use of alternative medicine (N)
15	Integration of poultry rearing with other cattle programs (N)	Slaughter age at of breeders (M)	Presence of ectoparasites (N)
16	Contribution to the home feeding support (N)	Fattening slaughter age (M)	Use of acharicides (N)
17	Contribution of local governments for the rearing (N)	Main feed used in rearing (N)	Poultry litter deposition (O)
18		Feeding quality (O)	Dead bodies deposition (O)
19		Knowledge feeds contribution (N)	Closeness of poultry producers (N)
20		Meat production destination (N)	Birds interchange (N)
21		Feeding frequency (M)	Other species on backyard (N)
22		Vitamins supply (N)	Promiscuity among bird species (N)
23		Minerals supply (N)	Birds procedence (N)
24		Birds grazing (N)	Purchase outside the municipality (N)
25		Grass preferred by birds (N)	Perimetral fence (N)
26		Agricultural area for birds feeding (M)	Trimestral mortality (M)
27		Crops for sowing (N)	Buying medicine expenses (O)
28		Main probleme for achieving the rearing success (N)	
29		Electricity expenses (O)	
30		Construction or repairing expenses (O)	
31		Sale transportation expenses (O)	
32		Buying feeds expenses (O)	

the unit, according to the thurstone (1935) criterion. In agreement with the relations of each variable in the dimensions, the highest saturation was taken to name each component.

When forming the components, the punctuation of the objects were scaled in a range from 0.01 to 5, corresponding to a better interpretation, considering that the best values are represented as they move away from the unit.

The making of the three components, husbandry, epizootiological and bioproductive, was conducted by means of the linear combination of the dimensions found with the following equation:

Σ di (λi / k)

where:

λi- eigen values associated with the components

k- amount of variables

d- dimensión, scaled value from 0.01 to 5.

The bioproductive indicator was obtained additively with the two previous.

The multivariate analyses were conducted with the statistical software SPSS (SPSS 2006). The comparison of the husbandry and epizootiological dimensions previously defined was carried out throughout the non-parametric variant of ANOVA of comparison by ranges of Kruskal Wallis (Siegel and Castellan 1995) for $P < 0.05$, in the statistical software Statistic (Statistic 1996).

Results and Discussion

Social description. The average age of the poultry backyard owner was of 43.20 years, superior to the mean age of the province for 2007 with 37.47 years, according to the last available census (ONE 2007). The 69.20 % corresponded to the male sex, with average family of 4.16 persons, with low variability, represented with CV= 15.2 %.

The education level was high, as 66.9 % of the surveyed persons had high or university degree. However, the knowledge on this activity was medium, 42.9 % of the producers admitted to have ideas about the topic. Nevertheless, 82 % expressed they were not trained, although 44.6 % of the people selected for the study had practiced poultry rearing for five years, even though not including persons with less than two years of experience on the activity was a premise.

In Latin America, many of the poultry backyard systems are paid attention by the family. In Nuevo León, Hernández (2002) demonstrated that the familiar labor is determining in the labor autonomy of a production system. Likewise, Forrero (2002), in Colombia, stated that for the good functioning of the farm in diversified agrarian systems, a work division is established between the members of the family, where the care and management of domestic animals is in charge of the women, children and old men, who play a determinant function.

This study differs from that stated in the cited studies, as only around the half backyards are paid attention by the producer and his family (51.4 %). This seems to be motivated because 28.6 % of the surveyed people conduct the agricultural activity as a labor occupation and the rest as stable labor contract.

The 65.8 % of the farms owners declared that they started the poultry rearing activity due to necessity, as a resource for house support. This response was also high (69.3 %) among those with no lands, but only 53.7 % was satisfied with the support of this activity for the feed safety of the house. That previously stated shows the lack of integration with other agrarian programs and is mostly presented with the swine activity (38.9 % of producers).

Gueye (2004) refers the necessity of governments, nongovernmental organizations, international agencies and donors to support the people interested or included to the sub-sector of family poultry rearing. The cooperation of local governments is low, as only 8.6 % of producers have received support for developing rearing.

Identification of the husbandry and epizootiological dimensions. The results of the survey established 59 variables identified, according to their characteristics, as husbandry or epizootiological (32 and 27, respectively). A total of 9 husbandry and epizootiological variables were excluded from the multivariate analysis for not having correlation or showing minimum variance. They should be considered for further analyses.

The dimensions created for the husbandry and epizootiological variables allowed to explain 72.90 % and 67.22 % of the total variance, in that order, with high consistence expressed by the values of the Alpha of Cobrach (tables 2 and 3).

Although it is common in this type of studies the analysis with the dimensions or components created, without comments on the variables with numeric nature, the nominalization of each component is justified in this study for a better understanding.

The productivity of a cattle system is influenced by indispensable variables. Those with higher weight in the first component for non-conventional poultry rearing were: predominating breed, main purpose, rearing system, stocking rate of birds/m², use of the artificial light, age at slaughtering of the breeders, birds grazing, minerals supply, trimestral meat production, proportion female/male and egg per bird. This component was denominated elements of the systems productivity.

Although the last two variables were saturated negatively, with values of -0.708 and -0.522 respectively, the influence on these systems is explained because when the female-male proportion is lower, those females sexually suitable for reproduction and production are less used. Thus, a lower production of fertile eggs is achieved,

Table 2. Saturation of the dimensions for the husbandry variables

Variables	Dimension			
	1	2	3	4
Predominant breed	0.856	-0.118	0.001	-0.038
Main purpose	0.937	0.419	-0.090	0.059
Rearing system	0.865	-0.424	0.099	-0.133
Density of birds/m²	0.865	-0.333	0.059	-0.167
Used materials facilities	-0.253	0.061	0.852	0.135
Type of feeders	-0.137	-0.016	0.908	0.094
Type of drinkers	0.185	-0.024	0.994	-0.175
Use of artificial light	0.508	0.169	0.242	-0.357
Primary statistical control	-0.177	0.133	-0.249	0.612
Lot composition this day	0.387	-0.157	-0.136	0.799
Females/males proportion	-0.708	0.360	-0.074	0.198
Egg per bird	-0.522	0.225	-0.050	0.045
Destination of the egg productions	0.299	0.753	0.010	0.170
Trimestral meat production	0.849	-0.369	-0.028	0.380
Slaughter age of breeders	0.519	-0.230	0.052	-0.034
Main feed used in the rearing	-0.600	-0.748	-0.061	0.124
Feed quality	0.272	0.728	0.003	0.160
Meat production destination	0.496	-0.334	0.074	0.585
Vitamins supply	0.564	0.744	0.066	-0.130
Minerals supply	0.621	0.387	0.094	-0.349
Birds grazing	0.451	0.139	0.068	0.287
Buying feeds expenses	0.410	0.690	0.077	0.283
Construction or repairing expenses	0.477	0.576	-0.220	0.076
Explained variance, %	32.19	18.36	12.98	9.37

Alfa of Conbrach: 0.983

influencing on the age at slaughtering of breeders, which will be higher.

The value of these variables for the poultry productivity is given because the breed used may express its genetic potential, in function of the characteristics and demands of housing and its susceptibility or resistance to stressing factors of the environment (Fraga 1997).

The birds' feeds should have minerals in amounts that allow a proper supply during each production phase. Under backyard conditions, and according with the rearing system, an additional supplement with minerals may or not be needed to guarantee the animal productivity (Li *et al*. 2000 and Lippens and Huyghebaert 2003).

The second component was named feeding opportunities of the systems, with 18.36 % of explained variance. It was formed by the variables: main feed used in the rearing, vitamins supply, feeding expenses, feed quality, egg production destiny and expenses for construction or repairmen. The first variable was saturated negatively (- 0.748), logical question as the classification of these variables ordinally expresses that as the main feed in of lower quality, the other variables, such as vitamins supply, feeding expenses and feed quality show superior values.

The feeds availability is, undoubtedly, the most critical problem of the family poultry rearing program, because the agricultural productions for poultry feeding is still an unsolved aspect. This statement was confirmed because 52.8 % of the people surveyed affirmed that the main obstacle for their rearing success is the insufficient feeding.

The variable egg production destiny, with saturation of 0.753, although not directly related with the rest, can be influenced by the feeding opportunities, as 48.0 % is for self-consumption and 12.6 % for external commercialization. The rest of the producers work hard for both destinies (39.4 %).

The third component, facilities quality of the systems, with 12.98% of explained variance, was formed by the following variables: materials used in the facilities, type of feeder and type of drinker with positive values (0.852, 0.908, and 0.994 in that same order). The objective relation between these variables that improve the birds' comfort for obtaining higher productive results was proved.

The fourth component, records on the rearing

Table 3. Saturation of the dimensions for the epizootiological variables

Variables	Dimension				
	1	2	3	4	5
Sanitary state of the place	0.720	-0.172	-0.181	-0.011	-0.144
Cleaning frequency of the feeders	-0.712	-0.470	0.280	-0.137	-0.175
Cleaning frequency of the drinkers	-0.752	-0.500	0.236	-0.088	-0.218
Disinfection conduction	0.491	-0.135	0.630	-0.100	0.092
Desratization conduction	0.465	-0.128	0.641	-0.202	0.226
Sanitary habilitation conduction	0.336	-0.109	0.496	-0.422	0.148
Veterinary attention quality	-0.381	0.406	-0.026	0.137	0.564
Type of veterinary attention	0.488	-0.129	-0.053	-0.315	0.281
Most frequent disease	0.597	0.672	-0.107	0.124	0.279
Use of alternative medicine	-0.314	0.019	-0.316	-0.494	-0.112
Presence of ectoparasites	-0.227	0.843	0.306	-0.003	-0.151
Use of achariciides	0.239	-0.843	-0.279	-0.006	0.143
Poultry litter deposition	-0.045	-0.171	0.187	0.697	-0.068
Dead body deposition	-0.160	0.166	-0.117	0.611	0.089
Closeness of poultry producers	-0.165	-0.419	-0.213	0.086	0.660
Birds interchange	-0.676	-0.169	0.251	0.189	0.493
Promiscuity between birds species	-0.697	0.427	0.212	-0.054	0.020
Other species on the backyard	-0.483	0.206	-0.288	-0.272	0.185
Explained variance, %	23.36	17.14	9.84	8.89	7.98

Alfa of Conbrach: 0.983

systems, with 9.37 % of explained variance, was formed by the variables: primary statistical control, lot composition, destiny of the meat production, saturating positively, with values of 0.612, 0.799, and 0.585. It is evident that the producers giving priority to meat production for commerce use better the primary controls. This is due to the short cycle of these rearings, so they have understood the need of recording the main husbandry events, such as the amount of bought birds, price of the grains and concentrates, among others.

In every productive system, the controls are a determining indicator for the sustainability of the familiar poultry rearing technology. Therefore, controlling the production process by the producers is important so they can correct immediately the process failures, its profitability and making decisions (INEGI 1998). In small lots, the poultry producers minimize the negative effects of the feeding limitations as they have higher control of the birds (Cisneros2002).

The factors directly related with the animal's health were identified as epizootiologic. Referred here are, as factors studied, the origin, frequency, distribution, development and extinction of diseases, as well as the health of the animal population at herd level. Besides, the causes and factors influencing on the animal's health to define the methods of creation, protection, improvement and recovery of the collective health by reduction and elimination of common diseases are also analyzed (Kouba 2001).

The first component, bioprotection elements of the systems, with 23.36 % of explained variance, included the hygiene-health state of the place, type of veterinary attention, cleaning frequency of the feeders and drinkers, other species in the backyard, birds interchange, and promiscuity among bird species. The first two variables had positive value, and the rest, negative. From the conceptual point of view, they may be gathered in two groups: the first for the hygiene, with the four first variables, and the second, referred to the risk with the other three.

An inverse relation of the variable hygiene-health state of the local and the others was observed. This proves that, for the alternative systems, the corresponding health providences like cleaning and disinfection of drinkers and feeders with a disinfectant of known action.

The variables related with the second subgroup expressed the risks a poultry system may have, even of backyard, when being vulnerable for having other species in the backyard and for the animals interchange, propitiating the promiscuity among species. These two mentioned elements can be related as there are more dangers in this type of rearing; the elements against hygiene can cause more damages.

The second component, absence of ectoparasites of the birds in the systems, was defined with three variables: use of acaricides, presence of ectoparasites and most frequent disease, with values of -0.843, 0.843 and 0.672, respectively. The inverse relation between

the first two variables was considered to name this dimension. The ectoparasitosis was not expressed as the most frequent disease but the respiratory ones (45.7 %) and enterobacteriosis (21.1 %), as it is more likely that the birds without being parasites removed suffer from these diseases.

The coccidiosis (20.6 %), avian cholera (3.4 %) and avian smallpox (9.1 %) were other diseases that affected the birds. The smallpox had higher incidence on the birds obtained by free mating because in the program of familiar poultry rearing, the chicks are given to the producers previously vaccinated against Newcastle and avian smallpox. Besides, a monitoring of epizootiological watching is practiced (Pampín 2002). For this cause, diseases like pest, smallpox, bronchitis, cholera, salmonelosis, coccidiosis and internal and external parasites are reported in Ecuador in backyard poultry rearing (Narváez and Oñate 2002).

The third component was formed by the measurements of epizootiological healing, with 9.84 % of explained variance, previously referred by Kouba (2003) in activities to reduce and eliminate the etiological agents of living animals. This author emphasized on the reservoir vectors of etiological agents expresses by the variables of desratization, disinfection and health habilitation, with positive values of 0.641, 0.630, and 0.496, respectively.

According to Ricaurte (2000), rodents' control and minimizing the germs is a very important factor in this type of rearing.

The management of solid wastes was the fourth component, with 8.89 % of explained variance. It was integrated by the variables of body disposition; poultry litter disposition and use of alternative medicine. The last variable had – 0.494, showing a subordination in the proper use of the main residues of rearing with the use of alternative medicine, as an alternative producers can afford to fight against certain diseases.

It is defined that the sick animals that die should be burned or buried with a layer of caustic lime far away from the henhouse (Segura *et al*. 2002). However, in backyard poultry rearing, as there is no enough space, the nuisance due to the poultry litter is frequent and may cause tensions and problems with the neighbors (FAO 2000). The familiar poultry rearing systems are frequently close, propitiating the infection of different pathologies. The variables veterinary attention and proximity of producers had positive saturations in this component. This matter is due to the need of specialized services for the therapeutic control in birds. This dimension was called risks of disease propagation due to proximity between systems. The viral affections, such as flu or avian influenza, highly contagious viral disease, is generally presented epidemically. It crosses the borders and eventually may affect humans (Gray and Kayali 2009). The proximity among systems is, among other factors, an important way for the disease propagation.

In studies conducted with methodology for non-traditional systems but with different species, rabbits (Casanovas *et al*. 2005) and sheep (Castro 2009), similarities in the dimensions for husbandry aspects were found, with emphasis on the productive potentials of these systems. However, they do not coincide integrally for the epizootiological ones, as in rabbits, sanity and biosecurity elements were defined as the most important ones. For sheep, the more specific factors were the prevention of podal and parasites diseases, related with the housing systems and the characteristics of the species.

Municipalities comparation according to the created indicators. The created indicators, such as husbandry capacity (four dimensions), epizootiological situation (five dimensions) and bioproductive characteristics (nine dimensions found), may reach in theory threshold values of 3.64, 3.36 and 7.00, respectively. The denomination of the bioproductive indicators is conceptualized as it includes all the variables integrated in the nine components determining the biological and productive efficiency of the poultry production systmes (table 4).

The husbandry capacity at municipal level did not have differences between the municipalities with low values from 1.67 to 1.88 or 45.87 % to 51.64 % of the threshold value. This proves the lack of faculty for developing the systems from this point of view.

The Cienfuegos municipality (1.68) was the best from the epizootiological point of view, with

Table 4. General indicators per municipality

General indicators	Municipalities							
	CFG	PAL	CRU	LAJ	AGU	ROD	ABR	CYG
Husbandry capacity	1.79[a] (91.60)	1.76[a] (92.70)	1.91[a] (98.50)	1.67[a] (67.50)	1.88[a] (99.70)	1.70[a] (78.90)	1.69[a] (71.00)	1.83[a] (88.90)
Epizootiological situation	1.68[a] (103.80)	1.68[ab] (93.30)	1.47[ab] (79.82)	1.67[ab] (88.90)	1.60[ab] (85.80)	1.52[ab] (79.30)	1.62[ab] (78.90)	1.41[b] (57.80)
Bioproductive characteristics	3.47[a] (98.40)	3.44[a] (95.10)	3.39[a] (86.60)	3.34[a] (81.10)	3.49[a] (96.00)	3.22[a] (72.40)	3.31[a] (76.20)	3.25[a] (68.90)

Rows with different superscripts differ for P< 0.05 (Kruskal Wallis)
( ) Ranges

significant differences ($P < 0.05$) compared to Cumanayagua (1.41), and without differing from the rest. However, the indicator is low in respect to the maximum value to reach, with 41.96 and 50.00 %, respectively.

The bioproductive indicator had low values, with means from 3.22 to 3.49 and from 46.00 to 49.85 % respectively, in relation with the maximum value to achieve (7.00).

It is concluded that with the techniques of multivariate statistics used, the non-controlled productive systems may be characterized. The backyard poultry production activity is not familiar. It is mostly represented by male owners with high education. The four husbandry components and the five epizootiological ones characterizing these systems have greater importance for the productive and feeding aspects. The bioprotection and absence of ectoparasites at municipality level are expressed in a low husbandry capacity and epizootiological situation. This proves the insufficient for the development of these systems.

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