Classification of Dairy Farms from Cooperatives of Credit and Services

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ABSTRACT

Dairy farms from Cooperatives of credits and services in the province of Ciego de Avila, Cuba were classified. A matrix with physical, productive and efficiency variables was designed for 372 cases, which were divided into three scales, according to cow possession: less than 11; between 11 and 25; and more than 25. The animals were grouped in each scale, following the hierarchic cluster analysis. Three groups were made up in the dairy units of less than 11 cows (the first one with 57.5 % of the cases, accounting for 1.7% of the total forage areas). In the 11-25 cow scale, five groups were made up (in the first and second, with 93.6% of the cases, the forage areas were 1.7 and 2.28 % of the total area, respectively). In the farms with over 25 animals, three groups were set up (the first and second ones had 75.5 and 23.4 % of the cases, with forage areas covering 0.76 and 2.94 % of the total areas, respectively). The best results were achieved in the groups with more advanced technological conditions, greater enclosing areas, and forage proportion.

Key Words: *milk production, farm dairy systems, multivariance analysis, efficiency*

INTRODUCTION

Analysis of cattle systems is very complex due to the diversity of current productive, ecological and socioeconomic systems. The studies of these systems in Chile (Avilez *et al*. 2010); México (Sánchez-Gil *et al.* 2008); and Venezuela (Páez *et al.* 2003), are examples of how this issue has been approached in Latin America.

In Cuba, Guevara *et al*. (2004), Benítez *et al*. (2008), and Acosta and Guevara (2009) used methodologies with multivariate techniques to analyze the factors that affect cattle systems (environmental, ecological, economic, productive and reproductive). This study is important to improve product sales and plan the distribution of resources and the application of new technologies.

Torres *et al*. (2008) suggested a methodology based on the combination of multivariate methods to determine and analyze impact indexes on the positive or negative behavior of individuals or study cases. Martínez-Melo *et al*. (2013) used that methodology to characterize factors that influence milk production on private farms, in the province of Ciego de Avila, Cuba, whose classification is unknown. Accordingly, the aim of this paper was to classify the dairy farms from Cooperatives of Credit and Services (CCS) in Ciego de Ávila.

MATERIALS AND METHODS

CCSs from the seven most productive municipalities in the province of Ciego de Avila (Ciego de Ávila, Majagua, Florencia, Baraguá, Chambas, Primero de Enero and Bolivia), were included in the study. The research covered 372 relevant dairy units. The selection criterions for the cooperatives was, being three years or more producing milk, being a regular year-round milk producer, and having reliable cooperative information.

Primary information on the quantitative elements was collected through visits to cooperatives and the farms they belong to. The information was divided into physical, productive and efficiency variables.

Physical variables (ha): total areas, uncultivated pastures, sugar cane, and king grass, invaded by undesirable species, apart from the number of grazing divisions. Other secondary variables were calculated later, such as percent of uncultivated pasture, cultivated pastures, sugar cane, king grass and undesirable species. The king grass areas (cutting areas) were included, provided they would not be classified into species due to diversification and crossings.

Productive variables: average total cows (u), cows under average annual milking (u), annual milk production (kg), average annual births (u).

Efficiency variables: percent of milking cows, natality, production of annual milk/cow total^{-1} (kg), annual production of milk/ha^{-1} (kg), load (UGM/ha^{-1}), calculated from primary information. To calculate the cattle units (UGM), the equivalent of 1 UGM = 1 500 kg bovine.

Hierarchic cluster analysis was used to determine the groups of farms, according to the methodology suggested by Torres *et al*. (2006), and the assumptions described by Torres *et al.* (2008).

For classification, the farms were grouped into three, according to cow possession (farms with less than 11 cows; between 11 and 25 cows; and more than 25 cows). The production units were also grouped within each cow scale. The groups were described according to their means and standard deviations. Analyses were made with SPSS 11.5.1 (Visauta, 1998).

RESULTS AND DISCUSSION

The analysis of hierarchic cluster analysis was used to group the farms and also know the patterns that describe their differences. From the group with less than 11 cows, three groups were made up (Table 1): the first one included 57.5% of the cases, with a lower total area average. The areas for this group grazed on cultivated grass, sugar cane and king grass, in less than a hectare (1.7 % of the total surface).

Groups I and II, with 95% of the farms, had similarities, in terms of the total area of uncultivated pastures and enclosures; whereas the main differences were observed in the mean values for the amount of milking cows, annual production, lowest productive performance, and total production per cow and hectare in group II (83% of the farms). However, nutrition was deficient in the three farm groups, where the values for the area of cultivated pastures, sugar cane, and king grass, were lower than 2% of the total areas in the first and second groups, and absent in group III.

Group III, with only three cases, comprised farms practicing extensive raising methods, low levels of land use, and widespread invasion of undesirable plants (53%) in the total area (Table 1), affecting grazing areas.

These values indicate the farm´s nutritional vulnerability to cope with dry seasons, over 180 days annually. The main sources of nutrition these systems have are uncultivated grass, with decreased yields in this season (Pérez Infante, 1970).

In the farm groups considered as small scale dairy systems, but with sufficient nutritional support, strategies for more effective land use must be applied, by planting high yielding forage that guarantee feeding the year round (Herrera, 2005).

Farms in the 11 – 25 cow scale were classified in five groups (Table 2). The first and second groups included the largest number of animals (93.6%). The second group was in as twice as much the area of the first group, and had two more milking cows; its annual production per total cow was lower. Additionally, land use was considered low, with an average of 0.35 UGM/ha^{-1}. These results have shown how important it is to use loads when planning feeding; it must be regulated according to the system´s biomass production capacity (Senra *et al.* 2005).

The units in the third group (similar area to the first group, and two more milking cows) produced 1 191 l total on a year average, which indicates less production per cow. The cause for this must be found in the high levels of undesirable plants (12.4%), among others (Table 2). However, the forage areas accounted for 1.7 and 1.6 % of the total areas in the first and third groups, respectively, also indicating nutritional vulnerabilities.

Moreover, the fourth group, using a similar area and load than the second group, had higher figures in annual production, per total cow, and hectare. It may be explained by the existence of large areas with cultivated grass, sugar cane and king grass (less than 0.5 UGM/ha^{-1}. In these conditions, the animals can choose the grass; over and under- grazed areas may exist (Senra, 2011).

Though the natality percents and milking cows (Table 2) were above 50 in most of the groups, they indicate the productive results of these herds under the handling and feeding conditions they are subject to, which may slightly affect the herd´s total milk production directly, as reported by Menéndez-Buxadera *et al*. (2004). In that sense, the herd´s reproductive control, and evaluation of basic parameters to organize and supervise the process, can be used to increase efficiency (Avilés *et al*. 2010). These results show that fertility problems are one of the causes that affect efficiency of milk production on these farms, where herd natality stayed below 85 %.

After the analysis, one case (group IV) from a farm with similar total area to groups I and II in the municipality of Florencia stood out. It had better technical conditions, like more enclosures and better nutritional conditions, with 9.3 and 4.6 % of the total area for sugar cane and king grass, respectively, as well as absence of undesirable plants. This case produced 6.5 times more milk than the farms in group I, with a higher productive efficiency, and better land use. These results coincide with criteria by Martín and Rey (1998), and Macedo *et al*. (2008), by increasing the quantity and quality of feedstuffs with the use of new technologies.

Farms with over 25 cows were classified in three groups (Table 3). The first one included 75.5% of the cases, whereas the second accounted for 23.4%. Generally, total cow productions in these three groups were higher than 500 l. Group III, with one case using less area and more milking cows than the other units, produced 2.2 and 3.2 times more milk per cow and hectare, respectively, than the first one. These results are explained by the existence of better technical conditions associated with better land use, and more area for forage production (16%). Other factors like the greater number of enclosures may also be decisive, as more efficient grassland management is guaranteed (Guevara *et al.*, 2003 and Senra *et al*., 2005).

The main differences between groups I and II were observed in the total area. The second, with a similar number of cows, used twice as much the area as the first group to feed the herds. However, the largest areas cultivated with sugar cane and king grass in group I (Table 3) made no difference in the total production per cow, compared to the units in the first group. This may mean that the amounts of biomass produced in these farms are still insufficient to satisfy the needs of herds, thus it is important to increase forage areas for feeding self-sufficiency, depending on the load used for each system (Herrera, 2005 and Martínez *et al*. 2010).

These dairy systems are characterized by reduced forage areas and low productive efficiency which differ from the systems described by García *et al.* (2010) in a region in Spain, where 49 % of production areas belong to small farms with limited intensive levels and cattle load adjusted to feed availability, occasionally using strategic supplementation. Furthermore, 30% of the largest production areas with higher technological development use high supplementation levels, and cattle loads are above the system´s capacity, largely dependent on foreign feedstuffs.

In short, groups I and II from every productive scale (Tables 1; 2 and 3), account for 95.4% of the cases studied, confirm that the productive volumes depend on the number of milking cows. However, the forage area percents in each group (below 3.07 % of the total area) show the features common to systems that do not use uncultivated grass as staple diet. The previous proves the need to gradually increase the areas with cultivated pasture and forages and guarantee nutritional self-sufficiency in the herds.

In Cuba there are results that validate the possibilities to achieve milk yields per hectare over 1 800 l, using more cost effective technologies, based on uncultivated grass, sugar cane, king grass, and low supplementation (Martín and Rey, 1998). In that sense, Ruiz (2011) claims that the ratio between loads and milk production increases per hectare relies on basic supplies to improve the grazing ecosystems; namely, use of forage and legumes, enclosing, nitrogen-based fertilizing, and balanced diet supplements, along with an adequate nutritional support, according to the animal´s potential.

CONCLUSIONS

The classification achieved for each scale, in relation with the number of cows, was useful in determining differences as to farm extension, features of the nutritional support, reproduction indicators, and milk production efficiency. Higher results were achieved on farms with the best technical conditions for better land use, enclosing, and large farm areas and proportion for forages and improved pastures.

REFERENCES

ACOSTA, Z. G. y GUEVARA, G. (2009). Caracterización y evaluación del impacto de la ganadería bovina en la cuenca del río San Pedro en Camagüey, Cuba. Rev. prod. anim., 20 (1): 1-6, 2009.

AVILÉS, J. P.; ESCOBAR, P.; VON FABECK, G.; VILLAGRAN, K.; GARCÍA, F.; MATAMOROS, R. y GARCÍA, A. (2010). Caracterización productiva de explotaciones lecheras empleando metodología de análisis multivariado. *Revista Científica FCV-LUZ, 10* (1), 74-80, 2010.

BENÍTEZ, D.; RAMÍREZ, ALINA; GUEVARA, O.; PÉREZ, B.; TORRES, VERENA; DÍAZ, MARGARITA; PÉREZ, DIANA; GUERRA, J.; MIRANDA, M. y RICARDO, OLGA (2008). Factores determinantes en la eficiencia productiva de fincas ganaderas de la zona montañosa de la provincia Granma, Cuba. *Rev. Cubana Cienc. Agríc.*, *42* (3), 247-253.

GARCÍA, A.; PEREA, J.; ACERO, R.; ANGÓN, E.; TORO, P.; RODRÍGUEZ, V. y GÓMEZ, A.G. (2010). Caracterización estructural de los sistemas ganaderos de las dehesas andaluzas. *Arch. Zootec.*, *59* (228), 577-588, 2010.

GUEVARA, G.; GUEVARA, R., PEDRAZA, R., MORALES, A., FERNÁNDEZ, N. y MORELL, A. (2004). Clasificación dinámica de los sistemas de producción lechera de la cuenca Camagüey-Jimaguayú, Cuba. *Rev. prod. anim*., *16* (1), 17-24.

GUEVARA, R.; GUEVARA, G. y CURBELO, L. (2003). Pastoreo racional Voisin para la producción bovina sostenible. Artículo Reseña. Primera parte: *Rev. prod. anim*., *15*, 1.

HERRERA, R. S. (2005). Evaluación de gramíneas. Contribución del Instituto de Ciencia Animal. *Rev. Cubana Cienc. Agríc.*, *39* (3), 253-259.

MACEDO, R.; GALINA, M. y ZORRILLA, J. M. (2008). Balance forrajero, energético y proteico de un sistema de producción tradicional de doble propósito en México. *Zootecnia Trop.*, *26* (4), 455-463.

MARTÍN, P. C. y REY, S. (1998). Relación entre la tecnología y la economía en la producción de leche. *Rev. Cubana. Cienc. Agríc.*, *32*, 361-367.

MARTÍNEZ, R. O.; TUERO, R.; TORRES, VERENA y HERRERA, R. S. (2010). Modelos de acumulación de biomasa y calidad de las variedades de hierba elefante, Cuba CT-169, OM-22 y *king grass* durante la estación lluviosa en el occidente de Cuba. *Rev. Cubana Cienc. Agríc.*, *44* (2), 189-193.

MARTÍNEZ-MELO, J.; TORRES, VERENA; HERNÁNDEZ, N. y JORDÁN, H. (2013). Utilización del índice de impacto en la caracterización de los factores que influyen en la producción de leche en fincas de la provincia Ciego de Ávila, Cuba. *Rev. Cubana Cienc. Agríc.*, *47* (4), 367-373.

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MENÉNDEZ-BUXADERA, A.; CAUNEDO, J. y FERNÁNDEZ, M. (2004). Relación entre el porcentaje de vacas en ordeño y la producción láctea total del rebaño. *Rev. Cubana Cienc. Agríc.*, *38* (4), 361-367.

PÁEZ, L.; LINARES, T.; SAYAGO, W. y PACHECO, R. (2003). Caracterización estructural y funcional de fincas ganaderas de doble propósito en el municipio Páez del estado Apure, Venezuela. *Rev. Zootecn. Trop.*, *21* (3), 301-320.

PÉREZ INFANTE, F. (1970). Efecto de tres intervalos de corte y tres niveles de nitrógeno en las ocho gramíneas más extendidas en Cuba. *Rev. Cubana Cienc. Agríc.*, *4*, 145.

RUIZ, R. (2011). Producción de leche basada en pastos y forrajes tropicales. *Ciencia y Tecnología Ganadera*, *5* (1), 1-21.

SÁNCHEZ-GIL, L. G.; SOLORIO, J. L. y SANTOS, J. (2008). Factores limitativos al desarrollo del sistema familiar de producción de leche en Michoacán, México. *Cuadernos de Desarrollo Rural*, *5* (60), 133-146.

SENRA, A. (2011). Cultura de trabajo para garantizar la sostenibilidad; eficiencia e impacto final de las tecnologías. *Avances en Investigación Agropecuaria (A.I.A)*, *15* (2), 3-12.

SENRA, A.; MARTÍNEZ, R. O.; JORDÁN, H.; RUIZ, T.; REYES, J. J.; GUEVARA, R. y RAY, J. V. (2005). Principios básicos para un pastoreo rotacional eficiente y sostenible para el subtrópico americano. *Rev. Cubana Cienc. Agríc.*, *39* (1), 23-29.

TORRES, VERENA; BENÍTEZ, D.; LIZAZO, D.; RODRÍGUEZ, L.; HERRERA, M. y ÁLVAREZ, A. (2006). *Metodología para la medición del impacto de la innovación o transferencia de tecnología en la rama agropecuaria*. La Habana, Cuba: Instituto de Ciencia Animal.

TORRES, VERENA; RAMOS, N.; LIZAZO, D.; MONTEAGUDO, F. y NODA, AIDA (2008). Modelo estadístico para la medición del impacto de la innovación o transferencia tecnológica en la rama agropecuaria. *Rev. Cubana Cienc. Agríc.*, *42* (2), 133-139.

VISAUTA, B. (1998). *Análisis estadístico con SPSS para Windows. Estadística Multivariante* (Vol. 2). España: MCGRAW-HILL Interamericana.

Tabla 1. Recursos, producción y eficiencia para los grupos de fincas con menos de 11 vacas

Indicators	Group I (n=42)		Group II (n=28)		Group III (n=3)	
	Mean	**DE**	**Mean**	**DE**	**Mean**	**DE**
Total area, ha	14.4	8.09	16.9	7.97	52.5	21.34
Uncultivated pastures, ha	12.4	8.17	13.8	7.29	50.1	25.00
Number of enclosures	1.76	1.03	1.93	1.18	1.00	0.00
Total cows, U	7.4	2.07	7.8	2.09	7.0	3.61
Milking cows, U	4.7	1.55	2.8	0.89	4.6	3.79
Annual milk production, kg	4 597.6	2 311.98	3 641.8	1 947.59	5 215.0	2 104.33
Milking cows, %	63.6	11.31	37.2	8.76	64.7	26.30
Natality %	68.9	12.57	48.4	13.15	77.2	11.82
Annual production. Total $cows^{-1}$, kg	523.7	257.49	465.6	217.76	790.8	134.73
Annual production. ha^{-1}, kg	402.3	276.98	237.3	121.04	103.2	44.55
Load, $UGM.ha^{-1}$	0.64	0.32	0.52	0.20	0.14	0.06
Areas of cultivated grass, ha	0.02	0.19	0.01	0.06	0.00	0.00
Sugar cane areas, ha	0.13	0.22	0.11	0.31	0.00	0.00
King grass areas, ha	0.03	0.11	0.04	0.20	0.00	0.00
Areas of undesriable plants, ha	0.75	1.92	1.83	2.84	26.40	7.26

() Number of farms, DE: Standard deviation

Table 2. Resources, production and efficiency for the farm groups between 11 and 25 cows

Indicators	Group I (n=152)		Group II (n=40)		Group III (n=7)		Group IV (n=5)		Group V (n=1)	
	Mean	DE	Mean	DE	Mean	DE	Mean	DE	Mean	DE
AT, ha	24.8	10.48	56.4	14.61	26.4	8.73	55.4	22.74	26.8	
PNC, ha	22.6	10.38	46.4	17.77	21.7	8.90	40.6	23.89	21.0	
NC	2.64	1.86	3.58	1.68	1.86	1.07	4.00	1.41	8.00	
VT, U	16.5	4.11	19.1	4.48	18.1	4.56	21.6	4.16	25.0	
VO, U	8.6	3.41	10.6	3.54	10.1	4.63	10.0	1.41	12.0	
PL, kg	9764.8	5134.74	7707.9	3633.11	8573.7	3866.16	10596.2	2817.34	63919.0	
%VO	51.9	15.46	55.2	12.75	57.3	22.59	47.6	11.40	48.0	
%NA	55.5	14.80	51.8	12.71	62.2	22.94	47.6	11.40	40.0	
LXVT, kg	588.3	264.06	392.4	142.44	485.5	236.62	490.2	80.10	2556.7	
LXAT, kg	433.7	234.88	142.4	74.61	393.2	271.96	239.2	181.76	2381.4	
LOAD, UGM.ha^{-1}	0.77	0.31	0.35	0.10	0.74	0.24	0.45	0.25	0.92	
APC, ha	0.04	0.34	0.86	1.42	0.00	0.00	4.90	3.29	1.00	
AC, ha	0.30	0.47	0.47	0.92	0.28	0.49	2.10	1.02	2.50	
AK, ha	0.12	0.28	0.82	1.02	0.14	0.38	5.20	5.50	1.25	
API, ha	0.68	1.60	6.80	8.31	3.28	3.73	1.50	2.06	0.00	

() Number of farms, DE: Standard deviation
AT: Total area, PNC: Area of uncultivated grass, NC: Number of enclosures,
VT: Total cows, VO: Milking cows, PL: Annual milk production, %VO: Milking cow percent,
%NA: Natality percent, LXVT: Annual production per total cows,
LXAT: Annual production per hectare, APC: Area of cultivated grass,
AC: Sugar cane areas, AK: King Grass areas, API: Areas of undesirable plants

Table 3. Resources, production and efficiency for the farm groups with more than 25 cows

Indicators	Group I (n=71)		Group II (n=22)		Group III (n=1)	
	Mean	DE	Mean	DE	Mean	DE
Total area, ha	48.4	22.10	102.1	24.34	38.8	
Areas of uncultivated grass, ha	45.0	21.51	94.5	25.07	30.5	
Number of enclosures	3.20	1.53	5.91	3.61	21.00	
Total cows, U	39.1	10.88	37.4	10.07	52.0	
Milking cows, U	18.2	8.85	22.6	8.29	32.0	
Annual milk production, kg	22096.2	13776.27	20181.3	8460.49	65641.0	
Milking cows, %	46.3	16.99	60.5	14.01	61.5	
Natality, %	52.8	17.60	51.3	11.76	53.8	
Annual production. Total cows^{-1}, kg	557.8	277.41	529.2	117.89	1262.3	
Annual production. ha^{-1}, kg	512.4	310.43	206.6	95.49	1689.6	
Load, UGM.ha^{-1}	0.95	0.47	0.39	0.12	1.35	
Area of cultivated grass, ha	0.12	0.62	2.12	1.75	1.04	
Sugar cane area, ha	0.22	0.43	1.19	0.92	4.16	
King grass area, ha	0.15	0.43	1.81	0.88	2.08	
Areas of undesirable plants, ha	1.89	4.56	1.42	1.93	0.00	

() Number of farms, DE: Standard deviation