Rev. prod. anim., 27 (2): 2015

Classification of Dairy Units at the *Valle del Perú* Cattle Raising Enterprise

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ABSTRACT

Thirty dairies from a dairy company were characterized. Discriminant Function Analysis was applied. Eleven variables were used: annual milk production; milk production/cow/day; births; percent of milking cows; total cows; empty cows; Percent of areas with *Pennisetum purpureum* vc. Cuba CT-115; percent of areas with improved pastures, milk L cost; total costs in CUP; and number of workers. The dairies were divided into three groups, based on annual milk production for three years (high, medium, low). Dairies in group 1 showed a more favorable behavior than in group 2; and the latter had higher values than group 3, except for the total costs. The most significant variables causing group differences were total births, percent of milking cows, and total cows. The results proved that, relatively, there were three types of dairies in the company: high, medium, and low annual milk production. That information was useful to set up technological strategies to improve the performance of the least producing dairies.

Key words: *multivariate analysis, classification, discriminant power, dairies*

INTRODUCTION

At present, cattle enterprises in Cuba and other parts of the world have limitations concerning analysis and assessment; analyses are based on comparisons of annual production plans, so the results achieved in the period evaluated are descriptive and unaltered. The previous is a detrimental element to productivity and efficiency of productive systems (Herrera, 2013).

Furthermore, for agricultural system analyses, several statistical analysis techniques are used. For instance (Martínez *et al*., 2010; Avilés *et al*., 2010; Righi *et al*., 2011), used principal components and conglomerate analysis to determine the main factors that influenced on crop and livestock area differentiation. However, the multivariate analysis technique used in this research (Discriminant Function Analysis (Miranda, 2011)), allows identifying the characteristics that contrast two or more groups of subjects, within a dependent or classification variable, and its dependency to several independent or discriminant variables. In that case, the matrix will have row arrangement; meaning that in the sample of individuals are pre-made groups, according to the dependent variable. For this kind of analysis the variables must be quantitative.

The reasons given set the foundations for this research, whose aim was to characterize 30 milking units from a dairy company in the 2006-2008 period.

MATERIALS AND METHODS

Location and climatic conditions. The study was conducted at a cattle raising company, in the municipality of San Jose de las Lajas, province of Mayabeque, Cuba. The climate is tropical humid. The main climatic variables behaved as follows, 1 426.66 mm mean precipitation; 24-22 ^{o}C mean temperature; and 77-63 % mean relative humidity.

General procedure. The information was collected from diagnostics made to 30 milking units, accounting for 54 % of the total. Out of 34 quantitative variables related to productive, economic, and social performances evaluated, 11 were chosen, following rejection by discrimination and redundancy (Valerio *et al*., 2004).

The variables used were, one dependent: annual milk production (I); and 10 independent: milk production/cow^{-1}/day^{-1} (l), births, milking cow percent, total cows, empty cows, CT-115 (*Pennisetum purpureum* vc. Cuba CT- 115) covered area percent, improved pasture area percent, cost of milk liter ($), total expenses ($) in CUP (Cuban Peso), and number of workers. Three groups of milking units (high, medium, low) were pre-made with a transversal cut, from a relative extent, according to their annual milk production.

Statistical aspects. A Discriminant function analysis was performed, and the Discriminant factor was estimated by the simultaneous technique (Hair *et al*., 1999). The data were processed in a panel, using SPSS, 15.0 (Visauta, 1998).

RESULTS AND DISCUSSION

The results from the Discriminant function analysis revealed that according to auto values, 90.5 % of data variability was explained with function No. 1; whereas function No. 2 explained 9.5% (Table 1).

Wilks' lambda concluded that with both functions the three groups were significantly distinguishable, since the critical value for the three of them was under 0.05; however, in the latter, the statistical value was higher, closer to 1, indicating that there was more overlapping among the groups, which corresponds to the variance percent that explained such function. Accordingly, it was not included in the technical evaluation, because its contribution to the model was significantly low (Table 2).

Table 3 shows the contribution made by each variable to group differentiation, in descending order, using standard coefficients.

In practice, this result meant assuming that the difference between the productive levels was explained by the order suggested, and that the milking units in group 1 had a more favorable behavior for the indicators measured than units in group 2, and these, in turn, worked better than group 3; except for total expenses, which means that the higher values the variable has, the lesser the profit of the unit. The previous was based on the centroid values (general means for each group) in function 1 (Fig. 1). In addition to it, a hierarchical list of variables was provided, according to the discriminating power.

Total births, was the variable that best explained group difference; according to Acosta and Guevara (2009), this variable is critical to productivity in the milking units. Milking cow percent had a high standard coefficient, reflecting the importance of this variable in dairy farm yields. Later, two variables with important scales were placed: total cows and total expenses, which are usually correlated positively to productive levels.

The empty cow percent had a considerable influence on the classification; this is a logical result, which showed preponderance of reproductive variables in dairy systems (Benítez *et al.*, 2010; Cavestany *et al*., 2009). It must be noted that the negative sign of the variable showed that the most productive milking units had lower percent of empty cows, and vice versa.

Milk production per day, per total cow ranked sixth, which proved that it was not one with high discriminant value, though the standard coefficient value was considerable in function No. 1, it was an important variable for classification.

The percent of area covered with CT-115 was the most discriminant variable related to nutrition, which may be associated with the contribution of the species to dry matter production, especially in the dry season, compared with native pasture (Martínez *et al.*, 2010). These results coincide with the values reported by Torres *et al*. (2008), in terms of this variable´s preponderance in specialized milk production systems with grazing.

The number of workers indicated that, generally, the total number of farm workers was higher in the milking units with the highest yields. It is important to highlight that this variable had a significant influence on the total expenses increase due to salaries. Accordingly, there is a close correlation between total expenses and number of workers.

Improved pasture percent had low standard coefficient, so it had little to do with differences among the groups, though the percent for milking units in group No. 1 was higher. This situation may be explained due to their low proportion in the units studied, coinciding with reports by Betancourt *et al.* (2005).

The whole cost of milk liter was an important discriminating element, and just like for the empty cow variable, the negative value for function No. 1 showed a worse behavior of the indicator in the milking units, depending on the productive category. Thus, it coincided with Cino *et al*. (2004) in that milking units with low production values are characterized by negative economic results per milk liter produced.

The dispersion diagram for the three groups of the discriminant functions (Fig. 1) corroborated the data in Table 1, with function No. 1 (horizontal axis), by distinguishing the three groups more clearly. In some cases, though, overlapping among elements from different groups was observed, and one case was not grouped (1.1 %). Inversely, in function No. 2 (vertical axis) the groups were poorly distinguishable.

Moreover, the analysis of discriminant scores of function No.1 helped visualize the performance of each unit longitudinally, based on a relative index which can be called "discriminant functional index", which, in turn, can become an independent variable impact index used in the model, above the dependent variable (annual milk production), which according to Nahed (2009) facilitates the milking unit multidimensional assessment (Fig. 2).

The dynamic analysis of discriminant functional indexes showed that between the first and second years, no marked differences were observed, though the second year was better for milking units in groups 2 and 3; and in the third year improvements were evident, especially for units with high and medium yields.

This analysis helped identify the moments with the highest and lowest indexes, making possible individual examination of the variables with the best score. For instance, in unit No. 24, the low percent of milking cows in 2007 had a remarkable effect on the negative impact index. On the contrary, unit No. 5, in 2006, the high positive indexes were caused by the total births.

In terms of individual performance, according to the estimated index, units No. 3; 4 and 5 were the most complete in the three-year period, so they could be used as models to the rest for technological adaptation (Simón *et al*., 2007; Zhu, 2009). In the worst milking units (28; 29 and 30), managements will have to prioritize new technological and organizational actions to increase production.

CONCLUSIONS

The results showed that, relatively, there were three kinds of milking units within the enterprise, depending on their annual production (high, medium, and low), useful information for new technological information strategies, leading to better unit performance of the less productive units. It can be achieved by improving the critical aspects revealed after analysis with the variables that contributed most to productive differentiation among the units studied.

Furthermore, discriminant functional analysis turned out to be a useful tool for analysis, dynamic and multidimensional assessment of productive enterprises, with an implicit reference approach.

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Received: 23-6-2015
Accepted: 25-7-2015

Table 1. Eigen values

Function	Auto value	Variance %	Accumulated %	Canonic correlation
1	6.114(a)	90.5	90.5	.927
2	.643(a)	9.5	100.0	.626

The first 2 canonic discriminant functions were used in the analysis

Table 2. Wilks´ Lambda

Function contrasts	Wilks´ Lambda	Chi-square	gl	Sig
1 - 2	.086	202.855	20	.000
2	.608	40.988	9	.000

Table 3.Structure matrix

Variables	Function	
	1	2
Births	.575(*)	.261
Percent of milking cows	.482(*)	-.395
Total cows	.461(*)	.288
Total expenses	.384	.565(*)
Percent of empty cows	-.375(*)	.229
Milk production $cow^{-1}day^{-1}$	.349(*)	-.297
Percent of area covered with CT-115	.349(*)	-.196
Number of workers	.342	.516(*)
Percent of areas with improved pastures	.237(*)	-.186
Cost of milk liter	-.149	.403(*)

(*) Greater absolute correlation between each variable and each discriminant function

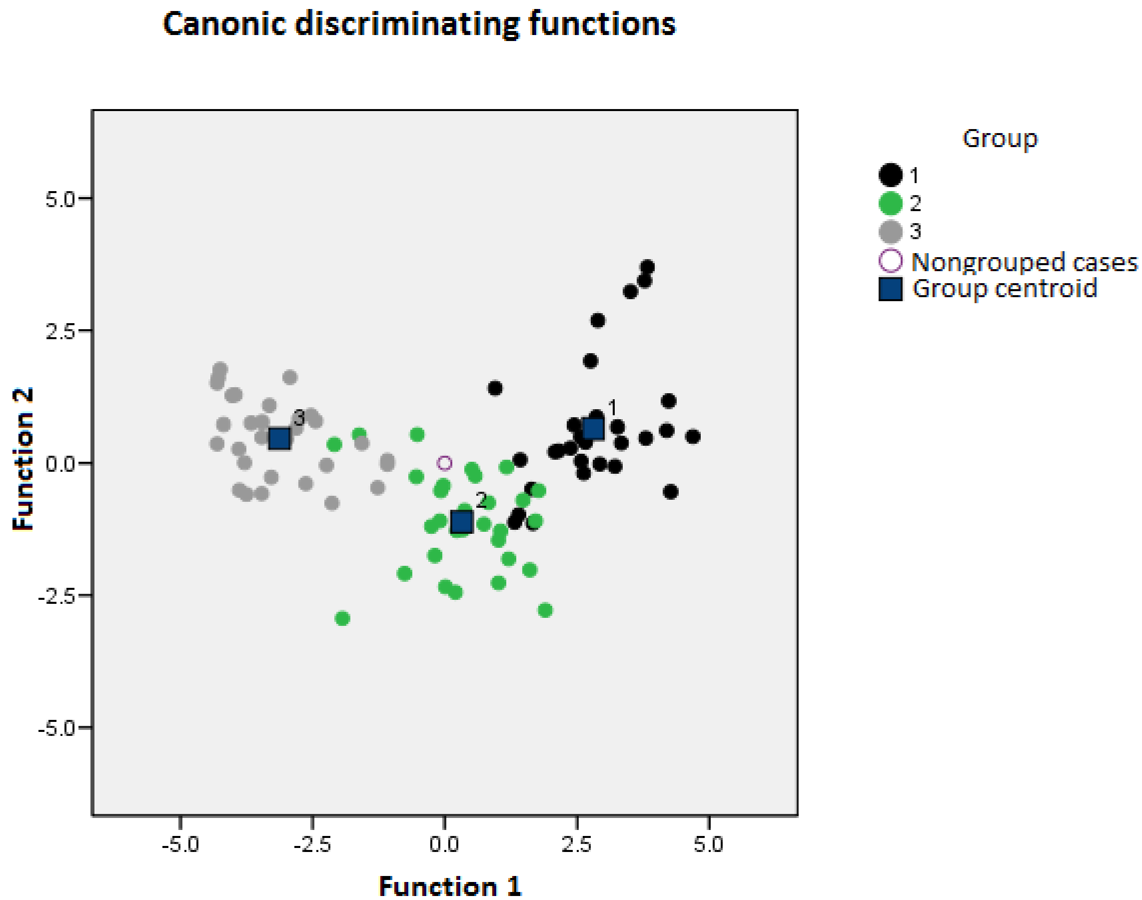

Fig. 1. Dispersion diagram of discriminant functions

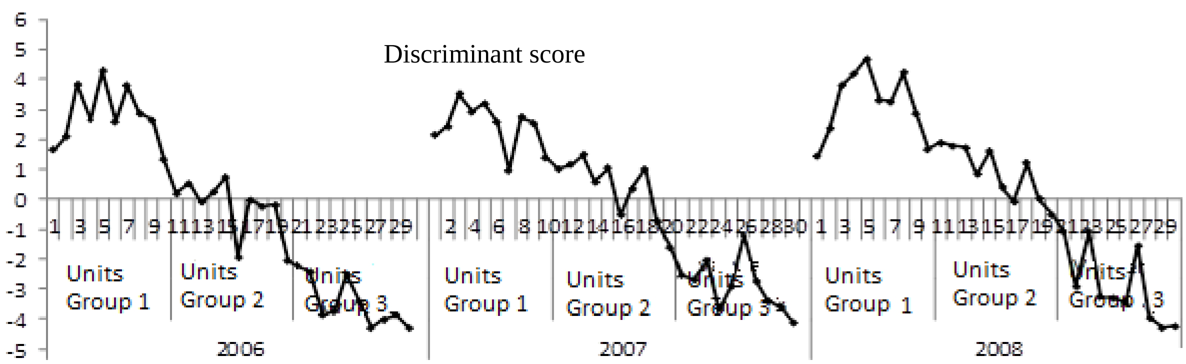

Fig. 2. Discriminant score for function 1