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Classification of Bulls for Slaughter in TERSO Industry

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ABSTRACT

In order to determine the feasibility to classify bulls into three categories according to their carcass and beef yields results from the period between 2007 and 2011 were studied when animals from the same category were slaughtered. The category included 110 cases, in which 2 572 bulls were grouped. Cross information was available for all of the variables assessed. A cluster analysis was performed to efficiency variables of carcass components in relation to carcass weight, using SPSS software. The results showed that a classification into three categories is feasible and that the second group was the best in terms of total beef yield and had the lowest proportion of bones. This was corroborated by a discriminating analysis that showed the three-category model is 95 %accurate.

Key Words: *bull carcass, categories, yields*

INTRODUCTION

The marked increase of world population since 1950 and the raise in life expectancy have generated a growing demand for agricultural products (FAO, 2009 and 2012). In addition, estimates indicate that the annual global demand of beef by 2020 will have risen to 2.72 %. Consequently, cattle farmers must be more aware of the importance of yields and carcass in order to boost their production and improve efficiency in production.

Beef production is a solid alternative to produce animal protein for human consumption. This assertion is based on the ability of ruminants to feed fundamentally on cellulose-rich biomass, which makes breeding less dependent on the price of fuels and other costly inputs. Consequently, beef prices will be more competitive in the future than other meats (Leng and Preston, 2003).

Agriculture in Cuba is one of the sectors whose sustainability should be assessed, not only for its dependence on the environment, but also because of its important role in the nation's economy. The main objective of Cuban agriculture is to produce food, which is strategic nowadays as insufficient production import costs are increased. To accomplish this goal, efficiency and sustainability of the production systems must be guaranteed by joining efforts with beef processing facilities (Machado *et al.*, 2009).

Cuesta (2008) has stated that cattle raising is an important production process affected by many factors. Animal production requires a lot more dedication from workers, who should know, from a scientific perspective, the indicators that produce more practical positive outcomes to improve results (Pérez, 2010).

Furthermore, Magaña (2006) and Arias (2012) considered efficiency in terms of beef yield. As a result, the value of bull carcass was compared (based on beef yield) at the slaughterhouses which have more gains than the standing animals (based on live weight).

Today, slaughterhouses must perform their assessment with a system approach. This method would help identify and shed light on current deficiencies, as well as take measures to eradicate them (Delgado, 2010).

A factor that seems to be generating great losses is the current bull classification system (Bebert *et al.*, 2012). This, along with the lack of a practical, accurate efficient assessment system in the area of beef production and processing industries, prevents sustainability of the process.

Therefore, the aim of this paper is to determine whether it is possible to establish a three-category classification of bulls when slaughtering in terms of carcass and beef yields.

MATERIALS AND METHODS

Location

The investigation was carried out at CHACUBA slaughterhouse and beef processing facility, from Rectángulo Cattle Enterprise, a beef producing company of the Ministry of Agriculture, located on Camino Jagüey, km 2 ½, Camagüey.

Database

A database was built including information from 2007 to 2011, when animals of the same category were slaughtered. Data from 110 cases comprising 2 572 bovines were included, for which comparison was carried out using cross information of every sacrifice variable evaluated.

The sacrifice indicators for the study were three primary variables and nine derivatives (called efficiency derivatives), that sum up 12 parameters (Table 1).

Description of the variables

Commercial Categories: From the classification system used for bull purchases, three categories were selected, which ranged from first to third grades (the most representative and minimum beef production yields pursued by companies). This classification is made by putting the weight of the live weight at purchase or shipping (Table 2) (MINAG, 2006).

Purchase live weight: The weight of the bull at the time it is purchased from the cattle breeding companies. It is measured in kilograms (kg).

Hot carcass: The carcass after slaughtering and air-drying. Carcass is understood as the entire animal after slaughtered, bled, skinned and eviscerated; the head cut at the level of the Atlanto-occipital joint, with the limbs cut at the level of the carpal-metacarpal and tarsal-metatarsal joints. Also, the carcass does not contain the kidneys, the fat surrounding them or fat from the pelvic cavity. It also lacks the thoracic and abdominal viscera, and the sexual organs, muscles, udders and mammary fat. The measure unit used is kilograms (kg).

Hot carcass yield: The hot carcass percentage that makes the live weight at purchase.

Total beef yield / PVC: The percentage of total beef in relation to the live weight at sacrifice. Total beef is all the first and second-grade beef, and the resulting beef from animal sacrifice and deboning.

First-grade beef yield / live weight at purchase: The equation between first grade beef yield and live weight at purchase, in percent.

Second grade beef yield / live weight at purchase: The percentage that represents second grade beef yield from live weight at purchase.

Bone Yield / live weight at purchase: The proportion of bone in relation to live weight at purchase.

Total beef yield / hot carcass yield: Percent of edible beef in relation to hot carcass weight, in percents.

First-grade Yield / Hot Carcass Yield: Proportion of first grade beef / hot carcass yield, in kg

Second-Grade beef Yield / Hot Carcass Yield: Second-grade beef (kg) in relation to hot carcass yield (kg), in percents.

Bone Yield / Hot Carcass Yield: Percentage of bone (kg) contained in the hot carcass.

Analysis of bull classification at slaughter

A discriminant analysis was performed in order to check the suitability of the slaughter categories used. The indicator slaughter category was used as a grouping variable, and carcass components were used as independent variables in relation to live weight at sale (total, first and second-grade beef and bone). All the requirements needed for this kind of analysis were met.

The equation used for the discriminant analysis was the following:

$D= b1x1+b2x2+b3x3+b4x4$

Where:

b: the adjustment of the independent variables.

x: independent variables.

Grouping by total beef, first and second-grade, and bone yields in relation to carcass weight.

A k-means cluster analysis was made in order to group the cases according to their variable values: total beef, first and second grade beef, and bone yield in relation to hot carcass weight. The groups were not formed in advance by the analyst, but using the resulting data (Table 1).

The following model represents the variance analysis of an indicator:

$Yi= \mu+Ti+ e_i$

Where:

Yi: dependent variable

μ: general constant of the experiment

Ti: effect of the i-differential group (cluster) with (i=1; 2; 3)

$e_{i:}$ effect of the experimental error. N (0, $б_e^2$)

A discriminant analysis was made to determine the possibility to establish a classification system of beef bulls based on the variables used in the cluster analysis.

The SPSS (2002) statistical package was used for all statistical analyses.

RESULTS AND DISCUSSION

Discriminant analysis of the current classification

The discriminant analysis to evaluate the relevance of the current classification system of bulls proves that the categories used by MINAG (Ministry of Agriculture) are not effective, as only 61.8% of the cases match their original categorization. This value is below the lowest acceptable level of correspondence according to Pardo, Avilés and Pardo (2005).

The discriminant analysis can determine the differences between categories. It was used by Guevara (2005) and Delgado (2010) to assess the classifications used by beef and/or dairy facilities. These authors have stated that it is necessary to establish classifications based on mathematical methods which substitute the current subjective, superficial, and reductionist groupings, currently used in our province and country. They also refer that the discriminant model is a dynamic multivariate tool that could be useful for clearing up denomination and differentiation between entities, which would lead to a better distribution of resources and to more effective strategies.

Table 1 shows the great dispersion that efficiency variables of carcass components have in relation to live weight. The table reflects the low correspondence (61.8 %) between the cases studied and the categories identified. This percentage proves that the current classification system is not sufficiently accurate, as its results fall below the accepted 62 % cut off for this type of analysis (Delgado, 2010).

González (2007) states that there are several factors acting against an accurate classification: the low proportion of beef in the animals, the content in their digestive tracts, the impossibility to identify age, genotype, and low specialization of the breeding process.

According to Delgado (2010), the classification system currently used in the industry is affected by subjective problems that hinder its efficiency. Bulls are classified collectively and without weighing, due to the lack of scales, for which the categorization depends on how well breeders develop the physical condition of the animal.

Among the three categories of bulls, the first one is the least affected, and there is a high percentage of animals that do not fit this classification but inferior ones (Table 1). This result is an example of the causes for the low productive efficiency found in the industry´s object of study (CHACUBA).

The values of the variables studied, the comparison with the results informed by several scholars across the world and the discriminant analysis, show the ineffectiveness of the current system of categories.

There are several causes that justify the low effectiveness of the current classification method for bulls. Two overlapping variables are important in the beef market: live weight and quality grade. According to González (2007) bull classification should only take into account live weight. The data are grouped into categories which are supposed to be different regarding the productive indicators of carcass components (basically beef). This classification does not consider factors that determine carcass and beef yield.

Many researchers like Panea *et al*. (2005) and Orta (2006), stated that breed is an important indicator to classify bovines, as it determines the quality of the carcass and the muscle percentage. Fettle and age at slaughter are other indicators that may lead to a more effective classification of bulls used with live weight.

Some other causes responsible for bad results are related to inefficient purchasing, incorrect handling of the cattle before transportation and mass weighing.

A cluster analysis was made in order to estimate the production within each category, especially regarding slaughter and preparation of the carcasses. It was based on efficiency variables, and carcass components in their relation to its weight (yields of total, first and second-grade beef, and bones). The best solution found was the formation of three clusters (Table 2), whose discriminant analysis resulted in high correspondence of the cases (95,5 %). Delgado (2010) indicates that a classification system is thought to be accurate if the discriminant exceeds 62 % of correspondence.

Table 2 shows that the second cluster has better overall results, for which it can be labeled as a superior carcasses cluster. This group features a combination of the best total beef and first-grade beef yields, with the smallest proportion of bones. As the beef industry requires a major contribution of total beef from production, it is necessary to slaughter bulls between two and three years of age, with high weight at slaughter and a good proportion of muscle, in order to obtain carcasses that maintain and improve the current results.

Cluster three is superior to cluster one in that it has higher total beef and second grade beef yields (Table 2). Furthermore, it shows total beef yields very similar to those of cluster two, but with less first-grade beef and more bone. Therefore it can be classified as a mid-carcass cluster.

Finally, cluster one comprises the lowest-quality carcasses and the lowest-beef yield as compared with the previous clusters.

These differences between carcasses regarding their yields make evident that they should be taken into account in a bull classification system.

Table 3 shows cluster statistics related to hot carcass (kg), from which it can be stated that there are no significant differences between them. This means that, although a multivariate analysis of total, first-grade, second-grade beef, and bone yields (relative to the weight of the carcass) make possible the creation of groups (Table 3); the weight of the carcass cannot be used as classification criterion. Studies that include a greater number of variables of morphology, weight, etc., must be conducted, in order to establish a carcass classification system that matches the results of the cluster analysis made in this project.

CONCLUSIONS

The classification used by TERSO industry for bull acquisition is accurate only in 61.8 % of the cases.

A new classification is possible using slaughter variables, which has 95.5 % accuracy according to the analysis made.

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Table 1. Primary and efficiency variables

Kind of variable	Variable name
Primary	Sacrifice Categoría de sacrificio
	Live weight at purchase
	Hot carcass
Derived	Hot carcass yield/live weight at purchase
	Total beef yield/ live weight at purchase
	First-grade beef yield/live weight at purchase
	Second-grade yield/live weight at purchase
	Bone yield/live weight at purchase
	Total beef yield/hot carcass
	First-grade beef yield/hot carcass
	Second-grade beef yield/hot carcass
	Bone yield/hot carcass

Table 2. Live weight ranges at purchase, set up for the bull category in the study (MINAG, 2006)

Purchase categories	Live weight ranges (kg)
First-grade	≥ 420
Second-grade	375-419
Third-grade	330-374

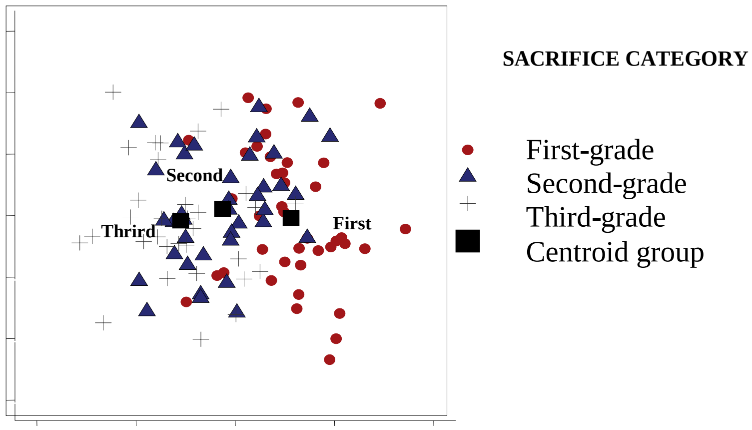

Fig. 1. Results from group belonging assessment in the discriminant analysis

	Sacrifice category	Expected belonging group			Total
		First-grade	Second-grade	Third-grade	
Recount	First-grade	32	7	1	40
	Second-grade	9	13	16	38
	Third-grade	2	7	23	32
%	First-grade	80,0	17,5	2,5	100
	Second-grade	23,7	34,2	42,1	100
	Third-grade	6,3	21,9	71,9	100

61,8 % of the originally grouped cases were correctly classified

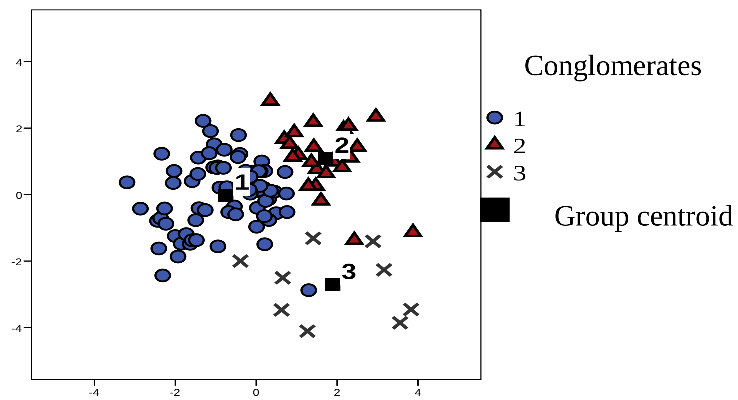

Fig. 2. Behavior of efficiency indicators of carcass components in the conglomerates.

Indicators	Conglomerates					
	1		2		3	
	Mean	D. E	Mean	D. E	Mean	D. E
Total beef yield/hot carcass	60.38	1.3	63.49	1	63.95	1.7
First-grade beef yield / hot carcass	34.29	1.2	36.34	1	33.06	1.1
Second-grade beef yield / hot carcass	24.63	1.6	25.58	1,4	28.93	0.6
Bone yield / hot carcass	26.69	1.9	24.11	1,6	26.44	1.4

95,5 % of the originally grouped cases were correctly classified

Table 3. Hot carcass comparison (kg) for the conglomerates

Conglomerate	Hot carcass (kg)		
	N	Mean	E.T.
1	77	193,12[a]	3,0
2	24	203,11[a]	5,7
3	9	189,24[a]	8,0