Correlation and Slaughter Weight on Sensitivity Analysis of Charolais Steers Feedlot Finished

Paulo S. Pacheco

João Restle

Janaine L. Olegario

Fernanda R. Menezes

Fabiano N. Vaz

Leonir L. Pascoal

Daniel B. Lemes

Karoline G. Valença

Gabriella I. O. Machado

Ana Clara T. Rodrigues

Federal University of Santa Maria
Av Roraima, 1000
Camobi, Santa Maria
RS, Brazil
97105-900
pacheco.dz.ufsm@hotmail.com

Abstract

The objective was to evaluate the behavior of the variables that comprise items of income and costs through sensitivity analysis with or without the use of correlation in the feedlot of Charolais steers slaughtered at 421.0 ± 45.0 kg, 461.0 ± 29.1 kg or 495.0 ± 17.8 kg. The feeding period was 110, 145 and 184 days, respectively. The financial indicator Net Present Value was used. For the process of stochastic simulation, the type of sampling Latin Hypercube, random number generator of Mersenne Twister, with 2,000 interactions, with or without Spearman correlation among the cost items that have certain probability distributions were used. For sensitivity analysis, the Multivariate stepwise regression method, with standardized regression coefficients was used. In decreasing order, the price of feeder and finished steers, diet costs, diet intake and discount rate are the most important items influencing the viability of feedlot, independent of body weight.

Keywords: cost management beef cattle, Monte Carlo simulation, livestock management, project investment, probabilistic simulation with correlation, rank correlation

1. Introduction

In Brazilian beef production, a portion of the resources for the intensification of production systems are targeted to technologies for reducing the age of slaughter of the males, allowing increased capital turnover. However, it needs a better economic management of items of costs and revenues.

In recent years, there has been strong pressure from agriculture to occupy areas for traditional livestock due to higher profitability per unit of area. Alternatives for livestock production aimed at competing with agriculture have been developed, with the confinement interesting technology and widespread in the country. According Anualpec (2013), there was an increase of 85% in the number of feedlot finished cattle in Brazil between the years 2005-2013.

The use of confinement allows working with changes in production characteristics such as time of termination, average daily gain and slaughter weight of animals from dietary modifications. So, technically it is possible to plan to improve the management of the investment. However, only with the economic analysis to be carried out jointly with livestock productivity indicators are taken that makes it possible for right ones decision.

This type of analysis has been technically denominated "bio-economic analysis" and ever more is being used considering the growing demand for technicians, producers and industry.

According to Pacheco et al. (2006) and Pacheco et al. (2014a), the cost of food is very representative in relation to the total production cost, excluding the cost of acquisition of feeder animals. Additionally, variations in slaughter weight of animals may reflect on return of investment. Pacheco et al. (2012) evaluated the economic feasibility of finishing steers slaughtered at different weights, and found that the increase in slaughter weight resulted in lower return on investment. Thus, to assess what slaughter weight, and therefore ideal feeding period, is certainly common for producers who experience the day-to-day of this activity.

A methodological alternative that may assist in the analysis of investment projects is the sensitivity analysis. According Moore & Weatherford (2001) the sensitivity analysis is based on the proposition that all parameters values, except for the parameter in analysis, are kept fixed and seek information about the effect of changing data that is allowed to vary.

The administration of costs and revenues by applying sensitivity analysis becomes of great importance in ensuring the economic success of the production systems. However, although sensitivity analysis is widely used in other segments of production, beef cattle implementation is still restricted, limiting the best management.

There are specialized software in this type of analysis, and spreadsheets the most widespread. The methodological approach to this type of analysis has evolved, allowing combining the use of simulation algorithms, sampling types and use of correlation between items of any type random variables with known probability distribution, aiming to refine the results, ie to improve the quality of information. In the study of Pacheco et al. (2014b), the authors evaluated the economic viability of the feedlot using probabilistic analysis considering slaughter weights as separate investment projects. The authors included, among other methods, the sensitivity analysis via multivariate stepwise regression, resulting in estimates of standardized regression coefficients for each item with probability distribution known to influence the financial indicator Net Present Value. Found that the inclusion of correlations changed the magnitude of the influence of component items of costs and revenues, concluding that the correlation must be included in simulations where possible.

Thus, the aim of this study was to evaluate the behavior of the variables that comprise items of income and costs through sensitivity analysis with or without the use of correlation in the feedlot of steers slaughtered at different weights.

2. Materials and Methods

2.1. Location and Animals

The experiment was conducted in the Department of Animal Science, Federal University of Santa Maria, Rio Grande do Sul state - Brazil (29° 43' S and 53° 42' W). Charolais steers (n=18) were obtained from the same experimental herd, with average initial age and weight of 30 months and 297.0 ± 11.5 kg, respectively, were used.

The confinement began in June and marketing of fatty animals occurred as they reached the predetermined slaughter weights of 420, 460 or 500 kg being the weights obtained from 421.0 ± 45.0 kg, 461.0 ± 29.1 kg and 495.0 ± 17.8 kg. The total feeding period was 110, 145 and 184 days, respectively, and the average values for subcutaneous fat thickness obtained 2.4 ± 1.0 mm, 2.6 ± 1.8 mm and 5.4 ± 1,0 mm, where only the last slaughter weight was obtained ($P < .05$) carcass finish above the minimum (3 mm) recommended by the slaughterhouse industry in the country. The average daily weight gain (1.11 ± .10 kg) and dry matter intake (9.63 ± .3 kg / day) were similar ($P > .05$) among slaughter weights.

2.2. Diet and Feeding Management

The diet contained 12% crude protein and 67.84% TDN (based on dry matter - DM), consisting of sugar cane crushed (43.00%), ground grain sorghum (35.00%), defatted rice bran (14.30%), soybean meal (4.70%), calcium phosphate (0.63%), salt (0.58%), limestone (0.23%) and urea (0.71%). The animals were fed twice daily (63% of the food provided in the morning and 37% in the afternoon). The forage and concentrate were mixed at the feeder at the time of delivery. The stage adaptation of calves to diet and management was 14 days. The animals were randomly divided into 3 lots of steers (2 lots per treatment) and housed in the open paddocks, with 80 m² area each, fitted with feeders and water drinker regulated by automatic float.

2.3. Items of Costs and Revenues

Methodologies proposed by Matsunaga et al. (1976), Resende Filho et al. (2001), Pacheco et al. (2006) and Pacheco et al. (2014b) were used. Historical series of average prices for the years 2004 to 2012 obtained from public and private companies (CONAB National Supply Company, IEA: Agricultural Economics Research Institute of São Paulo, EMATER / RS-ASCAR: Enterprise Technical Assistance and Rural Extension of the Rio Grande do Sul state and ANUALPEC: Brazilian Yearbook of Forestry) were used. All estimates were made per animal per year, deflated to the year 2012 by the General Price Index - Internal Availability of Fundação Getúlio Vargas. For purposes of currency conversion, it was considered that R$ = US$ .54.

The items cost (purchase of feeder animal, forage and concentrate feed, labor, health, depreciation and other operating expenses) and income (finished animal and manure) were associated with performance characteristics obtained during the feeding phase (weight average daily weight gain and dry matter intake). The facility costs were estimated for static capacity of 1,000 animals and lifespan of 10 years. Depreciation of facilities, machinery, implements and equipment were calculated for the planning horizon of one year. The costs of sanitary control consisted of product for control of endo-and ectoparasites, analgesic and anti-inflammatory, antibiotic and vaccines against foot and mouth disease, botulism and clostridiums all in dosage per animal, as the manufacturer's recommendations. The feed cost was obtained by the product of the total intake of forage and concentrate (kg DM / animal) for their respective costs / kg DM. For cost estimates with labor, was considered one (1) man / 500 animals and two minimum wages / month / 1,000 animals for technical assistance. For purposes of calculating the cost of hand labor, two months were added to the feeding period for preparation / maintenance of facilities and other activities. Other operational expenses such as maintenance of facilities, machinery, equipment and implements, fuel, electricity, freight, taxes and feeding labor were estimated by the equivalent of 2.5% of operational costs.

2.4. Financial Indicator

Cash flows with planning horizon of one year were prepared, considering each slaughter weight (with or without correlation between the input variables) an investment project mutually exclusive.

The financial indicator used was Net Present Value (NPV, US$ / animal) = $\sum_{i=1}^{n} \frac{\mathbf{values_i}}{(\mathbf{1} + \mathbf{rate})^{i}}$, where: values=values of cash flow (representing the payments and income); n=number of cash flows; and rate=discount rate (% a.m.).

2.5. Probabilistic Simulation and Sensitivity Analysis

The steps of stochastic simulation (probabilistic) were those defined in the study by Pacheco et al. (2014b). Microsoft ® Excel, @ Risk ® and SAS ® System software were used. Type of sampling Hypercubo Latino, random number generator Mersenne Twister, with 2,000 interactions (Palisade, 2010; Albright et al., 2010) was used, with or without Spearman correlation (Tables 1 and 2) between the cost items that had determined probability distribution (input variables).

For sensitivity analysis, we used the Multivariate stepwise regression method, with standardized regression coefficients (Frey & Patil, 2002; Palisade, 2010).

3. Results and Discussion

The simulation results of the financial indicator Net Present Value - NPV without the correlation between input items (Table 3) - ie, variable components of costs, revenues and growth performance - were compared with the simulation including the correlation (Table 4). The methodology used in the sensitivity analysis of this study allows us to compare items with different units of measure, given that the regression coefficients are standardized.

The rank of items in descending order of importance showed little change in the comparison of the simulation with and without correlation. Pacheco et al. (2014b), analyzing the methodology of stochastic simulation in economic viability of the feedlot steers slaughtered at different weights with sensitivity analysis, found similar results to the present study, ie the ranking of items remained practically unchanged in comparison to analyzes with and without correlation between the input variables. However, the authors found a marked reduction in the values of the estimated regression coefficients in the simulation with correlation. Same fact occurred in this study.

It can be seen in Tables 3 and 4 that the price of finished cattle was the most important influence on the NPV at all slaughter weights simulated as independent investment projects. Was the only item to show positive coefficients, given that this item makes up the revenue from the sale of finished steers. Ferreira et al. (2005) conducted sensitivity analyzes of the gross margin with performance data and costs of feedlot cattle for varying periods according to carcass finish of genetic groups: yearling Nellore, Nellore weaned, ½Valdostana ½ Nellore, ½ Nellore ½ Simmental, ½ Braford ½ Brangus, ½ Braford ¼ Nellore ¼ Angus, Brangus, ½ Canchim ¼ Angus ¼ Nelore and ½ Simmental ¼ Canchim ¼ Nellore. Sensitivity of gross margin was performed with variations in prices of beef selling and buying of corn, soybeans, corn silage and steers, keeping the others fixed prices. The authors found that the gross margin was more sensitive to variations in the purchase price of the animal than the selling price of meat.

Comment on marketing strategies of animals and inputs are presented by Lopes et al. (2011) and Pacheco et al. (2014b). The authors emphasize and encourage producers to use the options available as futures contracts, direct contracts with the slaughterhouse industry, bonuses programs from breed associations and retail networks in order to minimize the effects of price changes in the physical market.

The second and third most important items were the price of feeder steers and cost with roughage (sugar cane). Only for the slaughter weight of 495 kg the cost of roughage exceeded the value of the feeder steer. The method of forage's harvesting used in this study resulted in considerable cost with labor because it was harvested daily and chopped before being fed to animals. In the study by Pacheco et al. (2014b), the price of steers was the second most important item to influence the simulated NPV, while the cost per kg of dry matter of roughage (corn silage) took sixth place in the ranking of 14 items included in sensitivity analysis.

In studies involving deterministic analysis (Pacheco et al., 2006; Missio et al., 2009; Pacheco et al., 2014a), there was agreement regarding the relevant participation of items related to the marketing of animals and diet (roughage and concentrate) in the total cost, being as increased slaughter weight and / or level of concentrate in the diet, the relative shares of the items were changed. Assessing the economic response by sensitivity analysis of slaughter weights (425, 467 and 510 kg) of crossbred Charolais x Nellore steers feedlot finished, Pacheco et al. (2014b) found that the variables with the greatest impact on NPV were cattle prices, animal weight, and diet costs and minimum rate of attractiveness.

Interesting aspect to note is the reduction in the values of the linear regression coefficients with increasing slaughter weight for the items finished cattle price and feeder cattle price, both the analysis with or without correlation. For the first item, in the simulation without correlation the reduction was 11% while that in simulation with correlation of 19%. For the second item, the reductions were 23 and 27%, respectively. For all other items, there was an increase in the coefficients with the increase in slaughter weight. Pacheco et al. (2014b) found similar behavior, justified by increased costs and importance of diet consumption, minimum wage, minimum rate of attractiveness, machinery/implements and facilities/equipments, which are not significant items for lighter slaughter weights.

These results indicate that the increase in slaughter weight results in changes in the ranking of items, a result very relevant from the point of view of economic activity, and also management, considering that in Brazil the final weight of males confined is close to 500 kg (Millen et al., 2009; Costa Junior et al., 2013).

4. Conclusions

The simulations including or not the correlation between input items did not affect a relevant manner the ranking of the same, however, there were significant changes in the values of the regression coefficients. In decreasing order, the price of finished and feeder cattle, diet costs, diet intake and discount rate are the most important items influencing the viability of Charolais cattle feedlot finished, independent of slaughter weight.

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Table 1: Spearman Correlation Coefficients Between the Cost Items for Slaughter Weight of 461 Kg (Below the Diagonal) and 421 Kg (Above the Diagonal)

Items[1]	1	2	3	4	5	6	7	8	9
1		0.78‡	0.66‡	0.50	-0.83†	-0.23	0.66‡	-0.63§	0.10
2	0.75‡		0.78‡	0.73‡	-0.78‡	-0.11	0.85†	-0.81†	-0.18
3	0.66‡	0.86†		0.80†	-0.38	-0.48	0.96†	-0.95†	-0.41
4	0.50	0.85†	0.80†		-0.35	-0.05	0.86†	-0.88†	-0.58§
5	-0.83†	-0.58†	-0.38	-0.35		-0.15	-0.48	0.43	-0.23
6	-0.23	-0.33	-0.48	-0.05	-0.15		-0.35	0.26	-0.10§
7	0.66‡	0.91†	0.96†	0.86†	-0.48	-0.35		-0.98†	-0.46
8	-0.63§	-0.88†	-0.95†	-0.88†	0.43	0.26	-0.98†		0.53
9	0.10§	-0.33	-0.41	-0.58§	-0.23	-0.10§	-0.46	0.53	

[1] 1.Feeder cattle (US$/kg), 2.Finished cattle (US$/kg), 3.Minimum wage (US$/month), 4.Land (US$/ha), 5.Roughage (US$/kg DM), 6.Concentrate (US$/kg DM), 7.Depreciation Facilities/Equipment (US$/animal/day), 8.Depreciation Machinery/implements (US$/animal/day) and 9.Health (US$/animal).

† P< .01; ‡ P< .05; §P< .10.

Table 2: Spearman Correlation Coefficients between Cost Items to Slaughter Weights of 495 Kg

Items[1]	1	2	3	4	5	6	7	8
2	0.51							
3	0.85†	0.73						
4	0.53	0.98†	0.70‡					
5	-0.83†	-0.53	-0.70‡	-0.60§				
6	-0.23	0.26	-0.21	0.31	-0.15			
7	0.51	0.58§	0.71‡	0.56	-0.26	-0.40		
8	-0.78	-0.71‡	-0.83†	-0.70‡	-0.50	0.31	-0.83†	
9	0.10	-0.46	-0.26	-0.43	-0.23	-0.10	-0.45	0.40

[1] 1.Feeder cattle (US$/kg), 2.Finished cattle (US$/kg), 3.Minimum wage (US$/month), 4.Land (US$/ha), 5.Roughage (US$/kg DM), 6.Concentrate (US$/kg DM), 7.Depreciation Facilities/Equipment (US$/animal/day), 8.Depreciation Machinery/implements (US$/animal/day) and 9.Health (US$/animal).

† P< .01; ‡ P< .05; §P< .10.

Table 3: Regression Coefficients[1] and Ranking (In Parenthesis) of the Variables of Greater Relevance to the Net Present Value Simulated, Without Correlation between the Input Variables, According to Slaughter Weight

Input variables	Standard deviation of input variables	Without correlation		
		421 kg	461 kg	495 kg
Finished cattle, R$/kg	0,22	0,61 (1)	0,58 (1)	0,54 (1)
Feeder cattle, R$/kg	0,27	-0,56 (2)	-0,49 (2)	-0,43 (3)
Roughage, R$/kg DM	0,11	-0,35 (3)	-0,40 (3)	-0,45 (2)
Concentrate intake, kg DM/day	0,73	-0,29 (4)	-0,33 (4)	-0,36 (4)
Roughage intake, kg DM/day	0,73	-0,23 (5)	-0,27 (5)	-0,29 (5)
Discount rate, % a.m.	0,15	-0,22 (6)	-0,25 (6)	-0,28 (6)
Concentrate, R$/kg DM	0,05	-0,06 (7)	-0,07 (7)	-0,07 (7)
Depreciation machinery/implements, R$/animal/day	0,008	-0,02 (8)	-0,02 (9)	-0,02 (9)
Minimum wage, R$	78,88	-0,02 (9)	-0,02 (8)	-0,02 (8)
Depreciation facilities/equipments, R$/animal/day	0,005	-0,01(10)	-0,01 (10)	-0,01 (11)
Health, R$/animal	1,62	-0,01 (11)	-0,01 (11)	0,01 (10)

[1]Standardized multivariate regression coefficient, which indicates the number of standard deviations of the NPV that will change with each change of one standard deviation in the input variables (assuming as constants all the other input variables)

Table 4: Regression Coefficients[1] and Ranking (In Parenthesis) of the Variables of Greater Relevance to the Net Present Value Simulated, with Correlation between the Input Variables, According to Slaughter Weight

Input variables	Standard deviation of input variables	With correlation		
		421 kg	461 kg	495 kg
Finished cattle, R$/kg	0,22	0,94 (1)	0,81 (1)	0,74 (1)
Feeder cattle, R$/kg	0,27	-0,86 (2)	-0,68 (2)	-0,63 (3)
Roughage, R$/kg DM	0,11	-0,54 (3)	-0,55 (3)	-0,64 (2)
Concentrate intake, kg DM/day	0,73	-0,43 (4)	-0,46 (4)	-0,51 (4)
Roughage intake, kg DM/day	0,73	-0,35 (5)	-0,37 (5)	-0,41 (5)
Concentrate, R$/kg DM	0,05	-0,33 (6)	-0,35 (6)	-037 (6)
Discount rate, % a.m.	0,15	-0,09 (7)	-0,09 (7)	-0,10 (7)
Minimum wage, R$	78,88	-0,04 (8)	-0,05(8)	-
Depreciation machinery/implements, R$/animal/day	0,008	-0,03 (9)	-0,02 (9)	-0,04 (8)
Depreciation facilities/equipments, R$/animal/day	0,005	-0,02 (10)	-	-0,01 (9)
Health, R$/animal	1,62	-0,02 (11)	-0,01 (10)	-

[1]Standardized multivariate regression coefficient, which indicates the number of standard deviations of the NPV that will change with each change of one standard deviation in the input variables (assuming as constants all the other input variables)