Economic viability of using semi-purified glycerine in the feeding of feedlot sheep

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Abstract

The sheep farming industry has grown worldwide, however, the high costs of food stand out. In an attempt to lower production costs, semi-purified glycerine (SPG) has been used as an alternative to substitute diet ingredients without interfering with feed intake or animal performance. The aim of this study was to examine the economic viability of including SPG as a substitute for corn in the diet of feedlot lambs. The data for the economic evaluation were provided by the Laboratory of Animal Metabolism of the Faculty of Veterinary Medicine and Animal Science at the Federal University of Mato Grosso do Sul, located in Campo Grande - MS, Brazil. Thirty-two uncastrated male crossbred [Dorper × (Texel × Suffolk)] lambs at 4 to 6 months of age, with an initial body weight of 22.2 ± 5.51 kg, were assigned to four treatments consisting of diets with increasing levels of SPG substituting corn (0, 120, 240, and 360 g/kg DM). The economic evaluation was presented by means of a statement of economic results (SER), which consisted of gross revenue, costs (feeding), gross profit, and gross margin. The diet cost ranged from US$ 1.29 (120 g SPG/kg DM) to US$ 1.61 (360 g SPG/kg DM). The highest gross revenue and gross profit were US$ 343.31 and US$ 128.27 (120 g SPG/kg DM) higher, respectively, than those obtained with the diet without SPG inclusion (US$ 325.03 and US$ 118.36). Gross margin was 36.4, 37.4, 29.7, and 22.0% for the treatments with 0, 120, 240, and 360 g SPG/kg DM, respectively. Sensitivity analysis revealed that, in all scenarios, inclusion of 120 g SPG/kg DM showed to be economically attractive. All treatments yielded good results in terms of gross profit. Therefore, SPG is recommended as a substitute for corn, as it provides good economic results to the producer.

Keywords: Cost; Lamb; Sensitivity.

1. Introduction

Meat sheep farming has been growing worldwide by virtue of advantages over other meat-producing species like cattle, as sheep have the ability to survive and produce even in unsuitable areas (MORRIS, 2009). Until the year 2015, Brazil had a sheep herd of approximately 18.4 million head (IBGE, 2015), following a growth trajectory that began in 2013.

A major constraint to sheep production are the elevated costs of the activity, especially those related to animal feeding (OLIVEIRA et al., 2002) due to the high prices of diet ingredients. In an attempt to lower feeding costs, alternative feedstuffs have been investigated to partially substitute ingredients commonly used in diet formulations without, however, interfering with the feed intake and production performance of sheep (LAGE et al., 2010).

One of such studied feedstuffs is semi-purified glycerine (SPG), which is obtained during the biodiesel production process. Biodiesel is produced from vegetable oils or animal fat through a catalytic transesterification of triacylglycerols. The composition of glycerine includes glycerol, catalysis residues, soap, alcohol, monoacylglycerol, diacylglycerol,

glycerol oligomers, and water (OOI et al., 2004). Semi-purified glycerine is a high-energy product that has been employed nutritionally as an energy source to substitute ingredients in the formulation of diets for livestock animals such as sheep, swine, cattle, and others (KREHBIEL, 2008; BESERRA et al., 2016).

The study involves two relevant themes - production costs and Agribusiness, where its results have implications for understanding production costs in an important segment of Brazilian agribusiness. Many studies have examined the carcass characteristics and performance of sheep fed glycerine. However, economic evaluation studies are not carried out as often, despite their great importance in that they can help producers to increase their profit (BARROS et al., 2015). In view of these facts, the present study was undertaken to evaluate the economic viability of including increasing levels of GSP in substitution of corn in the total diet of feedlot lambs, in order to reduce production costs and this study is justified by the relevance that the activity presents in the country, being able to subsequently carry out the recommendation of the use of GSP in substitution of corn in the total diet of feedlot lambs.

2. Literature Review

Agribusiness is the most important sector of the Brazilian economy. This sector is composed of several productive activities, one of which is the rearing of sheep. In 2017, Brazil had 18 million head of sheep (FAO, 2017), and in recent years, sheep production has grown, being justified by the high productive potential when compared to the production of other animals and by the increase in meat consumption which by the year 2017 was 0.5 kg/inhabitant/year (LUCENA et al., 2018). This activity presents the possibility of being profitable even when using small production areas, when compared to beef cattle (PEREIRA et al., 2016).

It should also be noted that the commercialization showed a growth of 47.5% in relation to the last Census. It is possible to observe from these data that the commercialization presented a significant increase in relation to the production (number of animals), which may indicate an improvement in the zootechnical coefficients and in the productivity of the properties (IBGE, 2017).

There is a projection by the United Nations Organization for Agriculture and Food that by 2022 sheep production will increase by 14% in Brazil, attributing to this increase the vocation for livestock and the favorable climate (FAO, 2015).

However, this sector faces one of the biggest problems found in production systems: the cost to produce, with the diet being the more expensive item of the activity, accounting for 50 to 85% of the expenses, depending on the type of animal and the production system adopted for the production of meat, milk, skin or wool (PEREIRA et al., 2007).

According to Souza et al. (2014), in addition to meeting the growing demand, it is necessary that this meat presents standardization, quality and competitive price. However, in order for these requirements to be met, the producer must be in control of all the productive lines of his property, including the nutritional line where he seeks the use of substitute ingredients in the formulation of his diets, so that the production becomes economically viable. All agricultural production activities have witnessed the increase in production costs in recent years leading to a decline in profitability. In this way, all sectors need to make sound decisions to maintain the economic viability of their productions (ARTUZO et al., 2015).

The sheep production system may become economically unviable, since its economic viability is linked to the price oscillations of the grains that make up the diet, mainly corn and soybean. Since food is the basis for productive success, the producer must adopt strategies aimed at increasing the efficiency of nutrient use along with the reduction of food costs (AMARAL et al., 2011).

A production strategy that can be adopted in order to obtain better economic results is the confinement of lambs as this allows greater control of the nutritional and sanitary part and accelerates the return of capital invested in production (ZANETTE and NEUMANN, 2012). As an alternative to reduce the effects of the seasonal price of inputs (corn and soybean) and reduce the cost of the diets used in this production system, the food sources available in each region can be used to partially or partially replace corn and/or the soybean (LAGE et al., 2010).

Due to the need for studies on sheep production in Brazil, some research has been carried out in recent years presenting good productive results (REZENDE et al., 2017; ZIGUER et al., 2011; SOUZA et al., 2014; STIVARI et al., 2014; CÂNDIDO et al., 2015; OLIVEIRA et al., 2016), and some of them seek to find alternative foods that can be included in the diet, in order to minimize the costs of nutrition.

In a study by Pereira et al. (2013) found that it is possible to replace 100% of maize in sheep diets confined by mango meal without interfering with weight gain and consumption, reducing food costs by up to 40%. Using different agroindustrial residues (soybean hull, rice bran and beer malt powder) in the partial substitution of corn and soybean, Carvalho et al. (2016) obtained a gain of US$ 0.57/kg of live weight gain using mate powder beer, US$

0.29/kg of live weight gain with soybean hulls and US$ 0.35/kg gain of live weight with rice flour, concluding that all substitutions are profitable, however, malt powder from breweries has the lowest feed cost when compared to the others.

Some public policies in Brazil stimulated the demand for biodiesel and this increase in its production provided a high amount of glycerine, which is nothing more than the result of a transesterification process that occurs by the action of methanol on animal fat or vegetable oil with subsequent addition of salt (GERIS et al., 2007). In the industry, glycerin does not have a defined destination (BALEN et al., 2014), however, it can be used as an energy source in animal feed, providing 3,696 kcal/kg of total energy and 95% of metabolization due to its high rate of absorption and low molecular weight (ROSTAGNO et al., 2011).

In Brazil, the use of glycerin in animal feed was approved by Normative Instruction No. 42 of the Ministry of Agriculture, Livestock and Supply (MAPA), of December 16, 2010, where the minimum parameters for use were: minimum 800 g glycerol/kg, less than 150 ppm methanol/kg and a maximum of 120 g moisture/kg. Even after defining the strategies of production and nutrition, whatever the activity in the agricultural sector that wishes to remain competitive, must use tools of economic evaluation. The production costs of the activity and the revenue obtained are important factors for the success of any production system. This analysis allows us to identify an input that, at a given moment, can make the activity unfeasible, through fluctuations in market prices (PERES et al., 2004).

In the market economy, economic agents seek to maximize their profits, mainly by reducing production costs. Cost of production is the sum of the disbursements of the values of all the inputs and services used in the production process of an activity, referring to a certain period of time (SANTOS et al., 2002). Unfortunately, producers seldom control the finances of the property and when they do it they do not use all the items that make up the total cost of production (BARROS, 2008). Thus, the sheep producer needs to know the real production costs in its operating system, and then try to rationalize the process. From the moment the producer becomes aware of his productive costs, he becomes more motivated to invest in the activity (WANDER and MARTINS, 2004).

Because glycerin is a major co-product on the market and can be an energetic substitute in the ruminant diet such as sheep, it is up to the producer to decide the best time to use it at the expense of the prices of these inputs that make up the diet. For the study of these oscillations, sensitivity analysis is used to identify the limits (maximum and minimum) in which the price of the product can vary without compromising the economic viability of the production system. It is an essential tool for the decision-making process in the agribusiness,

since it allows the rural producer to visualize the economic-financial behavior of an input (ingredient) before the variation of a certain marketing or technical parameter (GUIDUCCI et al., 2012).

3. Materials and methods

The data used for the economic evaluation were obtained from an experiment described by Rezende et al. (2017) that was conducted at the Laboratory of Animal Metabolism at the Faculty of Veterinary Medicine and Animal Science (FAMEZ) of the Federal University of Mato Grosso do Sul (UFMS), located in Campo Grande - MS, Brazil.

Thirty-two uncastrated male crossbred [Dorper × (Texel × Suffolk)] lambs at 4 to 6 months of age, with an initial body weight of 22.2 ± 5.51 kg, were assigned to four treatments consisting of diets with increasing levels of SPG substituting corn (0, 120, 240, and 360 g/kg DM) (Table 1), aiming to lower the feeding cost and maintain or improve animal performance and feed intake (Table 2).

Table 1: Proportion of diet ingredients with increasing levels of semi-purified glycerine inclusion replacing corn.

	Glycerine in total diet (g/kg MS)			
Ingredients (g/kg)	**0**	**120**	**240**	**360**
Ground corn	435.00	293.40	150.00	5.00
Soybean meal	138.00	161.00	185.00	210.00
Semi-purified glycerine	-	120.00	240.00	360.00
Dicalcium phosphate	17.00	15.60	15.00	15.00
Urea	10.00	10.00	10.00	10.00
Tifton hay	400.00	400.00	400.00	400.00

Source: adapted from Rezende et al. (2017).

Table 2: Mean values and standard error of the mean (SEM) of the performance of feedlot lambs, as a function of the increasing levels of semi-purified glycerine inclusion replacing corn.

Performance	Glycerine in total diet (g/kg MS)				SEM
	0	120	240	360	
Initial body weight (kg)	22.62	22.14	22.32	21.66	1.629
Final body weight (kg)	42.46	43.26	43.30	41.40	2.135
Total weight gain (kg)	19.84	21.12	20.98	19.74	1.173
Average daily gain (kg/day)	0.24	0.25	0.25	0.23	14.061
Feed conversion	5.93	5.29	5.37	5.62	0.228
Feed efficiency (0-1)	0.17	0.19	0.19	0.18	0.008

Source: adapted from Rezende et al. (2017).

The cost of the experimental diets was calculated according to the amount of ingredients used and their respective unit prices (US$/kg) currently charged in the market. For the calculation of the revenues from each treatment, we considered performance data (carcass yield) and the current price paid by the meat-packing plant (US$/kg). After those variables were determined, the following economic indices were generated: gross revenue, effective operating cost, gross profit, and gross margin, which, together, formed the statement of economic results (SER). The respective variables were obtained using the following mathematical-financial formulae in electronic spreadsheets (MS-Excel®), according to methodology quoted by Scorvo Filho et al. (2004) and Costa et al. (2018):

•Gross revenue (US$) = Cold carcass weight (kg) × Sale price (US$/kg);

•Effective operating cost (US$) = Σ (price of each ingredient in the diet × quantity used);

•Gross profit (US$) = Σ Gross revenue – Σ Effective operating cost;

•Gross margin (%) = (Gross profit/Gross revenue) × 100

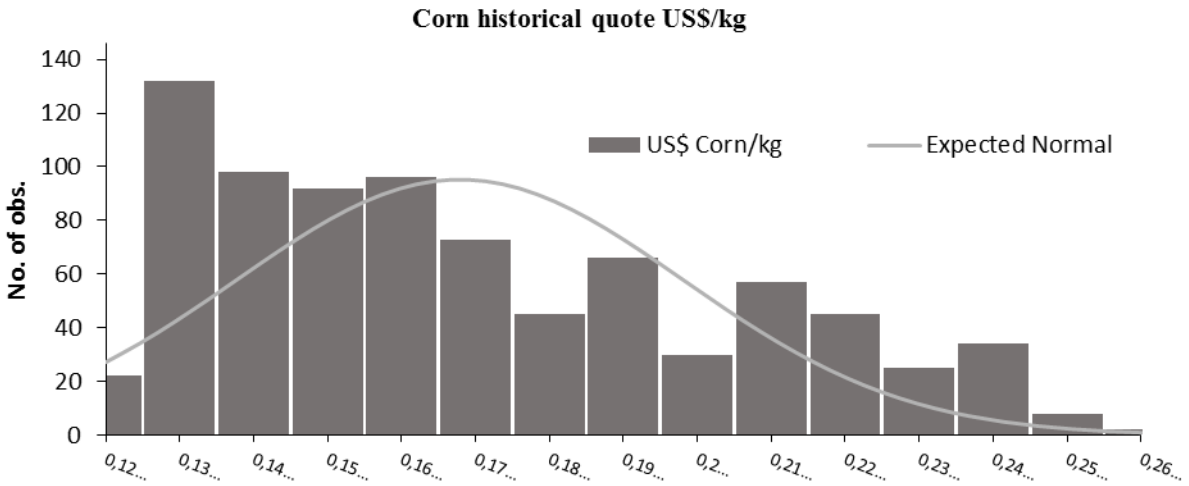
None of the calculations considered costs pertaining to infrastructure, purchase of animals, and man labor, since they were the same in all evaluated treatments. In this way, only the feeding expenses were taken into account.

Values referring to the prices of corn and soybean in the last three years (2015-2018) were taken from the historical series provided by CEPEA/ESALQ (2018) to make price frequency histograms. After sensitivity analysis, this histogram would make it possible to determine moments when the inclusion of SPG would be a viable alternative to replace corn, reducing the diet cost.

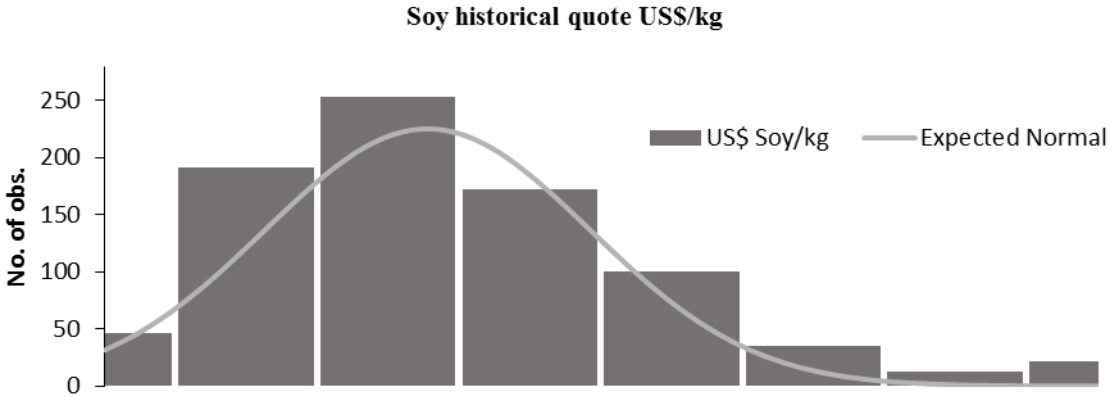
For the sensitivity analysis, we simulated variations in the economic scenario of the prices of the corn and soybean feedstocks to determine the impact of these variations on the unit cost of the diets, considering the classes of prices from the histogram. Two different scenarios were considered for corn (pessimistic: US$ 0.13/kg; optimistic: US$ 0.26/kg) and soybean (pessimistic: US$ 0.48/kg; optimistic: US$ 0.32/kg) and another two for both ingredients (completely pessimistic: corn at US$ 0.13/kg and soybean at US$ 0.48/kg; and completely optimistic: corn at US$ 0.26/kg and soybean at US$ 0.32/kg). The main objective of the sensitivity analysis was to allow for informed decisions using different input prices that reflect economic indicators (BARROS et al., 2016).

4. Results and Discussion

Conventional concentrate feedstuffs such as corn and soybean are key to increases in feeding costs (XENOFONTE et al., 2009). The history of the prices of corn and soybean in the last three years (Graphs 1 and 2) made it possible to observe the fluctuations in the prices of these two ingredients, which are major participants in lamb diets.



Graphs 1: Frequency histograms of corn historical quote. Period 2015-2018. Dollar quotation (annual average 2018): R$ 3,30.
Source: CEPEA / ESALQ corn indicator, 2018 (Authors' elaboration).

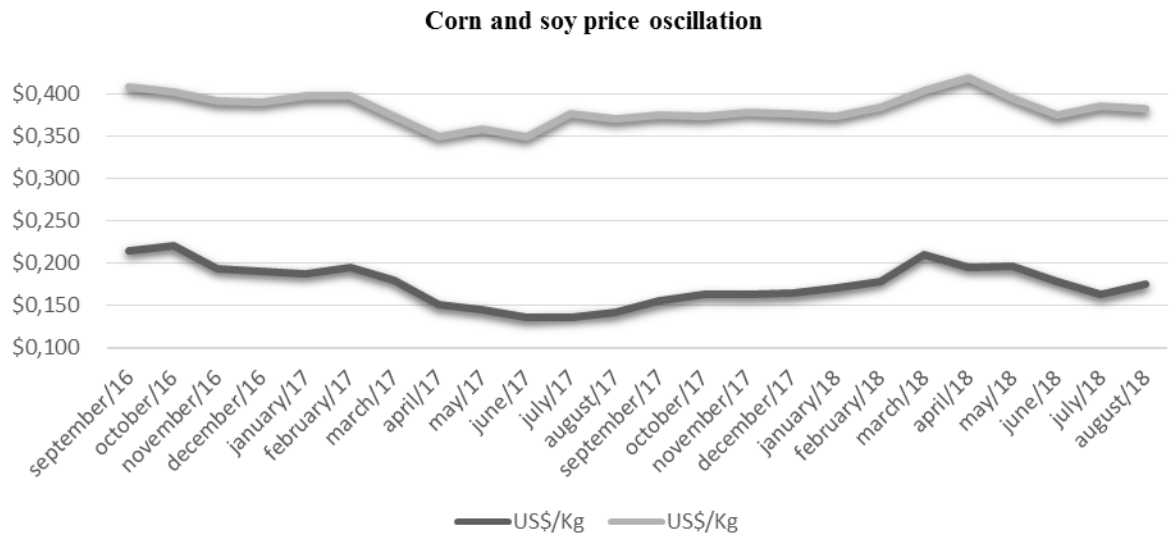


Graphs 2: Frequency histograms of soybean historical quote. Period 2015-2018. Dollar quotation (annual average 2018): R$ 3,30.
Source: CEPEA / ESALQ soy indicator 2018 (Authors' elaboration).

Price alterations in the commodities market are often associated with several factors such as the influence of the climate on producing regions, which makes the substitution of

corn for SPG at moments when the price of corn is high an option to minimize feeding costs (CUNHA et al., 2016).

In addition to the fluctuations in the prices of both ingredients, it can be observed (Graphs 3) that periods of rises and drops in the prices of corn and soybean follow a trend of occurring practically in the same period. For this reason, it is difficult to find times when the price of one is high and the other is low.



Graphs 3: Price oscillation of corn and soy in the two-year period.
Source: CEPEA/ESALQ corn and soy indicators, Sept 16/Aug 18. (Authors' elaboration).

During the Brazilian summer, the soy and corn crops compete with each other for planted area, with one being able to substitute the other. However, in animal feeding, there products complement one another, and so it is expected that these relationships be present in the prices of these two commodities (BINI et al., 2016).

In the Statement of Economic Results (Table 3), the cost of the diets (US$/kg carcass) ranged from US$ 1.29 (120 g SPG/kg DM) to US$ 1.61 (360 g SPG/kg DM), which are higher values than that of the diet without SPG (US$ 1.31). As corn is substituted with SPG, a nutritional correction must be performed with soybean meal by gradually increasing its inclusion in the diet, which will automatically elevate the diet cost due to the high price of the latter ingredient (US$ 0.38/kg). This probably raised the costs of the other two diets with SPG inclusion (240 and 360 g/kg DM). Due to this gradual increase in the effective operating cost of the diets, all showed higher costs than that without SPG. Only the diet containing 120 g SPG/kg generated a higher gross profit than the diet without the test ingredient, which was because of animal performance, which elevated gross revenue. Despite the increase in the

effective operating cost of the experimental diets, none of the treatments resulted in financial loss.

Table 3: Statement of Economic Results of increasing levels semi-purified glycerine in the total diet of feedlot lambs replacing corn [(1)].

	Glycerine in total diet (g/kg MS)			
	0	**120**	**240**	**360**
Gross Revenue (US$) – sale of lambs	40.63	42.91	40.09	38.76
Ingredients				
Ground corn	8.60	5.75	2.94	0.97
Soybean meal	6.10	7.06	8.11	9.14
Semi-purified glycerine	-	3.10	6.21	9.25
Dicalcium phosphate	1.01	0.94	0.88	0.88
Urea	0.26	0.25	0.26	0.25
Tifton hay	9.87	9.78	9.79	9.72
Effective operating cost (US$)	25.83	26.88	28.20	30.22
Gross profit (US$)	14.80	16.03	11.89	8.54
Gross margin (%)	36.4%	37.4%	29.7%	22.0%

Dollar quotation (annual average 2018): R$ 3,30. Values presented are relative an animal during a period of 84 days. (1) The prices of the ingredients refer to the values practiced in the year 2018 based on the dry matter of the food: Ground corn (US$ 0.17/kg), Ground corn (US$ 0.38/kg), Semi-purified glycerine (US$ 0.22/kg), Dicalcium phosphate (US$ 0.51/kg), Urea (US$ 0.22) and Tifton hay (US$ 0.21). The sale price was US$ 2.07/kg of the carcass.

Barros et al. (2015) published a result favorable to the inclusion of crude glycerine in the diet of feedlot-finished lambs, showing that it is efficient in minimizing feeding costs, as it reduced the concentrate cost from US$ 0.06/kg (without glycerine) to US$ 0.04/kg [at the inclusion level of 10.84%, on a dry matter (DM) basis]. This is because crude glycerine is a low-cost (US$ 0.06/kg) by-product of biodiesel in comparison with SPG (US$ 0.22/kg) (KERR et al., 2007).

The same was observed in the study of Lage et al. (2010), in which the gradual inclusion of crude glycerine caused the diet cost to gradually decline from US$ 0.20/kg (0% inclusion) to US$ 0.17 kg (12% inclusion). The diet cost per day also decreased due to the lower feed intake by the animals, demonstrating that its inclusion is limited to certain quantities and that, when in excess, despite the reduction of costs, it renders the diet unviable, causing a direct loss in animal yield and, consequently, in revenues.

In addition to the valuation of SPG in recent years, the cost involved in its purification and transformation is still high, generating a bottleneck that must be overcome (PEITER et al., 2016). A possible reduction of its cost in the future will enable a higher use of SPG to

replace corn, since larger amounts can be included in the diet without compromising lamb performance (REZENDE et al., 2017).

The substitution of corn with SPG at 120 g/kg DM (Table 3) provided the highest gross revenue (US$ 42.91), gross profit (US$ 16.03), and gross margin (37.4%) among all evaluated treatments, showing to be economically viable and superior to the diet without SPG inclusion (gross revenue: US$ 40.63; gross profit: US$ 14.80; and gross margin: 36.4%). In a study led by Orrico Junior et al. (2015), 24 lambs were fed diets containing crude glycerine replacing corn at the levels of 0, 2.5, 5.0, and 7.5% and only the treatment with 7.5% inclusion was viable, as it provided a higher profit margin (46.7%) than the diet without inclusion of the ingredient (40.3%).

The sensitivity analysis performed considering the optimistic and pessimistic scenarios for corn and soybean (Table 4) made it possible to determine how a diet can be viable at sometimes depending on fluctuations in the prices of the ingredients that make it up.

Table 4: Sensitivity analysis of increasing levels semi-purified glycerine in the total diet of feedlot lambs replacing corn.

Glycerine in total diet (g/kg MS)	**0**	**120**	**240**	**360**
Optimistic (corn US$ 0.26/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	30.39	29.92	29.76	30.73
Gross profit	10.24	12.99	10.33	8.02
Gross margin (%)	25.2%	30.3%	25.8%	20.7%
Pessimistic (corn US$ 0.13/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	23.81	25.53	27.51	29.99
Gross profit	16.82	17.39	12.58	8.77
Gross margin (%)	41.4%	40.5%	31.4%	22.6%
Pessimistic (soybean US$ 0.48/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	27.44	28.74	30.33	32.63
Gross profit	13.19	14.18	9.76	6.13
Gross margin (%)	32.5%	33.0%	24.3%	15.8%
Optimistic (soybean US$ 0.32/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	24.87	25.77	26.92	28.78
Gross profit	15.76	17.15	13.17	9.98
Gross margin (%)	38.8%	40.0%	32.9%	25.8%
Totally Optimistic (corn US$ 0.26/kg soybean US$ 0.32/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	29.42	28.81	28.48	29.29

Gross profit	11.20	14.10	11.61	9.47
Gross margin (%)	27.6%	32.9%	29.0%	24.4%
Totally Pessimistic (corn US$ 0.13/kg soybean US$ 0.48/kg)				
Gross Revenue	40.63	42.91	40.09	38.76
EOC	25.41	27.38	29.64	32.40
Gross profit	15.21	15.53	10.45	6.36
Gross margin (%)	37.4%	36.2%	26.1%	16.4%

Dollar quotation (annual average 2018): R$ 3,30. EOC: Effective operating cost. Values presented are relative an animal during a period of 84 days.

In the optimistic scenario (corn: US$ 0.26/kg), the diets with 120 and 240 g SPG/kg DM were viable due to the rise in the price of corn, which made substitution with SPG a more advantageous option, as it reduced the feeding costs and increased gross profit and gross margin. In the optimistic scenario (soybean: US$ 0.32/kg), the reduction in the price of soybean was not sufficient for its inclusion in the diets to compensate, since its inclusion rose as SPG was added. The diet with 120 g SPG/kg DM had a slightly higher cost than the diet without glycerine, but also provided higher gross profit and gross margin than the other diets, because of the animal performance. This compensation of ingredients occurring as glycerine is used, with a consequent increase in costs, was reported by Batista et al. (2013), who analyzed the substitution of corn with SPG in the diet of meat quail. The diet cost rose linearly as the inclusion of SPG was increased, because of its low metabolizable energy content. As a result, a vegetable oil had to be included in the diets, elevating their cost.

In both pessimistic scenarios (corn: US$ 0.13/kg; soybean: US$ 0.48/kg), there were times in which the use of glycerine was not recommended when aiming to lower the diet cost, since the declining price of corn enabled its continued use, and the rising price of soybean made the diet even costlier. Even in pessimistic scenarios, the diet with 120 g SPG/kg DM would provide a higher gross profit than the diet without glycerine, but similar profit margins. The simulations of the price of corn revealed that the inclusion of 120 g SPG/kg DM started to provide a higher gross profit (US$ 18.40) than the diet without glycerine (US$ 18.34) when the price of corn was equal to or higher than US$ 0.10/kg.

In a completely optimistic scenario (corn: US$ 0.26/kg; soybean: US$ 0.32/kg), all the tested diets had lower costs than the diet without SPG; however, gross profit was highest in the diet with 120 g SPG/kg DM, whereas the highest gross margins were obtained in the diets with 120 and 240 g SPG/kg DM (32.9 and 29.0%, respectively). In the completely pessimistic scenario (corn: US$ 0.13/kg; soybean: US$ 0.48/kg), by contrast, the cost of all tested diets were higher than that of the diet without SPG inclusion. The only positive point was the

increase in gross profit (US$ 15.53) at the SPG level of 120 g/kg DM, which was higher than that of the diet without the test ingredient (US$ 15.21). In the study conducted by Socreppa et al. (2015), when corn was substituted with crude glycerine in the diet of grazing beef cattle in the rainy period, in a completely pessimistic scenario [depreciation of 5% in the price charged per arroba (15 kg) and 15% increase in the diet], the authors observed that only the substitution of up to 66% of corn with crude glycerine provided financial return.

5. Conclusion

Semi-purified glycerine can substitute corn in the diet of feedlot lambs. In view of the changes in the prices of the feedstocks that make up the diet, semi-purified glycerine is recommended to replace corn when the price of corn is higher than that of semi-purified glycerine. The price of soybean should be taken into account, since it is a necessary ingredient to correct the nutritional value of the diet. All diets were profitable; however, the dietary inclusion of semi-purified glycerine at 120 g/kg DM provided the highest gross profit and gross margin among all treatments because of the higher obtained revenue and lower cost (US$ 4.27/kg carcass) when compared with the treatment without its inclusion (US$ 4.34/kg carcass).

It is important that scientific publications in this area indicate, not only the productive performance of animals, but also carry out the correct economic evaluation, which is often neglected in publications. This information should reach the producers knowledge so that they can be able to choose to use the substitute ingredients in the diet of feedlot lambs, having knowledge of the costs necessary and the returns that will be achieved at short, medium and long term.

6. References

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