



Lamb Production Costs: Analyses of Composition and Elasticities Analysis of Lamb Production Costs

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ABSTRACT: Since lamb is a commodity, producers cannot control the price of the product they sell. Therefore, managing production costs is a necessity. We explored the study of elasticities as a tool for basing decision-making in sheep production, and aimed at investigating the composition and elasticities of lamb production costs, and their influence on the performance of the activity. A representative sheep production farm, designed in a panel meeting, was the base for calculation of lamb production cost. We then performed studies of: i) costs composition, and ii) cost elasticities for prices of inputs and for zootechnical indicators. Variable costs represented 64.15% of total cost, while 21.66% were represented by operational fixed costs, and 14.19% by the income of the factors. As for elasticities to input prices, the opportunity cost of land was the item to which production cost was more sensitive: a 1% increase in its price would cause a 0.2666% increase in lamb cost. Meanwhile, the impact of increasing any technical indicator was significantly higher than the impact of rising input prices. A 1% increase in weight at slaughter, for example, would reduce total cost in 0.91%. The greatest obstacle to economic viability of sheep production under the observed conditions is low technical efficiency. Increased production costs are more related to deficient zootechnical indexes than to high expenses. (**Key Words:** Economic Analysis, Elasticity, Lamb, Production Cost, Production System, Technical Indicator)

INTRODUCTION

Brazilian sheep production, unlike what has been happening in most other countries, has since the early 2000s attracted investors and expanded in numbers and quality. The focus of development of the activity is the production of lamb, mostly to meet demanding markets such as the state of Sao Paulo's. However, new sheep breeders have no tradition or experience in the field. They are attracted by the steady demand for the product, which motivates imports of most of the sheep meat consumed by Brazilians, and by the high prices charged by restaurants and boutiques that sell specialty meats.

However, the path between the birth of lambs and the

consumer's table can offer many drawbacks, and new breeders face several difficulties to establish effectively in the activity. The greatest of these is the challenge of keeping a healthy and productive flock at production costs that do not compromise the economic viability of the activity. To get around this, it is necessary to apply efficient methods of managing, which occurs in only a few cases (Raineri, 2012).

The primary productive activity is the most vulnerable segment of the supply chain due to technological and management limitations. Because they fail to control the price of the product they sell, producers need to administer the variables that are under their control. Their economic outcome in a competitive market environment depends on management of production costs and of economies of scale (Reis et al., 2001). However, according to the latest Brazilian Agricultural Census, more than 50% of Brazilian sheep flock is housed in properties of up to 100 hectares, and most breeders own less than 100 animals (IBGE, 2007). In this context, knowledge of production costs is critical in

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managing the property, because small producers need to be efficient to be competitive. On the other hand, Costa (2007) concluded, by analyzing the supply chain of sheep industry, that most farmers do not have any mechanisms for managing their property. The percentage of adoption of technologies related to infrastructure, administration and flock handling is still very low among sheep producers.

Brazilian studies about sheep production costs are scarce, and most of them are restricted to evaluate the variable costs involved in lamb finishing process. Even rarer are studies that assess the profitability of investments in meat sheep farming. Thus, farmers who want to calculate their production costs find very little specific scientific basis. International literature also offers not many articles on economic evaluation of sheep production, and most of the available papers deal with broader issues, or economic analyzes of specific procedures, not with the calculation of production costs specifically. Some examples are Kilkenny and Read (1974), Galal et al. (1996), Milan et al. (2003), Perez et al. (2007), Morris (2009) and Tzouramani et al. (2011).

The aim of this study is to investigate the composition of production costs of lamb, and its influence on the performance of the activity. We intend to improve understanding of the factors that influence the cost and the way in which this occurs, in order to generate useful information for the management of sheep farms.

MATERIAL AND METHODS

First we defined the representative characteristics for a sheep production farm in the region of Sao Jose do Rio Preto, state of Sao Paulo, Brazil. Based on these, we calculated the annual cost of breeding lambs for these conditions. Then economic analyses were performed, as follows: i) study of costs composition, and ii) study of the total cost elasticities according to the prices of inputs and zootechnical indicators.

Characterization of the studied property

The technical, productive and economical characteristics of the studied lamb production farm were defined by the method of panel meeting (Plaxico and Tweeten, 1963; Vereijken, 1999; Richardson et al., 2007; Almeida, 2010; CONAB, 2010). The panel consists of a meeting with the researcher and a group of producers and technicians in the area at issue, in which participants discuss together and seek to draw a typical production system in a certain locality. During the discussions, the group fills a previously structured spreadsheet to represent a typical situation in the region (Ferreira Filho et al., 2009). The collected data were not obtained from an individual farm, or from statistical averages: they were based on a consensus in

a panel meeting.

Thus, through the local experience of producers, we outlined a sheep production system that represents the region of Sao Jose do Rio Preto, state of Sao Paulo. This region has the greatest concentration of sheep in the state, according to the Brazilian Institute of Geography and Statistics (IBGE, 2012), comprising over 17% of Sao Paulo's flock. Thirteen breeders and technicians, as well as the researcher in charge of the study, participated in the panel.

The aspects approached during the performed panels refer to six groups of features, namely: i) characteristics of property and manpower (total area of the property, area assigned for sheep production, period for which the activity has been conducted, amount of hours reserved for administration of the activity, amount of employees and time reserved for the sheep routine, existence or absence of technical assistance), ii) flock (quantities of ewes and rams, outcome rate, sheep breeds), iii) handling (performed stages of production cycle, production system, feeding stuffs used, health management, weaning method, breeding system), iv) equipment and facilities, v) feed production (pastures' characteristics and handling, forages used in the dry period, source of supplementary concentrates) and vi) zootechnical indicators.

Thus, the entire production system was characterized including the selection of products and services used, their prices and quantities. These technical coefficients were kept fixed for the proposed cost model, configuring a Leontief production function (Leontief, 1936).

Calculation of cost and its composition

The lamb production cost in the representative property was calculated for a period of one year, according to the method developed by Raineri (2012). The method is based on Economic Theory and different methods consecrated and used in agriculture, which have undergone adaptations for use in breeding lambs.

The cost components are grouped into the categories of variable costs, operational fixed costs, operational costs and total cost. Variable costs include all components involved in the activity that only occur if there is production, and that are directly related to the number of animals produced. The components were: feeding (pasture, supplementary roughage, concentrates, and mineral salt) and veterinary expenses (anthelmintics and vaccines).

The elements of expenses that are borne by the producer, regardless of the production volume, are included in the operational fixed costs. The elements considered in this study were manpower, depreciation (of facilities, machinery, purchased ewes, and rams), maintenance and preservation (of machinery, facilities, and pastures) and other fixed costs (energy and fuel).

The operational cost consists of all items of variable costs and the share of fixed costs directly associated with the implementation of the activity. It differs from the total cost only for not including the income of factors, considered as the expected return on capital and on the land (Matsunaga et al., 1976). The total cost of production comprises the sum of the operational cost plus the compensation assigned to production factors (CONAB, 2010).

Analysis of the elasticities

In economic terms, the elasticity expresses a relation between two functionally interrelated variables (Passos and Nogami, 2003). That is, the elasticity measures the proportional response of one variable with respect to changes in another.

Analyses of elasticities were performed with the following objectives: i) to estimate the intensity of variation of the total cost of production due to the variation in the prices of inputs used; and ii) to estimate the intensity of variation of the total cost of production due to variations of the zootechnical indicators. Thus, one can identify which variables the total cost of lamb production is more sensitive to.

The cost sensitivity to price variations of production factors is called "price elasticity factor of the total cost", and is obtained through the equation:

$$EPFC_{fr} = \left(\frac{CT_{rt+1} - CT_{rt}}{CT_{rt}} \right) / \left(\frac{PF_{frt+1} - PF_{frt}}{PF_{frt}} \right) \quad (1)$$

In which:

$EPFC_{fr}$: price elasticity factor of the total cost for the production factor f in region r ;

CT_{rt} : total cost of production in region r during period t

CT_{rt+1} : total cost of production in region r during period $t+1$ (period after occurred variation) (in Reais);

PF_{frt} : price of the production factor f in region r during period t (in Reais); and

PF_{frt+1} : price of the production factor f in region r during period $t+1$ (period after occurred variation) (in Reais).

The cost sensitivity to zootechnical indicators' variations is called "zootechnical indicator elasticity of the total cost", and is obtained through the equation:

$$EZTC_{zr} = \left(\frac{CT_{rt+1} - CT_{rt}}{CT_{rt}} \right) / \left(\frac{ZT_{zrt+1} - ZT_{zrt}}{ZT_{zrt}} \right) \quad (2)$$

In which:

$EZTC_{zr}$: zootechnical indicator elasticity of the total

cost for the production factor z in region r ;

CT_{rt} : total cost of production in region r during period t

CT_{rt+1} : total cost of production in region r during period $t+1$ (period after occurred variation) (in Reais);

ZT_{zrt} : value of the zootechnical indicator z in region r during period t ; and

ZT_{zrt+1} : value of the zootechnical indicator z in region r during period $t+1$ (period after occurred variation).

RESULTS AND DISCUSSION

Production system

The production system of the representative property studied can be classified as intensive, but presents characteristics indicative of low technical efficiency. This fact can be explained by the short time that the activity has been being conducted with an economic nature in the region (4 to 5 years), and by the inexperience of the sheep farmers.

The flock on the representative farm is composed of about 300 hair ewes (Santa Ines breed and Santa Ines mixes) with very low or no reproductive seasonality, mainly bred to Dorper rams. The dams are kept in pastures and lambs are confined from birth to sale. This system uses the technique of controlled sucking, which consists in separating dams and lambs during the day and allowing offspring to suck overnight. This practice starts around 20 days after birth, as soon as the lambs are able to feed concentrates, and not only milk. Therefore, this practice is associated to the use of creep feeding – that is the supply of concentrate in an exclusive feeder for lambs from the first days of life. The goals are reducing feeding costs for ewes, stimulating lambs to consume larger quantities of grain as early as possible and familiarizing lambs with the absence of their mothers, in order to reduce weaning stress.

The supplementary roughages used are sugar cane and elephant grass stocking piles (*Pennisetum purpureum*, SCHUM), in the dry season (April to September) and rainy season (October to March) respectively. Lambs receive concentrates based on grains since birth, and the ewes only during late gestation and early lactation. Table 1 presents the zootechnical indicators of the representative property of the region of Sao Jose do Rio Preto.

Production cost

This item presents the production costs of the farming system studied. Table 2 shows the aggregate costs for the activity on the representative property, at mean prices of inputs for the months of July to September 2012.

The item "E - Revenue from culled ewes" was included in the calculations for two main reasons. First, Economic Theory states that all factors of the production system should be remunerated. The case of the culled ewes is no different, and they are remunerated according to their

Table 1. Zootechnical indicators of the representative property studied, according to data obtained in panel meeting

Zootechnical indicators	
Pregnancy rate (%)	80.0
Prolificacy rate (%)	120.0
Lambing interval (months)	10
Birth weight (kg)	3.0
Weaning age (d)	75
Weaning weight (kg)	19.0
Pre weaning ADG (kg/d)	0.213
Pre weaning mortality (%)	15.0
Slaughter live weight (kg)	38.0
Slaughter age (d)	140
Post weaning ADG (kg/d)	0.292
Carcass yield (%)	48.0

ADG, average daily gain.

The author calculated average daily gains of the representative properties according to information on weights and ages.

Source: data from the research.

market value, as well as lambs are remunerated in the same way. Thus, if these females were not removed from this account, they would be being mistakenly remunerated twice, unnecessarily burdening the system. Second, discounting the value of ewes facilitates comparison between the total cost and the price of lamb, in view of the profitability analysis: the calculated total cost per kilogram starts to refer

Table 2. Annual costs for the production of meat lambs, considering mean prices of the months of July to September 2012, for the representative property of the region of Sao Jose do Rio Preto (in Reais per year)

Cost items	Annual cost ¹
A. Variable costs	
I. Feeding	62,592.36
II. Veterinary expenses	971.57
Subtotal variable costs	63,563.93
B. Operational fixed costs	
III. Manpower	11,000.00
IV. Depreciation	5,698.74
V. Maintenance and preservation	4,004.12
VI. Other fixed costs	763.21
Subtotal - operational fixed costs	21,466.06
C. Operational cost (A+B)	85,030.00
D. Income of factors	14,056.61
E. Revenue from culled ewes ²	9,450.00
F. Total cost (C+D-E)	89,636.61
Total cost in BRL/head	277.40
Total cost in BRL/ kg (live weight)	7.30
Total cost in BRL/ kg (carcass weight)	15.21

¹ Values in Reais (BRL) per year. Average exchange rate for the period: BRL 1.00 = USD 0.5115.

² Considering the sale of 54 culled per year (annual culling rate of 18%) with average live weight of 50 kg at a BRL 3,50/kg.

Source: data from the research.

only to the lamb, so it can be directly compared to the values offered by buyers.

Considering the average prices for lamb, which did not exceed BRL\$ 6.65 per kilogram of live weight during the period (UNICETEX, 2012a, b, c, d), the observation of the total cost leads to questions about the economic viability of the activity.

Authors such as Barros (2008), Heaton et al. (1999) and Nix (1988) found that many sheep breeders disregard several items in their cost estimates, and for this reason consider the activity viable and remain in it. Thus, we performed new calculations of costs for the representative properties, excluding the sum of items that are commonly ignored by breeders, either by ignorance or by choice. Table 3 presents the total cost of sheep production, and also the costs deducted from cost of the pasture, the income of the factors of depreciation or all of these items.

The values obtained, especially when excluding the three items of cost, are significantly reduced compared to the total costs, and are more consistent with the market price of the product. Other aspects should be highlighted in this discussion, as the great involvement of breeders in the informal market and the occurrence of cross-subsidy in the properties.

Sorio and Rasi (2010) affirm that informality is present in Brazilian sheep production, trade, slaughter and carcass processing, and that one of the reasons for that is the higher value obtained by producers when performing the slaughter and marketing the meat themselves. In a survey with sheep producers in the state of Sao Paulo, Souza et al. (2008) found 55% of producers performing slaughter in their own farms as a way of selling their production. In spite of providing higher income for producers, formal slaughter is associated with tax evasion and exclusion of animal health surveillance system, being a great concern for Brazilian sheep industry.

The cross-subsidy is the use of profits from one activity of the property to support another (Souza and Braga, 2007), in this case, sheep raising. That is, there is a transfer of costs from one activity to another so that producers cannot

Table 3. Total and discounted production costs (in BRL for kg of live lamb)

Costs ¹	Cost ²
Total cost (TC)	7.30
TC – cost of pastures	5.06
TC – income of factors	6.16
TC – depreciations	6.84
TC – cost of pastures – income of factors – depreciations	3.58

¹ The costs shown represent the arithmetic mean for the three months studied in each region.

² Values in Reais (BRL) per year. Average exchange rate for the period: BRL 1.00 = USD 0.5115.

Source: data from the research.

identify which culture is responsible for each portion of the profit or cost: they count only the general result of the property. Lamb production is a complementary activity in the representative sheep farm, commonly secondary, coexisting mostly with sugar cane culture.

Nix (1988) and Niznikowski et al. (2006) claim that it is necessary to consider that sheep industry is an evolving activity and that the zootechnical indicators, usually inadequate due to lack of application of technologies, reflect the low efficiency of the system which is often responsible for the high cost of production. As the technical efficiency of breeding increases, costs can be reduced.

Kumm (2009) also noted a low profitability of the activity in Sweden, with several similar causes to the Brazilian situation. The study revealed that some aspects, such as the need to increase scale of production, the sheep farmer's lack of experience, the small area of the properties and the high opportunity cost of land, have to be worked out to make lamb production viable in the country. On the other hand, also the same as in Brazil, domestic production meets only a small portion of sheep meat consumption, which creates the desire and the opportunity to increase production.

Cost composition

Table 4 shows the proportion of each type of cost (variable and operational fixed cost and income of factors) in the cost of the representative property.

As shown above, the largest portion of the cost is represented by variable costs (64.15% of total). Operational fixed costs appear as the second largest type of cost (21.66%), and income of factors, as third (14.19%).

Feedstuffs are responsible for most of the production cost. It is worth noting that the feeding basis of the flock in question is pasture, and that the opportunity cost of the land is included in the pasture value. The cost of pasture was BRL\$ 0.01 per kg of dry matter, disregarding the value of

fertilizers and mechanical operations of conservation. Such cost could be reduced if the support capacity of the area and therefore the stocking rate were higher. The overall stocking rate throughout the year adopted in the system is 24 ewes per hectare.

As explained previously, depreciations were calculated for the facilities, machinery, equipment, ewes acquired or retained for flock expansion and rams.

The item "maintenance and preservation" includes machinery, equipment, facilities and pastures. Operations of fertilizer and manure application were considered as pasture maintenance.

The facilities were responsible for a significant portion of production cost, representing approximately 60% of the cost of depreciation, over 26% of the costs of maintenance and over 82% of remuneration on fixed capital. The average *Selic* rate for the period, used to remunerate the capital, was 6.24% per year.

Elasticities

The analyses of elasticities were conducted in order to assess which factors the total production cost of lamb is more sensitive to. We evaluated two categories of factors: the inputs and the zootechnical indicators. Table 5 presents the inputs used and their elasticities.

The data obtained clarify that the costs of pasture and the land opportunity costs (which are directly correlated, as discussed in item 3.2) have, among the inputs, the greatest impact on the total cost of production: an increase of 1% in its price leads to an increase of 0.2666% in the cost of lamb.

The other inputs follow in descending order of impact, relating mainly to feedstuffs such as corn, sugar cane, soybean meal and concentrates for finishing lambs and adults. Housing costs and interest on capital assets (directly related, as stated in item 3.2) are also among these items.

Manpower occupied positions 10th and 12th on the list, followed by creep feeding concentrate and by the interest on working capital. Machinery and implements such as forage harvester and tractor come after that, followed by limestone used for the maintenance of pastures. Inputs with elasticities lower than 0.01 were employed in the herd health management (vaccines and anthelmintic), energy and fuel, breeding rams and cart.

The results of the second step of the elasticity analyses, which studied the total cost response to variations of the zootechnical indicators, can be seen in Table 6.

The first important observation when analyzing the table is that the impact of increasing any zootechnical indicator is significantly higher than the impact of rising prices of inputs used in the activity. A 1% increase in weight at slaughter, for example, causes a reduction of approximately 0.91% in total cost, which represents an almost linear relation.

Table 4. Proportion of each cost item in the total cost

Item	Total cost ratio (%)
Variable costs	
Feeding ¹	63.17
Veterinary expenses	0.98
Fixed costs	
Manpower	11.10
Depreciation	5.75
Maintenance and preservation	4.04
Other fixed costs	0.77
Income of factors	
Interest on fixed capital	10.27
Interest on working capital	3.92

¹Includes the opportunity cost of lease of the area, which is built into the cost of pasture.

Source: data from the research.

Table 5. Price elasticities of production factors of the total cost for representative property of Sao Jose do Rio Preto: percentage change that would happen in the total cost of production by 1% increment in the price of the relevant production factors

Input	Elasticity
Pasture	+0.2666
Land	+0.2666
Corn	+0.1353
Housing	+0.1213
Sugar cane	+0.0964
Interest on immobilized capital	+0.0920
Soybean meal	+0.0874
Concentrate for adults	+0.0873
Concentrate for weaning	+0.0871
Day-laborer	+0.0610
Mineral salt	+0.0576
Permanent employee	+0.0513
Concentrate for lactating dams	+0.0482
Interest on working capital	+0.0350
Forage harvester	+0.0292
Agricultural limestone	+0.0160
Tractor	+0.0102
Vaccines	+0.0092
Diesel	+0.0089
Rams	+0.0062
Cart	+0.0053
Electric energy	+0.0053
Anthelmintics	+0.0017

Source: data from the research.

These results show that investing in inputs that allow improvements in the technical efficiency of the breeding can be advantageous, such as in the case of supplementing lambs with concentrates to improve weight gain, supplementing ewes to increase prolificacy or reduce lambing interval, in using fertilizers or limestone to intensify the use of pastures, in applying vaccines and other medicines to enable reductions in pre-weaning mortality, or in purchasing breeding rams with proven genetic potential for productivity gains. This is in agreement with the

Table 6. Zootechnical indicator elasticity of the total cost for representative property of Sao Jose do Rio Preto: percentage change that would occur in the total cost of production upon a 1% increase in the zootechnical indicators

Indicator	Elasticity
Slaughter weight	-0.9091
Hot carcass yield	-0.9091
Lambing interval	+0.6755
Prolificacy rate	-0.6141
Pregnancy rate	-0.6141
Pre weaning mortality rate	+0.6141
Number of ewes	-0.4488

Source: data from the research.

statements by Barros (2008) and Viana and Silveira (2008).

It is also interesting to emphasize that it is possible to improve zootechnical indicators without the need to increase quantities or expenses of inputs used. This is what happens when the farmer performs selection of ewes and rams, and oriented culling of unproductive or less productive animals, that produce lambs of inferior performance (Raineri, 2012).

CONCLUSION

The characterization of the studied production system, its cost composition and the analysis of elasticities clearly show that the biggest obstacle to the economic viability of lamb production, under the observed conditions, is the low technical level of the activity. High production costs are often more related to inadequate zootechnical indicators, than actually to high expenses.

Situations like these highlight the flaws in the activity management, and demonstrate the importance of providing tools and basic guidance so that sheep farmers can know and control their production costs.

It is clear that by controlling costs it is possible to generate important information for making decisions on the property, as exemplified by studies of the compositions of costs and of elasticities.

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