# Economics of Callipyge Lamb Production[1]

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**ABSTRACT:** This paper examines the economic implications of callipyge (CLPG) lamb production. The price, as it relates to competing meats and excess fat, significantly impact lamb demand, and CLPG genetics improves those factors. The CLPG phenotype does not affect number or weight of lambs weaned or postweaning ADG, but it does improve postweaning feed efficiency by approximately 10%; dressing percentage approximately 7.5%; and yields of wholesale leg (11.8%), loin (4.7%), rack (2.5%), and shoulder (2.3%). Total production costs for a 59-kg lamb are 4% lower in CLPG lambs due to improved feed efficiency. Assuming pelt and offal value pays for slaughter costs, the costs of normal (N) and CLPG carcasses are the same as for live lambs, $81 and $78, respectively; but, due to dressing percentage, the N carcass weighs 29.2 kg and the CLPG carcass, 31.4 kg. Thus, carcass costs for N and CLPG lambs are $2.77/kg and $2.49/kg, respectively. Decreased feed costs, combined with increased carcass and primal cut yields for CLPG lambs, lowers the price required to recover meat costs for leg, loin, rack, and shoulder by 19.7, 14.4, 12.6, and 11.9%, respectively. Successful marketing of CLPG loin and rack depends on the use of one of several postharvest tenderization procedures. Moisture-enhanced pork is accepted by consumers and often sells for a premium; and moisture enhancement may be appropriate for CLPG lamb. The meat cost per kilogram (including a $.10 per kilogram treatment cost) of tenderized and moisture-enhanced CLPG leg, loin, rack, and shoulder containing 10% added water and ingredients would be lowered to $2.51, $4.65, $5.34, and $1.85, respectively. That represents a total of a 20.9% reduction in cost-basis price. When expressed on the basis of increased revenue from the additional yield of cuts at a given market price, the value of CLPG and moisture-enhanced CLPG cuts from a 59-kg lamb would be, respectively, 14.2% and 23.4% higher than for N lamb. Industrywide adoption of CLPG could increase intermediate-run U.S. profits by $109 million, but the actual effects of CLPG attributes, such as a visual appeal, lower fat and cholesterol content, and reduced seam fat, on consumer demand need to be quantified. If accepted by packers and consumers, moisture-enhanced CLPG lamb has the potential to decrease the cost of lamb to consumers and increase lamb industry profitability.

Key Words: Callipyge, Lamb (meat), Economics, Production Costs



## Introduction

United States lamb production has been declining since 1942. Many factors have contributed to that decline, including predation losses, increased cost and decreased availability of grazing lands, loss of government incentive programs, and, perhaps most importantly, decreased demand (Bastian and Whipple, 1998). Price relative to competing meats, excess fat, and lack of convenient cuts are important factors affecting lamb demand (Purcell, 1995, 1998; Ward et al., 1995; Field and Whipple, 1998). Lambs exhibiting the callipyge (**CLPG**) phenotype are superior to normal (**N**) lambs in economically important traits, such as feed efficiency, dressing percentage, and yield of retail cuts (see Shackelford et al., 1998 for review), resulting in lower unit production costs for CLPG retail cuts. Furthermore, retail cuts from CLPG lambs have less fat and cholesterol than do normal cuts

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(Leckie et al., 1997). Several approaches have been identified to mitigate the well-documented toughness of CLPG lamb (Carpenter et al., 1997; Leckie et al., 1997; Koohmaraie et al., 1998), and some of these can be combined with moisture enhancement and further processing to improve juiciness and convenience. The objective of this article is to quantify the potential increase in revenue and net reduction in production and processing costs, and to estimate the effect of CLPG lamb production on lamb price and demand using econometric models.

## Increased Revenues and Reduced Costs

This article focuses on the decreased costs associated with CLPG lamb production because the price of lamb relative to competing meats is a primary factor hindering demand (Purcell, 1995). However, it is also possible to express the economic advantage for CLPG lamb on the basis of increased revenue from the additional yield of cuts from CLPG carcasses at a given market price as was done by Shackleford et al. (1998). Thus, for comparative purposes, economic differences will be expressed both on an increased revenue and decreased cost basis.

The effects of the CLPG phenotype on most production traits of economic importance have been well documented (Snowder et al., 1994a,b; Jackson et al., 1997a,b). Reproductive rate, birth weight, rate of dystocia, weaning weight, and postweaning growth rate are not affected by the CLPG phenotype, but the CLPG phenotype is associated with about a 10% improvement in feed efficiency. Therefore, the CLPG gene should not affect production costs except for postweaning feed costs. Production costs for a 59-kg lamb are about $81, of which about $30 is for postweaning feed costs (Table 1). A 10% improvement in feed efficiency for a 59-kg CLPG lamb decreases the production cost to $78. Thus, at the point of slaughter, production costs per kilogram of live weight for N and CLPG lambs would be $1.37 and $1.32, respectively.

Callipyge lambs dress about 7.5% higher than normal lambs (Snowder et al., 1994a; Koohmaraie et al., 1995; Jackson et al., 1997b). Assuming that pelt and offal value pays for slaughter, the costs of N and CLPG carcasses are the same as for live lambs, $81 and $78, respectively. But using the commercial dressing percentages reported by Snowder et al. (1994a), the N carcass weighs 29.2 kg and the CLPG carcass, 31.4 kg. Thus, carcass costs for N and CLPG lambs are $2.77/kg and $2.49/kg, respectively (Table 1), a reduction of over 10%. Expressed on an increased-revenue basis, this represents an increase in value of $8.88, which is in close agreement to the advantage of $9.30 reported by Shackleford et al. (1998).

Table 1. Production costs of normal and callipyge phenotype lambs weighing 59 kg

| | Muscling phenotype | |
|---|---|---|
| Variable | Normal | Callipyge |
| Preweaning expenses (ewe maintenance, etc.)[a] | $41 | $41 |
| Postweaning feed costs[b] | $30 | $27 |
| Postweaning expenses (veterinary, labor, facilities and equipment, death loss, etc.)[c] | $10 | $10 |
| Total production cost for live lamb | $81 | $78 |
| Live weight, kg | 59 | 59 |
| Lamb production costs per kg of live weight | $1.37 | $1.32 |
| Dressing percentage[d] | 49.44 | 53.14 |
| Carcass weight, kg | 29.2 | 31.4 |
| Total production cost for carcass[e] | $81 | $78 |
| Lamb production cost per kg of carcass weight | $2.77 | $2.49 |

[a]Based on Snowder et al. (1994a,b).
[b]Based on a 10% improvement in feed efficiency (Snowder et al., 1994b; Jackson et al., 1997a).
[c]Snowder, unpublished information.
[d]Based on Snowder et al. (1994a).
[e]Assuming that the value of pelt and offal equals slaughter costs and that slaughter costs for callipyge and normal lambs are equal.

The CLPG phenotype improves yields of wholesale leg (11.8%), loin (4.7%), rack (2.5%), and shoulder (2.3%). Actual cut weights from Snowder et al. (1994a) are shown in Table 2. Based on prices recorded in the January 16, 1998, issue of the USDA *Weekly National Lamb Market Summary*, CLPG cuts would be valued at $13.42 more than N cuts, a 14.2% increase. Based on those prices and closely trimmed cut yields, the leg, loin, rack, and shoulder of a normal lamb represented 29.5, 18.4, 18.2, and 13.4%, respectively, of carcass value. In our example, if individual CLPG primal cuts recover the same percentage, the cost basis of the leg, loin, rack, and shoulder of CLPG carcasses would be $22.97, $14.34, $14.16, and $10.47, respectively. The combination of decreased feed costs, increased dressing percentage, and increased primal cut yield lowers the price required to recover meat costs for leg, loin, rack, and shoulder from $3.30 to $2.65/kg, $5.85 to $5.01, $6.60 to $5.77, and $2.18 to $1.92, respectively. That represents a weighted-average reduction of 15.9% in cost-basis price for the four major cuts.

Table 2. Potential increase in revenue- and cost-basis prices for normal, callipyge (CLPG), and moisture-enhanced callipyge (MEC) closely trimmed wholesale cuts from 59-kg lambs

| Cut | Price, $/kg[a] | Weight of cut, kg[b] | | | Cut value, $[c] | | | Normal cut value as % of carcass[d] | Cost-basis value, $[e] | | | Cost-basis price, $/kg[f] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Normal | CLPG | MEC | Normal | CLPG | MEC | | Normal | CLPG | MEC | Normal | CLPG | MEC |
| Leg | 4.84 | 7.23 | 8.68 | 9.55 | 34.98 | 42.02 | 45.27 | 29.5 | 23.86 | 22.97 | 22.97 | 3.30 | 2.65 | 2.51 |
| Loin | 8.58 | 2.55 | 2.86 | 3.15 | 21.84 | 24.57 | 26.71 | 18.4 | 14.89 | 14.34 | 14.34 | 5.85 | 5.01 | 4.65 |
| Rack | 9.68 | 2.23 | 2.45 | 2.70 | 21.56 | 23.76 | 25.87 | 18.2 | 14.70 | 14.16 | 14.16 | 6.60 | 5.77 | 5.34 |
| Shoulder | 3.19 | 5.00 | 5.45 | 6.00 | 15.95 | 17.40 | 18.54 | 13.4 | 10.88 | 10.47 | 10.47 | 2.18 | 1.92 | 1.85 |
| Total cuts | — | 17.00 | 19.5 | 21.40 | 94.33 | 107.75 | 116.39 | 79.4 | 64.33 | 61.95 | 61.95 | 3.78 | 3.18 | 2.99 |
| Carcass | 4.07 | 29.2 | 31.4 | 31.4 | 118.77 | 127.65 | 127.65 | 100.0 | 81.00 | 78.00 | 78.00 | — | — | — |

[a]Based on prices recorded in the January 16, 1998, issue of the USDA *Weekly National Lamb Market Summary*.
[b]Based on commercial cutting tests reported by Snowder et al. (1994a).
[c]Cut value = weight of cut × January 16, 1998, price. For moisture-enhanced cuts, the cut prices were reduced by $.10/kg to account for the treatment cost.
[d]Normal cut value as % of carcass = (cut value for normal lamb/normal carcass value) × 100.
[e]Cost-basis value = total production cost for carcass (from Table 1) × normal cut value as percentage of carcass.
[f]Cost-basis price = cost basis value/weight of cut. For moisture-enhanced cuts, the cost basis price was increased by $.10/kg to account for the treatment cost.

Successful marketing of CLPG loin and rack depends on the use of one of several postharvest treatments to improve meat tenderness (Carpenter et al., 1997; Leckie et al., 1997; Koohmaraie et al., 1998), and an improvement in juiciness may also be necessary. Moisture-enhanced pork is accepted by consumers and often sells for a premium (Johnson, 1997), and moisture enhancement may be appropriate for CLPG lamb. The cost of tenderization and moisture enhancement can be accomplished for about $.10 per kg. The total cut value of tenderized CLPG leg, loin, rack, and shoulder containing 10% added water and ingredients would be increased to $116.39 compared with $94.33 for untreated N lamb; an increase of 23.4%. The meat cost per kilogram (including a $.10/kg treatment cost) of tenderized and moisture-enhanced leg, loin, rack, and shoulder containing 10% added water and ingredients would be lowered to $2.51, $4.65, $5.34, and $1.85, respectively. That represents a 20.9% reduction in meat cost per kilogram. If accepted by consumers, moisture-enhanced CLPG lamb can potentially decrease the cost of lamb for consumers and increase lamb industry profitability. Moisture enhancement could also be combined with further processing such as high-temperature pasteurization (searing the outside) and preseasoning to improve the convenience of lamb.

These results illustrate the impact of CLPG lamb in a "closed system," in which factors such as supply and demand remain constant. That is clearly not the case; thus, it is also important to look at the effect of CLPG lamb in a global marketplace.

## Economic Effects

The adoption of CLPG lamb by producers and consumers can be represented by an economic model, which can be used to predict the economic effects of CLPG on the lamb industry. The adoption of CLPG by producers can be represented graphically as a shift downward or to the right in their supply curve due to lower production costs. This shift is represented in Figure 1 as a shift in the supply curve from Q1 to Q2. As discussed in Purcell (1995), an increase in supply causes a downward shift in prices if demand does not change, P1 to P1*, where Q2 intersects with D1.

Consumer response to CLPG, assuming that consumers respond favorably to lower cholesterol and fat levels, is represented as a shift upward or to the right of the aggregate consumer demand curve. In Figure 1, this is represented as a shift from D1 to D2. This shift in consumer preference can be stated as follows: at a given price, consumers are willing to purchase more lamb, or, alternatively, consumers are willing to pay a higher price to purchase a given amount of lamb. Thus, if consumers view CLPG lamb as a more desirable product and supply does not change, the shift in preference would cause the demand curve to shift from D1 to D2 and the price would increase to P1** because of greater demand for a given supply.

However, given the interaction of shifts in both supply and demand, the effects on price could be an increase, a decrease, or no change. As presented in Figure 1, price remains unchanged. Nevertheless, the overall shift and resulting effect on price is an

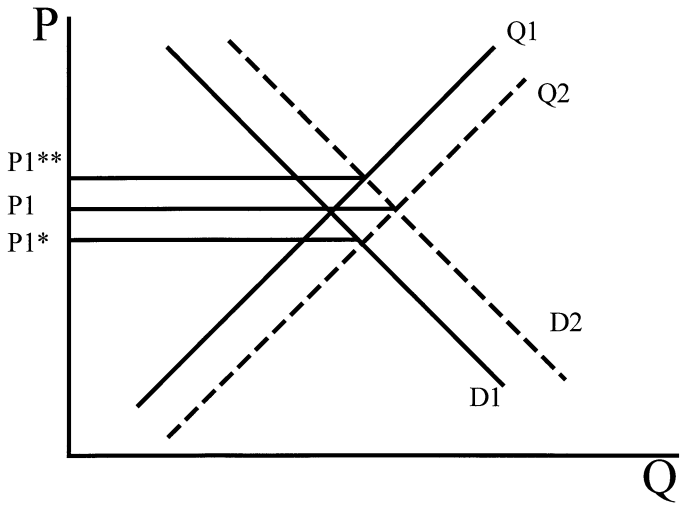


Figure 1. Potential shifts in supply and demand caused by the presence of callipyge (CLPG) phenotype lambs, where Q = quantity, P = price, D1 = original demand, Q1 = original supply, D2 = demand with favorable consumer response to CLPG, Q2 = supply at lower production cost, P1 = original price, P1* = lower price due to increased supply, and P1** = higher price due to increased demand.

empirical issue that depends on the underlying relative supply and demand elasticities. These elasticities are interpreted as the percentage change in supply or demand due to a 1% change in price and represent consumer response to changes in price.

To assess the likely effects of CLPG lamb on the sheep industry, an economic simulation model of the United States and the rest of the world's lamb and mutton industry was developed. The model is developed to predict both short-run and intermediate-run scenarios. Because of the lack of data on actual CLPG lamb supply and demand, the model includes a number of essential assumptions.

The base data including supply, demand, net import price, elasticities, and response parameters are presented in Table 3. The model is based on 1997 supply and demand data for lamb and mutton (Economic Research Service, 1997). The base price represents the weighted average of the leg, loin, rack, and shoulder cost-basis price for normal lambs shown in Table 2. Basic supply and demand elasticities are taken from Roningen et al. (1997).

To further capture the changes in the characteristics of CLPG lamb, response parameters that represent consumer responses to changes in cholesterol and fat levels were included in the demand equation. These parameters were developed from the consumer perception of lamb presented in Ward et al. (1995) and are calculated based on the mean response relative to the maximum response for each characteristic.

To assess the effects of CLPG, a number of scenarios are simulated, including the adoption of CLPG lamb (with no shift in demand), the adoption of moisture-enhanced CLPG (with no shift in demand), the adoption of CLPG with a shift in demand (or demand response), and moisture-enhanced CLPG with a demand response. The four scenarios were further defined as short-run and intermediate-run scenarios. In the short-run scenarios, only U.S. producers adopted CLPG lamb and U.S. imports are held at their 1997 levels so only the U.S. market is affected by the changes in supply and demand. In the intermediate-run scenarios, only U.S. producers adopt CLPG, but U.S. imports are allowed to adjust to equalize supply and demand.

Overall, there are eight scenarios representing combinations of supply and demand shifts and the short and intermediate run. The results of the scenarios are presented in Table 4. The results suggest that, in the short run, as production increases due to the introduction of CLPG lamb, prices will drop. Moisture-enhanced CLPG lamb further reduces prices due to a further increase in supply.

As consumers recognize the merits of CLPG lamb, their demand curve shifts and results in increased demand. According to our response parameters, the decreased levels of cholesterol (80% of normal lamb) and fat (40% of normal lamb) cause demand to increase dramatically. At the resulting equilibrium, with lamb imports fixed at 29,000 metric tons, prices increase to $4.66 and $4.47/kg for untreated and moisture-enhanced CLPG, respectively.

Table 3. Base data, elasticities, and response parameters

| | World | U.S. |
|---|---|---|
| 1997 data | | |
| Supply, 1,000 MT | 6,396.4 | 107.3 |
| Demand, 1,000 MT | 6,367.3 | 136.4 |
| Net imports, 1,000 MT | –29.1 | 29.1 |
| Price, $/kg | 3.78 | 3.78 |
| Elasticities | | |
| Supply | 0.35 | 0.8 |
| Demand | –.28 | –.7 |
| Income | .6 | .6 |
| Response parameters | | |
| Cholesterol | –1.0984 | –1.0984 |
| Fat | –1.1011 | –1.1011 |

Table 4. Short- and intermediate-run simulation results

| | No demand response | | | | Demand response included | | | |
|---|---|---|---|---|---|---|---|---|
| | Not moisture-enhanced | | Moisture-enhanced | | Not moisture-enhanced | | Moisture-enhanced | |
| | World | U.S. | World | U.S. | World | U.S. | World | U.S. |
| | Short-Run results | | | | | | | |
| Supply, 1,000 MT | 6,396.4 | 117.4 | 6,396.4 | 125.5 | 6,396.4 | 142.6 | 6,396.4 | 150.6 |
| Demand, 1,000 MT | 6,367.3 | 146.5 | 6,367.3 | 154.6 | 6,367.3 | 171.7 | 6,367.3 | 179.7 |
| Price, $/kg | 3.78 | 3.55 | 3.78 | 3.36 | 3.78 | 4.66 | 3.78 | 4.47 |
| Net imports, 1,000 MT | –29.1 | 29.1 | –29.1 | 29.1 | –29.1 | 29.1 | –29.1 | 29.1 |
| Cholesterol | | | | | | 80% | | 80% |
| Fat | | | | | | 40% | | 40% |
| Price change, % | 0 | –6.20 | 0 | –11.11 | 0 | 23.09 | 0 | 18.18 |
| Added profit, million $ | 0 | 42.9 | 0 | 42.3 | 0 | 210.1 | 0 | 222.6 |
| | Intermediate-Run results | | | | | | | |
| Supply, 1,000 MT | 6,393.0 | 122.6 | 6,390.2 | 134.8 | 6,409.1 | 123.3 | 6,406.4 | 135.4 |
| Demand, 1,000 MT | 6,379.0 | 136.6 | 6,388.2 | 136.8 | 6,323.7 | 208.7 | 6,333.0 | 208.9 |
| Price, $/kg | 3.78 | 3.78 | 3.77 | 3.77 | 3.81 | 3.81 | 3.80 | 3.80 |
| Net imports, 1,000 MT | –14.0 | 14.0 | –2.0 | 2.0 | –85.4 | 85.4 | –73.4 | 73.4 |
| Cholesterol | | | | | | 80% | | 80% |
| Fat | | | | | | 40% | | 40% |
| Price change, % | –.15 | –.15 | –.27 | –.27 | 1.03 | 1.03 | .91 | .91 |
| Added profit, million $ | 0 | 72.9 | 0 | 105.0 | 0 | 76.6 | 0 | 109.2 |

The price changes have a significant effect on profits. Based on a break-even price for CLPG lamb of $3.18 per kg and $2.99/kg for moisture-enhanced CLPG lamb, producer profits increase substantially. The increase in profits ranged from $42.3 million with no demand response to over $222 million for moisture-enhanced CLPG with a demand response.

The intermediate-run scenario assumes that imports respond to changes in domestic supply and demand. Supply and demand shifts still occur, but imports absorb the net effect with a small effect on price. Given that the United States is a small producer in the world market, the small price effects are reasonable and expected. The United States remains an importer of lamb and mutton under all of the scenarios. Although the predicted effects on prices are small, the effects on profits are still substantial and range from $72.9 million up to $109 million.

The results of the simulation suggest that, in the short run, there are potentially large supply, demand, and price effects due to the introduction of CLPG lamb. There is a corresponding increase in profits due to lower production costs. In the intermediate run, there are relatively large supply and demand effects, but imports adjust to absorb the net effect. Prices are relatively unaffected. However, profits still increase substantially due to lower costs of production for callipyge.

The results, especially profits, are encouraging. However, the model does not account for substitution effects with other meats and assumes that the shift to CLPG in the U.S. is immediate and complete. The model also assumes that the rest of the world does not adopt CLPG technology. This assumption in the intermediate run may be unrealistic because it is likely that producers in other countries would adopt the genetics to lower costs. In the long run, it would be reasonable to assume that many producers in many countries would adopt CLPG to reduce costs.

Given the assumptions embodied in the model, the results may represent an upper bound on profits and prices. If actual consumer response data were available, accurate estimates of consumer preferences for lower cholesterol and fat could be estimated. Nevertheless, the results are encouraging and highlight the need for further research. The actual effect of CLPG lamb attributes, such as a visual appeal, lower fat and cholesterol content, and reduced seam fat, on consumer demand need to be quantified.

## Summary

Callipyge lamb has the potential to decrease the cost of lamb to consumers and increase lamb industry profitability. The cost-basis price of CLPG lamb with no added water and moisture-enhanced CLPG lamb

would be reduced by 15.9 and 20.9%, respectively, compared with N lamb. When expressed on an increased-revenue basis, the value of CLPG and moisture-enhanced CLPG cuts from a 59-kg lamb would be, respectively, 14.2 and 23.4% higher than for N lamb. Industrywide adoption of CLPG could increase intermediate-run U.S. profits by $109 million. These are, however, only potential benefits because many packers are unwilling to purchase CLPG lambs. Packers need to determine whether the costs and effort required to apply a postharvest tenderization procedure in their individual operations are justified by the substantial benefits of CLPG lamb. Further, moisture enhancement has been widely accepted in the pork industry, but studies are needed to determine whether consumers will accept moisture-enhanced lamb.

## Implications

If accepted by packers and consumers, tenderized and(or) moisture-enhanced callipyge lamb has the potential to decrease the cost of lamb to consumers and increase lamb industry profitability. The economic value of lower fat and cholesterol, reduced seam fat, and improved visual appeal of callipyge lamb needs to be quantified.

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