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**A Hedonic Analysis of Sheep and Goat Prices in a Changing Environment: The
Role of Consumers and Implications for Management**

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VERY DRAFT

*Selected Paper prepared for presentation at the American Agricultural Economics
Association*

Annual Meeting, Providence, Rhode Island, July 24-27, 2005

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Introduction

Revenue from lamb sales is an important source of income to small family farms in West Virginia (WV) and the surrounding Appalachian regions because of the proximity to the large Northeast market, the abundance of forage resources and the region's strong heritage of sheep production. Although regional sheep enterprise budgets continue to show positive returns, the industry in this region continues to decline. The emergence and growth of specialty markets for lamb, particularly the 'Halal' ethnic market in the Northeast, appears to have altered long-established patterns in the region in terms of periods of demand and characteristics of the product demanded. It is likely that market values of lamb characteristics may have changed over time such that the market may be offering prices for product characteristics that are significantly different from past patterns. If present, failure to communicate such structural changes to producers results in a failure to alter management practices in order to meet consumer expectations. This deficiency ultimately reduces producer's profitability and exacerbates industry exit.

Demand for goat meat in the Northeast is dramatically increasing among ethnic groups and the health and gourmet food sectors, and has considerable growth prospects. Goat production has the potential to become an economically viable option for small farmers in WV and the wider Northeast region because of their closeness to the growing Northeast consumer base, their lower production costs compared with other livestock, and their potential to convert marginal lands to useful grazing areas. However, limited information is available on the Northeast goat industry to guide producers' management decisions. More specifically, little is known about the specific product attributes or market factors affecting regional variations in prices and number of goats sold.

The agricultural industry is rapidly changing from an industry driven by producers to an industry organized around meeting end-user demand and processor needs. Because the magnitude of premiums and discounts could influence decisions by producers (industry exit, downsizing operations, specific production and marketing decisions), a more detailed look at short-run price relationships in the sheep and goat industry is warranted. Relationships such as price/weight, price/lot size, price/grade,

etc, could be expected to extend knowledge on price relationships in both industries. Sheep and goat producers can use the information gathered from auction markets to assist in the formulation of production decisions (such as weight and grade (condition/finish) at which to sell animals) and marketing decisions (such as lot size determination). The overall objective of this study is to determine if market participants in the live lamb and goat markets in the Northeast region have systematic preferences for specific live product attributes (age, weight, market class, sales lot size, market location and timing of sale) and whether they offer price premiums or discounts for these attributes consistent with their preferences.

This paper is organized as follows: The next section provides some background to the sheep and goat industries in the US. The following sections describe the sources of data and the choice of analytical method, and the results, discussion and conclusions. The paper concludes with some limitations of the study and issues to be addressed in future research.

Background and Objectives

The US Sheep and Goat Industry

The marketing environment for lambs in the Appalachian region and throughout the Northeast is changing (Northeast Sheep and Goat Marketing Program, 2002). Shrinking supplies coupled with declining marketing support services have caused much of this change. Poor market coordination and the fragmentation of traditional marketing channels exacerbate problems associated with limited supplies and lack of uniformity in market offerings (America Lamb Council, 2002). The emergence and growth of specialty markets, particularly that of the ‘Halal’ ethnic market in the Northeast, appears to have altered long-established seasonal price patterns in the region. The results of such changes in the lamb marketing environment appear to have caused the lamb marketing system in WV and the surrounding region to become obsolete and inefficient. The existing marketing system could be ineffective in communicating demand for lambs, in defining differences in the quality and value of the lambs marketed, and in delivering lambs to the market (American Sheep Industry [ASI], 2003).

Product price has been found to be a significant determinant of profitability in the sheep industry (Purcell, 1995). As such, expectation of future sheep market prices is one of several critical factors affecting a producer's marketing alternatives. cursory examination of lamb prices in the US indicates that prices received by WV lamb producers tend to be low relative to other regions and exhibit a considerable amount of variability, but little has been done to delineate the sources of the price variability in WV (USDA Sheep and Goat Summary, 1997-2001).

While previous studies have examined slaughter lamb price differences (Ward, 1998; Ward and Hildebrand, 1993; Jones and Schroeder, 1998; and Ward, 2000), and slaughter lamb marketing differences (Kazmierczak, 1998 and Ward et al., 2000), there is little consensus regarding the factors that affect individual producer's marketing decisions and lamb price differences for smaller markets, such as WV. Results of such an analysis will provide important insights into the management and marketing practices that impact prices and will indicate how producers can better tailor their product offerings to increase profitability. Further, more effective applied research and extension educational efforts could be executed.

Many decisions by producers directly affect the profitability of their enterprise. For example, producers choose which lambs to market based on the attributes of their lambs. Consumer demand is reflected in their willingness-to-pay for certain product attributes, which is in turn captured in the prices dealers and packers are willing to pay for specific slaughter lamb characteristics. Additionally, the interactions of the supply and demand characteristics of a commodity influence seasonal (annual) price patterns. For the sheep industry, such annual patterns are affected by macro-factors such as reproductive seasonality and related production decisions, grain and hay availability and seasonal demand for sheep and lamb products, among others (Purcell, 1995). The annual intra-year price differentials/ranges however, are caused by several micro-factors. Many studies (Alberta Sheep and Wool Commission, 1999; Buccola, 1980; Lambert et al., 1989; and Ward et al., 2001) have determined that when selling finished lambs, seasonality of supply, location of buyers, packer requirements (degree of finish, weight and breeds), animal quality and market conditions, all affect the market price of finished lambs. Whether similar factors affect lamb prices in WV is unknown. To

date, no studies have been specifically directed towards documenting the precise factors that affect the prices received or variations across markets in smaller markets such as that found in WV. It is therefore necessary to understand how the above factors interact to determine market value for lambs, and ultimately, the price that producers receive in smaller markets. Further, it is likely that market values of lamb characteristics have changed over time such that the market may be offering prices for characteristics that are significantly different from past patterns. Whether such structural changes have affected market relationships relevant to the determination of prices received by lamb producers in WV is unknown. However, as the speed of price adjustment and responsiveness to new information are important factors impacting the viability of the WV sheep industry, it is necessary to identify the factors affecting price differences, but to also determine if these relationships have changed over time.

The meat goat industry is the fastest growing animal industry in the United States (US). The US goat industry is predominantly an infant industry with considerable growth potential. Sales of goat meat (chevon) throughout the US and particularly in the Northeast have risen dramatically since the early eighties and are at an all time high. The Northeast market is the largest consumer base for chevon with demand emanating from ethnic markets, and the health and gourmet food sectors. Because of the persistence in maintaining cultural practices, the demand for goat meat among ethnic groups is thought to be relatively inelastic. Further increase in demand is projected as the size and purchasing power of ethnic populations grow. Growth potential also exists in the health and gourmet food sectors because of the unique taste and relative 'healthful' nature of goat meat. However, many goat producers nationwide are limited by the availability of accessible markets, suitable and sufficient land and technical know how. Such limitations can depress or delay supply response, even in the face of favorable prices.

Goat production has the potential to become an economically viable option for small full-time farmers and the growing number of part-time farmers in the Northeast region. Several factors support this assumption, including increasing demand in the Northeast, lower cost of production compared with other livestock, and the ability of goats to effectively utilize poorer quality forage.

Pennsylvania (Philadelphia), New York, New Jersey and Washington DC (the urban Northeast) are major goat meat consumption areas within the Northeast. West Virginia (WV) is well positioned geographically to supply goats to these areas with high demand. However, an inadequate supply of chevon year round, low prices, as well as inconsistencies in meeting specific consumer preferences limit the expansion of the goat meat industry in the Northeast. Overall, limited information is available on the Northeast goat industry, research and extension is lacking, as is appropriate information to guide producers' management decisions.

Analyses of a price series and development of hedonic price models for the lamb and goat industries in WV and surrounding areas will help explain price relationships and price differentials among live lamb and goat prices in WV (Ward, 1998; Ward and Hildebrand, 1993; and Ward, 2000). Observing and studying such price patterns over time will help producers to identify those product attributes most important to consumers and help producers improve management and marketing decisions by knowing and meeting desired product and market characteristics. In so doing, producers directly impact the price they receive for end-products.

Growth of Ethnic Markets and Implications for the US Sheep Industry

Ethnic markets are becoming an increasingly important market segment for lambs for the Northeast region. The Jewish population is considered a traditional consumer base for lamb in the US, while in recent years, the growing Muslim market has influenced lamb markets across the Northeast. The National Jewish Population Survey 2000-01, placed the U.S. Jewish population at 5.2 million, down 5 percent from 1990 (United Jewish Communities, 2002). In contrast, estimates of the U.S. Muslim population vary widely, ranging anywhere from 1 to 7 million (Kosmin et al., 2001). The American Religious Identity Survey conducted in 2001 estimated that during the period 1990-2000, the U.S. Jewish population decreased by 10 percent while the U.S. Muslim population more than doubled, increasing by 109 percent (Kosmin et al., 2001). By the year 2010, the U.S. Muslim population will surpass the U.S. Jewish population - with Islam becoming the second largest organized religion in the U.S., following Christianity (Power, 1998).

If the Muslim population and markets in the region do in fact continue to grow, they could have a pronounced effect on long-established regional demand and supply patterns, and by extension, price patterns. Retail sales of lamb and goat products to ethnic communities in the US are seasonal in nature, tied to religious holidays. Consumers in niche markets, especially in the Northeastern ethnic markets, also vary in their preferences for specific weights, especially the ethnic eastern markets. For example, some ethnic consumers require a lighter lamb or goat for cultural/religious purposes while the conventional markets require a heavier carcass.

Factors Affecting Price Differentials

Analysis of the factors affecting price differentials can help producers identify management practices that may directly impact the price they receive for their livestock. For example, in a study of cattle prices, weight, lot size, health, pregnancy, grade, dressing percent, breed, time of sale, and market location were found to be important factors in short-term price variability for cows across lots on a given day (Mintert et al., 1990). Ward (2001) found that the nature of cattle production differed by geographical location, and this together with different supply and demand conditions gave rise to very different market conditions, even between markets separated by no more than 50 miles. Similar studies (Alberta Sheep and Wool Commission, 1999; Mintert et al., 1990; Lambert et al., 1989; Buccola, 1980; and Ward, 2001) have determined that when selling finished lambs, seasonality of supply, location of buyers, packer requirements (degree of finish, weight and breeds), animal quality and market conditions, all affect the market price. However, many WV sheep producers have complained that lamb prices in WV are relatively low and exhibit variability (Figure 2.6 shows monthly US slaughter lamb prices averaged \$2.36 in 2001). Such variations complicate marketing decisions of a sheep producer who is assessing short run market trends before determining appropriate market actions. Further, no recent studies have been done to determine if changes in the market requirements have occurred. For instance, current consumer demand research has indicated the existence of different market specifications with regard to lamb product offerings for different market

segments; the emerging ethnic markets may require a lighter, leaner lamb. Targeting such specifications in the market can result in higher prices for WV farmers.

Profitability considerations require looking beyond prices. Virginia Extension Service budget analyses have shown that the production of heavier lambs (110 -125 lbs) generates more income than lighter lambs. Purcell (1995) reports that although budget analyses have shown that the production of heavier slaughter lambs weighing 110-125 lbs generates more income than the production of lighter lambs, significantly higher prices obtained for lighter lambs compared to heavier lambs could erode differences in gross value between the market classes. Additionally, in marketing lambs, the distance to market is reflected in marketing costs. In addition to the direct cost of transporting lambs to a market, other costs must be considered. Both weight loss and stress during transport can lead to shrinkage and loss of finish; the end-result being a lower price received per lamb.¹ Producers must weigh the associated transportation cost, which includes carcass shrink and commensurate finish losses, against the higher prices received at the market in determining profitability.

Objectives

The overall objective of this study is to determine if buyers of live lambs and goats in the Northeast region have systematic preferences for specific live product attributes (age, weight, market class, sales lot size, market location and timing of sale) and whether they pay significantly different prices for these attributes consistent with their preferences. As a preliminary step, the lamb market is examined to determine if any significant industry changes occurred during the period of the study to change market value for lamb characteristics. Answers to these questions can have implications for producers in terms of selecting management and marketing strategies appropriate for targeting the intended market.

¹ A weight loss of 3-5 pounds per lamb is not uncommon during transport to market.

Materials and Methods

Sources of Data

Sales transactions from auction markets in Virginia, Pennsylvania and West Virginia for the period 1994-2003 for lambs and 1999-2003 for goats were used for this analysis. For the lamb prices, a statistical test of structural change was made to determine if significant changes occurred in the sheep industry during 1994-2003. A hedonic price model was then fitted to determine the factors influencing lamb prices. Similarly, a hedonic price model was fitted to determine the factors influencing goat prices, but no test for structural change was conducted since none was warranted. Sale transactions data for WV Livestock Auction Markets from 1994-2003 were obtained from the West Virginia Department of Agriculture (WVDA). Sales transaction data were collected for the New Holland, Pa. livestock auction market as reported by the New Holland Sales Stables, Inc. for 1994-1999. Data for the total number sold and prices received by Pennsylvania sheep and goat producers for all market outlets from 1994-1996 were obtained from the Pa. Agricultural Statistics Service.

Description of the Data

Data analyzed included lamb and goat sales transactions collected weekly by the WV Department of Agriculture from licensed public stockyards and auctions in West Virginia, including Alderson/Caldwell (Al/Ca), Buckhannon (Bu), Elkins (El), Ripley (Rp), Beckley (Be), Wheeling (Wh), Mineral Wells (Mi), Marlinton (Ma), Terra Alta (Te), Moorefield (Mo), Spencer (Sp), Weston (We), and Riverton (Rv). The data from each market included price, number sold, time of sale (year, month, and week), location of sale, and category of animal sold. This study uses a monthly average of these weekly prices.

The WV auction markets routinely grade lambs offered for sale as either slaughter or feeder lambs. The grades reflect both the weight of the lamb (live weight) and the anticipated carcass grade based on USDA standards. In general, “blue” lambs are slaughter lambs expected to grade USDA Prime or Choice, and “red” lambs are feeder or lower-yielding lambs expected to grade USDA Choice or Good (see

Appendix A). Information on these livestock auction markets are contained in Appendix B. Prices were reported for six categories of lambs sold:

- Category 1 Slaughter Lambs 100-125 lbs
- Category 2 Slaughter Lambs 85-100 lbs
- Category 3 Slaughter Lambs <85 lbs
- Category 4 Feeder Lambs 85-100 lbs
- Category 5 Feeder Lambs 70-85 lbs
- Category 6 Feeder Lambs <70 lbs

In contrast, in terms of grading or classification of lambs, the livestock auction markets in Virginia and New Holland, Pa., generally report all lambs marketed as “slaughter lambs”, regardless of weight and degree of finish. In addition, the weight ranges reported by these markets are slightly different from those reported in WV.

Demand for lambs sold at the auctions and stockyards included in this study is comprised of demand for slaughter and feeder lambs suitable for use as flock replacements as well as for slaughter and/or fattening. Data detailing buyers’ intended uses for the lambs and sheep were not available, making it impossible to identify differences in the impact of various characteristics on lamb prices depending on the type of demand for the lambs. As a result, the price effects of some lots of lambs may have differed between packer/dealer buyers and those bidding on lambs for fattening or to retain for breeding purposes. However, personal communications with managers of stockyards have suggested it is likely that the majority of the lambs included in this study were purchased for slaughter purposes, not as stock for feedlots or as potential herd replacements. Therefore, the use of the categories ‘slaughter’ and ‘feeder’ lambs are mainly to denote weight classifications rather than intended use of the lamb sold.

Similar information was collected for the goat auction market except that prices were reported for five different categories:

- Category 1 ‘Choice and Prime’ Goats 30-50 lbs
- Category 2 ‘Choice and Prime’ Goats 50-80 lbs
- Category 3 ‘Good’ Goats 30-50 lbs
- Category 4 ‘Good’ Goats 50-80 lbs
- Category 5 “Aged’ Goats >80 lbs

Analytical Methods

Markets require information in order to operate efficiently but also create other information as they function. A hedonic price function relates the price of a product (good or service) to the various attributes or characteristics embodied in the good. Hedonic price analysis therefore, extracts information from markets and provides that information back to market participants. The underlying hypothesis of such analysis is that products have utility bearing attributes and that the values of those attributes contribute to the price of the product. The observed price of the product is therefore a composite of the implicit values of the product's attributes (Jabbar, 1997; Ethridge, 2002, Agbola et al., 2002). Among the earliest applications of hedonic analysis in agricultural products was by Taylor (1916) on the values of quality attributes in cotton and by Waugh (1928) on quality factors influencing vegetable prices. Currently, hedonic analysis is used to assess quality attributes of other agricultural commodities as well as products in all industries. Economists have yet to satisfactorily merge hedonic price theory and classical price theory, although progress has been made (Ethridge, 2002).

Why is it important to have more accurate and complete information about lamb and goat prices and price premiums for certain attributes? For the sheep industry, there is no mechanism available to coordinate attributes produced with those needed across markets. It is particularly important for the goat industry, which because of its infancy, has little recorded information to guide producers' management and marketing decisions. It is important that someone discern this information because the market does not directly reveal the values of the attributes embodied in the good/commodity (Ethridge, 2002).

A recap the basic tenets of hedonic theory follows based, on Agbola et al., 2002; Sheppard, 1997; Wahl et al., 1995; and Kolstad, 2000. On the demand side, assume a consumer demands a good based on the utility provided by a vector of characteristics (Z) of the good. Assume a fixed income (M) and a price function $P(Z)$, where the price of the good is a function of the characteristics embodied in the good. Assume the customer maximizes utility subject to the budget constraint. The utility function is represented by

$$u = u(Z, Y, a)$$

where $u(\cdot)$ is the utility derived from consuming the good; Z is a vector of the characteristics of the good; Y is a composite of other product consumed by the customer and a is a vector of observed and unobserved parameters, which characterize the preferences of the customer. An optimizing customer will consume the good with characteristic Z by solving his utility maximizing problem:

$$\max_{Z, Y} u = u(Z, Y, a) \quad \text{subject to} \quad (1)$$

$$M = P(Z) + Y \quad (2)$$

The Lagrangean can be expressed as

$$L = u(Z, Y, a) - \lambda (M - P(Z) - Y) \quad (3)$$

The first-order conditions for this problem is

$$\frac{\partial L}{\partial Z} = \frac{\partial u(Z, Y, a)}{\partial Z} + \lambda \frac{\partial P(Z)}{\partial Z} = 0 \quad \text{and} \quad \frac{\partial L}{\partial Y} = \frac{\partial u(Z, Y, a)}{\partial Y} + \lambda = 0 \quad (4)$$

$$\text{From the above first-order conditions, } \frac{u_Z}{u_Y} = P_Z \quad (5)$$

where $u_Z = \partial u(\cdot) / \partial Z$, $u_Y = \partial u(\cdot) / \partial Y$ and $P_Z = \partial P(Z) / \partial Z$.

The buyer's bid function (maximum price consumer is willing to pay for Y units of a good with characteristics Z and income Y) can be expressed as

$$P(\cdot) = P(Z_1, Z_2, \dots, Z_m; Y, a) \quad (6)$$

where $Z(Z_1, Z_2, \dots, Z_m)$ is a vector of the characteristics of the good, and the other variables as described above. From equations (5) and (6), it can be shown that the derivative of the bid function with respect to a characteristic, $\partial P / \partial Z$, in equation 6 is equal to the hedonic price in equation 5.

On the supply side, assume that a producer supplies a heterogeneous good with a cost function given by $C(\cdot)$, the producer's profit function can be expressed as

$$p = P(Z)N - C(Z, N, \theta) \quad (7)$$

where $p(\cdot)$ is profit earned by the producer, Z is the characteristics of the good, N is the amount of the good supplied and θ are the parameters which characterize each producer. From equation (7), an optimizing producer will supply the good with characteristics Z by solving the profit-maximizing problem

$$\max_{Z,N} P(Z)N - C(Z, N, \theta)$$

where the variables and parameters are defined as above. The first-order conditions are

$$\frac{\partial p}{\partial Z} = \frac{\partial P(Z)N}{\partial Z} - \frac{\partial C(Z, N, \theta)}{\partial Z} = 0 \quad \text{and} \quad \frac{\partial p}{\partial N} = P(Z) - \frac{\partial C(Z, N, \theta)}{\partial N} = 0 \quad (8)$$

$$\text{From equation 8, } P(Z) = C_N \text{ and } P_Z = C_Z \quad (9)$$

Where $C_N = \partial C(\cdot) / \partial N$, $P_Z = \partial P(Z) / \partial Z$ and $C_Z = \partial C(\cdot) / \partial Z$.

The expressions given in equation (9) indicate that a profit-maximizing producer equates the marginal cost of each characteristic to its hedonic price and continues to increase production until the marginal cost of producing an additional good is equal to the value of the good. The seller's offer function (minimum price the seller is willing to accept for supplying N units of a good having characteristics level Z) can be specified as

$$F(\cdot) = F(Z_1, Z_2, \dots, Z_m; N, \theta) \quad (10)$$

where N is the quantity of good, z is a vector of characteristics and θ is the parameter vector whose value reflects factor prices and production technology. The derivative of the seller's offer function in equation (10) with respect to any characteristic, $\delta F / \delta Z_i$, yields the seller's marginal implicit offer from an additional amount of that characteristic.

In summary, equilibrium in the hedonic market is reached when the buyer's marginal bid equals the seller's marginal implicit offer for the good. This equilibrium point is represented by a locus of tangencies between a series of marginal cost curves and the bid curves, and is also referred to as the hedonic price function. The hedonic price function is formalized as

$$P(Z) = f(Z_1, Z_2, \dots, Z_m) \quad (11)$$

where P(Z) is the price if a good and $z(z_1, z_2, \dots, z_m)$ is a vector of quality characteristics of the good.

Empirical Model Specification/Functional Form

The accuracy of the derived implicit prices hinges on the accuracy of the functional form (i.e., mathematical form or model structure) specified. General supply

and demand forces determine the general level of prices in any given period, but the mix of other product attributes determine the implicit prices of these attributes. Conceptualizing the functional form for hedonic models *a priori* can be difficult because of an absence of a theoretical basis. Unlike general pricing models where price is determined by supply and demand variables, hedonic models determine implicit prices of specific attributes embodied in a product on the basis of the value (utility or productivity) end-users ascribe to these attributes (Brown and Ethridge, 1995; Jabbar 1997; and Agbola et al., 2002).

Most hedonic regression models use a set of quantitative (continuous) variables, a set of qualitative (discrete) variables in the form of dummies, and in some cases, a set of interaction variables. For quantitative variables in the regression, the respective partial derivative of the function represents the implicit marginal attribute price. The estimated coefficient in qualitative variables measure the impact of the presence of the given attribute, but the implicit (predicted) price cannot be derived directly and required further manipulation. Further, the use of several qualitative variables with many categories requiring many dummy variables and several interaction terms results in a large number of terms in the equation and complicates interpretation (Jabbar, 1997).

An alternative is to use Analysis of Covariance (AnCov) technique, which is a combination of linear regression and analysis of variance (ANOVA). In the Ancov technique, the results are adjusted for the linear relationship between the dependent variable and the factors (qualitative variables) and covariates (quantitative variables). In principle, both linear regression and Ancov techniques perform the same function except that AnCov technique allows for more direct interpretation and comparison of differences between categories of a factor (Gujarati, 1988). The general explicit form of the AnCov model may be written as:

$$P = F(Q,C) + U \tag{12}$$

where P is the observed price of the product, Q is a set of factors, C is a set of covariates, and U is a residual error term. Interactions terms may be included as needed. According to Jaffar, (1997) and Gudjarati, (1988), the estimate parameters of the model can be used to estimate the adjusted mean prices of different categories of the product; when coefficients are not homogeneous, the effect of the adjustment will be

different for different values of the covariate to which groups are equated. Also, because of joint confidence intervals, differences among categories of a factor can be estimated.

The attributes that may impact the price for lambs and goats include weight, category, location, sale size, and timing of sale. The empirical hedonic price models for lambs and goats are specified as equations 913) and (14), respectively:

$$P_{Lijkmn} = \alpha_1 + \alpha_{2i}WGT_i + \alpha_{3i}WGT_i^2 + \alpha_{4j}LOC_j + \alpha_5 SIZE + \alpha_6 SIZE^2 + \alpha_{7k} TIME_k + \alpha_{8m} YEAR_m + \varepsilon_{Lijkm} \quad (13)$$

$$P_{Gijkmn} = \beta_1 + \beta_{2i}WGT_i + \beta_{3i}WGT_i^2 + \beta_{4j}LOC_j + \beta_5 SIZE + \beta_6 SIZE_k^2 + \beta_{7k} TIME_k + \beta_{8m} YEAR_m + \varepsilon_{Gijkm} \quad (14)$$

where P_L and P_G represents the price of lambs or goats in the i^{th} WGT (weight category), j^{th} LOC (market location), m^{th} TIME (month), and n^{th} YEAR (year), for specific SIZE (total number of animals for sale); α_1 and β_1 are the constant intercept terms for equation (13) and (14), respectively; $\alpha_1 - \alpha_8$ and $\beta_1 - \beta_8$ are the regression coefficients for equation (13) and (14), respectively; and ε_{Lijkm} and ε_{Gijkm} are the random residuals for equations (13) and (14) respectively, with null mean and variance σ^2 . Table 1 presents all variable definitions and measurements. The hypothesis that the impact of the above independent variables (factors and covariates) on price for the sheep model (equation 13) changed during the sample period was tested by dividing the sample period into two periods, 1994 - 1997 and 1998 – 2003. The model was estimated separately for the two time periods using the AnCov procedures of SAS (Statistical Analysis System) (SAS Institute, 1988).

A Chow test was used to test the hypothesis that the variable estimates from the two models were equal (Chow, 1960). The following steps are required for the Chow test: 1) run a single pooled regression for 1994-2001 (Equation 13) and obtain the residual sum of squares (RSS_1); 2) run individual regressions for each period (1994-1997 and 1998-2003) and obtain RSS_2 and RSS_3 , and create a summation of these RSS_4 ($RSS_4 = RSS_2 + RSS_3$); 3) calculate the difference between RSS_1 and RSS_4 ($RSS_5 = RSS_1 - RSS_4$); and 4) compute an F-value using RSS_4 and RSS_5 . If the computed F-

value exceeds the critical F, then the hypothesis that the two regressions are the same can be rejected (Gujarati, 1988; Turner et al., 1992).

Preliminary Results

In this paper, given the non-linear specification of the hedonic price model, the coefficient of the attribute variables can be interpreted as dollar premiums or discounts per unit change in their measurement value (Agbola, 2002; Turner et al., 1991). The marginal implicit values and price flexibilities with respect to specific attributes of live lambs and goats estimated at the mean values of each variable are presented in Table 2 and 3 for lambs and goats, respectively. Only significant variables are reported. The residuals were inspected for heteroscedasticity, but no evidence was apparent.

Mean annual changes in WV lamb prices data from 1994-2003 points to potential price by year by category interactions (Figure 1). During 1994-1997, significantly higher prices (approximately \$5/100 lbs) were received for slaughter lambs; however, during 1998-2003, prices were significantly higher for feeder lambs (approximately \$11/100 lbs) compared to slaughter lambs. The summary results for the Chow Test for the lamb price model are presented in Table 2. Both models explain 62% of the price variation adjusted R^2 , (adjusted R^2 of .61 and .63 for 1994-1997 and 1998-2003 models, respectively). In the 1994-1997 model, 1995 was used as the base year and the dummy variables for 1994, 1996 and 1997 were all significant ($P < 0.05$). The 1998-2003 model used 2001 as the base year, and the dummy variables for 1998, 1999, 2000, 2002 and 2003 were significant. Thus, the hypothesis that the parameter estimates for the two models were equal could be rejected ($P < 0.05$).

The relationship between lamb prices received and weight classes is significant. The heaviest slaughter weight category (100 -1125 lbs) was used as the base. Lighter-weight slaughter lambs and all weight classes of feeder lambs brought significant discounts in the earlier period while heavier slaughter lambs brought significant premiums. In the latter period, the premiums for heavier lambs dissipated dramatically, with premiums paid for lighter-weight lambs; all prices were higher compared to the base period.

The results showed similar trends for goat prices. Prices received for goats in category four (50-80 lb 'good' goats) was used as the base for comparison. Prices for goats in categories 1 – 3 were significantly higher than the base group, indicating some preference for better conditioned animals and lighter weights. Animals in category five (aged animals) received considerable discounts compared to the base group, which may be attributed to over-conditioning and heavier weights.

The effect of the number of animals (both lambs and goats) for sale and number of animals squared on prices received was significant. This means that premiums were paid for larger groups of lambs and goats, but premiums increased at a decreasing rate. This result is somewhat unexpected; supply and demand relationships dictate that prices decrease as supply increases. The results reflect the trends towards premiums for larger lots of animals, and suggest that some potential exists for enhancing profitability through pooling lambs and goats among smaller producers.

The month of sale was aggregated into several groups (quarterly) on the basis of test runs which showed that prices were similar during certain quarters for the price models for both lambs and goats. The Oct. – Dec. quarter was used as the base period and results for the two time periods (1994-1997 and 1998-2003) were similar. Compared to the base period, prices in Jan. – Mar were significantly higher. Prices during Apr. – June were significantly higher but falling compared to the base period. Prices during July to Dec. were significantly lower than the base period. Some attempt to link the trends in prices to the 'Halal' market is shown in Figure 2.

The location variable tended to significance for both the lamb and goat models, with prices received differing among market locations (results not shown). Prices of lambs available for sale differed significantly ($p < 0.01$) by market location independent of the number of lambs available for sale. However, a more important finding was the price relationship between market and month as shown in Figure 3. Wider fluctuations were observed for prices received during the first two quarters of the year, indicating possible fierce competition for available animals when supply was limited. During the last two quarters of the year when animal availability is greatest, fluctuations between markets in terms of prices received were lower. This points to possible significant

interactions between the market by month categories, which should be included in future improvements of the current price models used.

No statistically significant differences were obtained for year-to-year prices so these results are not reported.

Preliminary Discussion and Conclusion

The results of the study suggest that, in terms of prices received by sheep and goat producers, economic differences were present and were significant. These differences have long-range marketing and economic consequences.

The existence of significant 'Market Class by Year' interactions for WV lamb prices is an important finding. The results indicate that from 1994-1997, highest prices were received for heavier slaughter lambs (100-125 and 85-100 lbs). After 1997, highest prices were observed for lighter feeder lambs (70-85 and <70 lbs), which suggest that a structural change in the WV lamb auction market occurred between 1994-1997 and 1998-2003 in the price-category relationship for slaughter and feeder lambs. This structural change could be attributed to: 1) changing consumers tastes and preferences, such as a demand shift toward a leaner product for health reasons; 2) growth of the regional ethnic markets, which requires a lighter, leaner carcass; and/or 3) response to increasing imports from New Zealand and Australia, which flood the market with heavier carcasses in the >90 lbs range. Whatever the cause of the change, producers must alter their production and marketing strategies to adapt to these industry changes in order to increase their competitiveness. Producing lambs that meet these consumer requirements could contribute to producers' profitability by ensuring that supply matches demand.

Further, the negative price margin for heavier lambs and goats is an important factor in determining the value of gain resulting from a production practice that increases the weight of the final product. The price premiums for carcass weight and/or carcass quality (degree of fat cover) can be secured through careful management and marketing of lambs and goats. The speed of production and marketing changes as well as the speed of price adjustment and responsiveness to this new information may determine the viability of the both industries.

The higher prices received for lighter feeder lambs and lighter-weight goats support the view that consumers required a leaner product and/or a smaller cut. However, such preferences, or their associated potential profitability, are not sufficiently transmitted back to producers, such that, heavier and fatter animals are still being produced in greater quantity than lighter-weight animals. In the past, higher profits were linked to producing and processing heavier lambs that were often over-finished; heavy lambs returned more per ewe to the producer, were more profitable for the feeder and are more efficient to process, but the increased profits may be small when one considers the decline in lamb consumption due to fatter cuts, and the consistently higher prices observed for leaner, lighter carcasses since 1998. Overall, decreased consumer demand for lamb cuts with excess external fat counters the production and processing efficiencies of heavy, fat lambs, and may actually compound the overall industry decline. The same is assumed to apply to the market for goats.

The reduced supply of lighter-weight feeder lambs coupled with increased demand for this category of lamb is reflected in the relatively larger premiums paid for lightweight lambs than for slaughter lambs. Two implications flow from a divergence in the implicit prices of attributes such as weight, and is applicable to both the sheep and goat industries. First, the existence of such a divergence suggests that there may be gross benefits to the industry from developing a system of weight and grade or description selling. The size of the benefit would be related to the extent of the price divergence coupled with the reduced (increased) production costs associated with feeder (slaughter) lambs. Recognizing and analyzing these signals correctly can help a producer determine which weight may be more profitable to sell and whether or not to hold the lambs to a heavier weight. Second, producers should link production decisions about weight with the decision about whether the lambs are to be sold through an auction market or through a system in which the implicit prices of attributes are more closely related to consumer valuations of these attributes, such as direct markets.

If producers are to be properly rewarded for value and are to make prompt responses to market adjustments, price changes at any level of the marketing system must be quickly and completely transmitted to all other levels. The failure of producers to increase production in response to price signals could be due to an inefficient

marketing system. Shifting to greater price efficiency necessitates moving from average pricing (pricing for an entire lot of animals) to more value-based pricing (pricing based on individual animal characteristics) and ensuring the correct economic signals are sent from retail-wholesale markets to producers. Price incentives ensure that producers will be adequately rewarded for producing higher quality/more targeted specifications to meet the needs of consumers while simultaneously being properly discounted for producing lower-quality animals. It is likely that pricing efficiency improvements can induce marketing efficiency if producers can identify the types of animals they are producing and sell them at a market that rewards those attributes.

The efficiency of the pricing system and the timeliness of price responses to rapid supply changes and other factors impact producers' abilities to respond to economic incentives. Possible constrictions in the marketing channels and the resultant failure of preference signals to be efficiently transmitted back to producers could contribute to producers' reluctance or inability to produce market offerings consistent with consumer demand. Producers should learn more about the type of animal they produce and then use that information to make management and genetic improvements and to select profitable markets for their product offering.

Producers who recognize and utilize the widest set of alternative marketing methods have the best chance of improving the profitability of their enterprise. An effective marketing method might provide more market power and control to the producer and consequently play a key role in determining overall profitability. Small and medium-sized producers may pool their animals with those of other producers for transportation to a distant market and/or for improved marketing considerations offered to larger volumes. Carefully timing production and marketing dates can help capitalize on the price premiums available at strategic time of the year. However, the full potential of the market will only be realized when there is some integration of weight and finish condition, increasing lots size, and timing production and sales.

Limitations and Future Research

This study was limited by the absence of quality attributes in the secondary data used. To truly be deemed a 'hedonic' analysis, this study needs to include quality

attributes based on intended use (restaurant, religious, processing), including condition (good, choice, prime), frame size (large, medium, small), muscling (grades 1, 2, 3), and meat characteristics (fat content), among others.

This study did not identify the singular most efficient functional form, but rather, used the form common to the cattle industry (Faminow and Gum, 1986). Future research should include illustrations of other functional forms that may be appropriate, based on analysis of residuals performed on alternate functional forms. Residual analysis conducted in this manner ensures the absence of structural error and a functional form model that can accurately represent the pricing structure. This will provide some objectivity to the discovery process required to identify appropriate functional forms.

This study should also be expanded to include some other interactions that may provide some more insight into the sheep and goat industry, including location by month interactions and weight by month interactions.

Summary

Revenue from lamb sales is an important source of income to small family farms in West Virginia (WV) and the surrounding Appalachian regions because of the proximity to the large Northeast market, the abundance of forage resources and the region's strong heritage of sheep production. The emergence and growth of specialty markets for lamb, particularly the 'Halal' ethnic market in the Northeast, appears to have altered long-established patterns in the region in terms of periods of demand and characteristics of the product demanded. It is likely that market values of lamb characteristics may have changed over time such that the market may be offering prices for product characteristics that are significantly different from past patterns. If present, failure to communicate such structural changes to producers results in a failure to alter management practices in order to meet consumer expectations. This deficiency ultimately reduces producer's profitability and exacerbates industry exit.

Demand for goat meat in the Northeast is dramatically increasing among ethnic groups and the health and gourmet food sectors, and has considerable growth prospects. Goat production has the potential to become an economically viable option for small

farmers in WV and the wider Northeast region. However, this potential is limited by a lack of information to guide producers' management decisions. More specifically, little is known about the specific product attributes or market factors affecting regional variations in prices and number of goats sold.

The overall objective of this study is to determine if buyers of live lambs and goats in the Northeast region have systematic preferences for specific live product attributes (age, weight, market class, sales lot size, market location and timing of sale) and whether they pay significantly different prices for these attributes consistent with their preferences. Sales transactions from auction markets in Virginia, Pennsylvania and West Virginia for the period 1994-2003 for lambs and 1999-2003 for goats were used for this analysis. For the lamb prices, a statistical test of structural change was made to determine if significant changes occurred in the sheep industry during 1994-2003. A hedonic price model was then fitted to determine the factors influencing lamb prices. Similarly, a hedonic price model was fitted to determine the factors influencing goat prices, but no test for structural change was conducted since none was warranted.

In general, the results indicate the presence of structural change in the lamb market for WV, Virginia and Pennsylvania. The results indicate that both lamb and goat buyers have systematic preferences for specific weight, market class and timing of sale, and that these preferences are implicitly reflected in prices offered in traditional auction markets. Producers can capitalize on price differences based on these attributes by targeting specific weight and market class categories and by better timing production and marketing undertakings.

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Figure 1: Mean Annual Lamb Prices for Slaughter and Feeder Lambs (1994-2003)

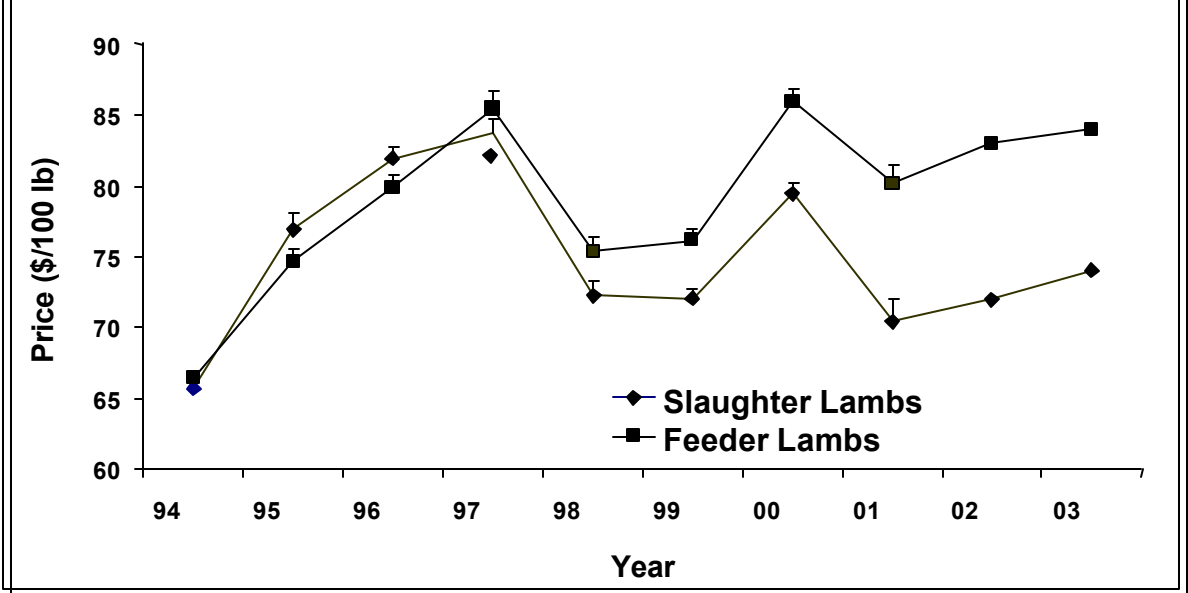


Figure 2: Monthly Changes in Mean Prices of Slaughter and Feeder Lambs (1994-2003)

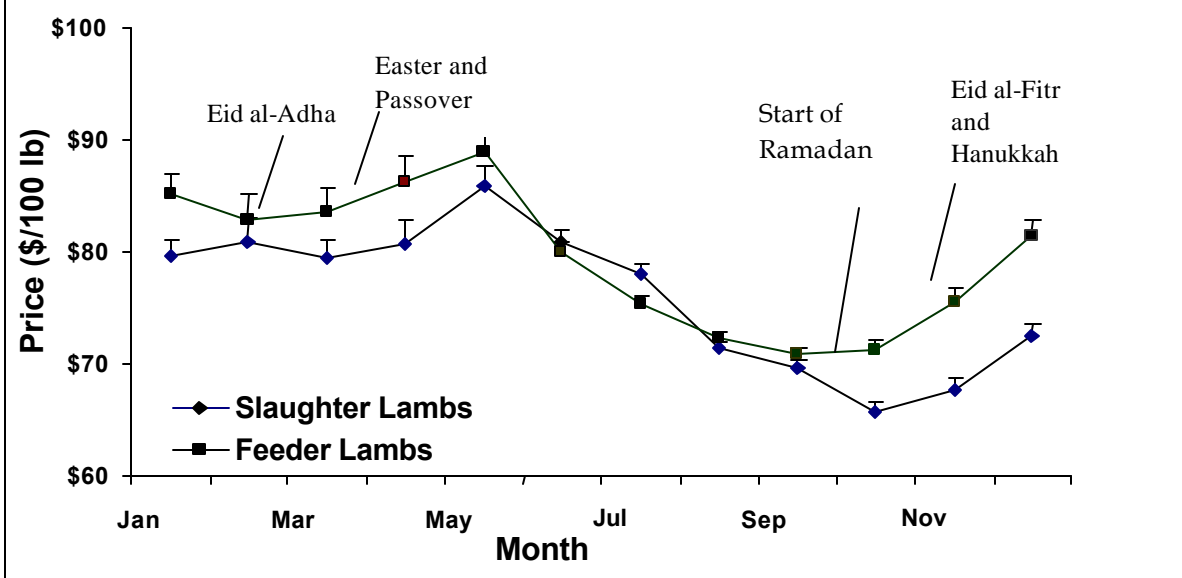


Figure 3: Variations in Monthly Lamb Prices in Selected WV Markets (1994-2000)

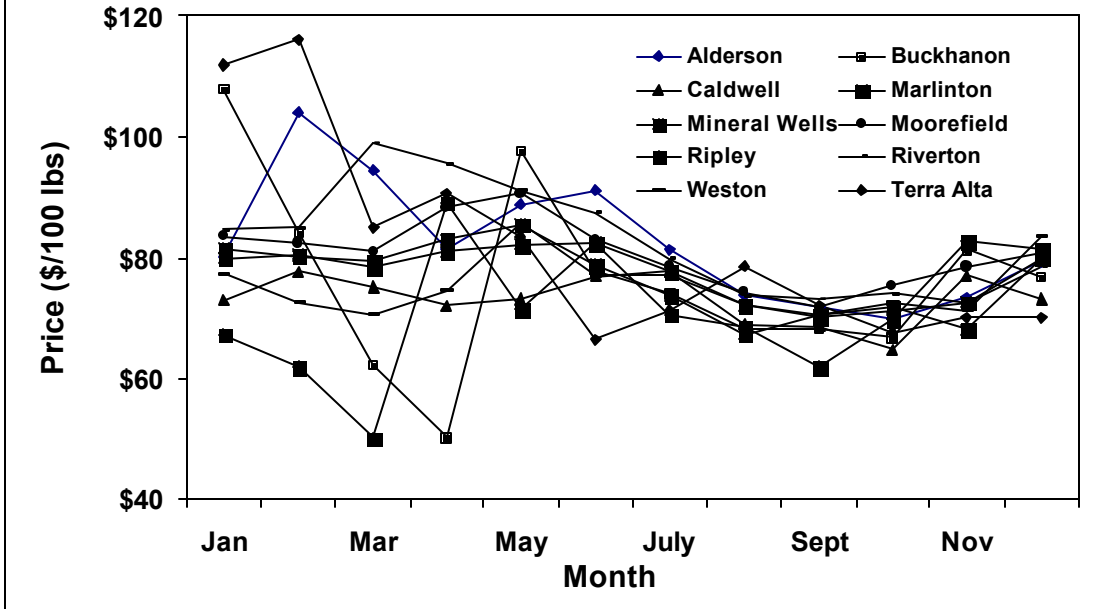


Table 1: Variable Definitions and Measurements for the Lamb and Goat Hedonic Price Models

Variable	Definition	Measurement
$(P_{Lijkm}) WGT_i$	Estimated weight where $i = 1$ if slaughter lambs 100-125 lbs, $i = 2$ if slaughter lambs 85-100 lbs, $i=3$ if slaughter lambs <85 lbs, $i = 4$ if feeder lambs 85-100 lbs, $i = 5$ if feeder lambs 70-85 lbs, and $i = 6$ if feeder lambs <70 lbs.	(\$/100 lbs) 1 if i , 0 otherwise
$(P_{Gijkm}) WGT_i$	Estimated weight where $i = 1$ if ‘Choice and Prime’ Goats 30-50 lbs, $i = 2$ if ‘Choice and Prime’ Goats 50-80 lbs, $i=3$ if ‘Good’ Goats 30-50 lbs, $i = 4$ if ‘Good’ Goats 50-80 lbs, and $i = 5$ if ‘Aged’ Goats >80 lbs .	(\$/100 lbs) 1 if i , 0 otherwise
LOC_j	Location of auction market where $j = 1$ through 13 if Alderson/Caldwell (Al/Ca), Buckhannon (Bu), Elkins (El), Ripley (Rp), Beckley (Be), Wheeling (Wh), Mineral Wells (Mi), Marlinton (Ma), Terra Alta (Te), Moorefield (Mo), Spencer (Sp), Weston (We), and Riverton (Rv), respectively.	1 if j , 0 otherwise
$SIZE$	Number of animals for sale.	Actual no.
$SIZE^2$	Number of animals for sale squared.	Actual no.
$TIME_k$	Auction price for a particular lot where $k = 1$ if Jan. to March, $k = 2$ if Apr to Jun, $k = 3$ if Jul to Sept, and $k = 4$ if Oct to Dec.	1 if k , 0 otherwise
$YEAR_m$	Auction price for a particular lot where $m = 1$ if 1994 to $m = 10$ if 2003.	1 if m , 0 otherwise

Table 2: Parameter Estimates of the Hedonic Price Models for Lambs in WV

Variable	Parameter	1994-1997		1998-2003	
		Estimate	Std. Error	Estimate	Std. Error
Intercept	α_1	168.34	7.54	198.07	6.49
WGT _i	α_{21} (base)	0.054*	4.44	-0.096*	3.98
	α_{22}	0.023*	3.57	-0.034*	4.23
	α_{23}	-0.043*	2.12	0.013*	0.93
	α_{24}	-0.024*	3.11	0.025*	3.41
	α_{25}	-0.033*	1.12	0.034*	.093
	α_{26}	-0.013*	0.96	0.047*	3.22
SIZE	α_5	0.0039*	0.83	0.0021*	0.71
SIZE ²	α_6	-0.00076	0.28	-0.00073	0.45
TIME _k	α_{71}	43.43*	12.24	39.54*	7.34
	α_{71}	-22.33*	9.65	-14.12*	3.43
	α_{71}	-32.33*	5.33	-12.32*	2.35
	α_{71} (base)	43.22*	17.22	23.32*	6.76
R ² -adjusted		.61		.63	
No. of Observations		21640		30576	

* Indicated *t* values are significant at the 5% level.

Table 3: Parameter Estimates of the Hedonic Price Models for Goats in WV

Variable	Parameter	1994-1997	
		Estimate	Std. Error
Intercept	β_1		
WGT _i	β_{21}	0.054*	4.44
	β_{22}	0.021*	11.43
	β_{23}	0.086*	3.23
	β_{24} (base)	-2.32*	0.93
	β_{25}	-0.65*	2.34
SIZE	β_5	0.0039*	0.83
SIZE ²	β_6	-0.00076	0.28
TIME _k	β_{71}	35.41*	4.43
	β_{71}	-12.56*	4.83
	β_{71}	-9.45*	2.15
	β_{71} (base)	24.65*	7.76
R ² -adjusted		.67	
No. of Observations		22560	

* Indicated *t* values are significant at the 5% level.

APPENDIX B

WEST VIRGINIA LAMB GRADE STANDARDS

Official USDA Grading Standards will be used for grading all livestock in West Virginia. Since most sale locations use our grade designations, marks, and sorting services to establish sale lots, it is necessary that sorting, marking, and sale procedures based on a combination of grade, weight, breed, yield, and sex be used in order to be of practical value in establishing sale lots and sale packaging systems rather than grading systems. The following grading and/or packaging systems will be used for all classes of livestock in West Virginia:

LAMBS

Blue Back	Ewe and Wether slaughter lambs that grade Prime or Choice by USDA standards and weigh in the general range of 100 to 125 pounds.
Blue Head	Ewe and Wether slaughter lambs that grade Prime or Choice by USDA standards and weigh in the general range of 85 to 95 pounds.
Blue X	Ram slaughter lambs that grade Prime or Choice by USDA standards and weigh in the general range of 95 to 125 pounds.
Double Blue	Ewe, Wether, and Ram slaughter lambs that grade Prime or Choice by USDA standards and weigh over 125 pounds.
Red Back	Ewe and Wether low yielding slaughter and/or feeder lambs that grade Choice or Good by USDA standards and weigh in the general range of 95 to 125 pounds.
Red X	Ram low yielding slaughter and/or feeder lambs that grade Choice or Good by USDA standards and weigh in the general range of 95 to 125 pounds.
Blue Rump	Ewe and Wether feeder lambs that grade Fancy or Choice by USDA standards and weigh in the general range of 75 to 90 pounds.
Blue Shoulder	Ram feeder lambs that grade USDA Fancy or Choice and weigh in the general range of 75 to 90 pounds.
Red Rump	Ewe and Wether feeder lambs that grade USDA Fancy or Choice and weigh in the general range of 60 to 75 pounds.
Red Shoulder	Ram feeder lambs that grade USDA Fancy and Choice and weigh in the general range of 60 to 75 pounds.
Blue Tail	Ewe, Wether, and Ram feeder lambs that grade USDA Good and weigh in the general range of 45 to 60 pounds.
Red Tail	Ewe, Wether, and Ram lambs that are inferior to any of the above listed grades. This designation will include lambs commonly known as skips, dead or alive, and slow.

Source: WVDA

VIRGINIA LAMB GRADING SPECIFICATIONS

Lambs with a blue mark will be expected to grade USDA Choice or Prime and a red mark will indicate a feeder lamb or USDA Good grade slaughter lamb. Lambs must have a minimum of about .07 inch backfat to grad Choice or Prime.

LAMBS

Blue O Lamb	Choice, Few Prime, Yield Grad 1, 2, Few 3 weighing 100-125# and up.
Double Blue O Lamb	Choice & Prime, Yield Grade 3-4 weighing 130# and up.
Ram Lambs	Will be marked with a blue mark on the rump in addition to slaughter grade mark.
Red O Lamb	Heavy feeder lamb, or Good and Low Choice lamb weighing 85-100 lbs.
Red Shoulder	Large and medium framed feeder lambs weighing 70-85#, expected to finish at 100# and up.
Blue Shoulder	Small framed feeder lambs weighing 70-85#, expected to finish at less than 100#.
Red Back	Large and Medium framed feeder lambs weighing 60-70#, expected to finish at 100# and up.
Blue Back	Small framed feeder lambs weighing 60-70#, expected to finish at less than 100#.
Red Tail	Large and Medium framed feeder lambs weighing 50-60#, expected to finish at 100# and up.
Blue Tail	Small framed feeder lambs weighing less than 60#, expected to finish at less than 100#.

Ram lambs will be marked with red mark on the rump, in addition to feeder classification, i.e. Red Shoulder Ram Lambs.

Source: VDACS