Sheep & Goat Research Journal
Volume 18: 2003

Contents:

Use of the Lamb Vision System to Predict Carcass Value

A. S. Brady[1], B. C. N. Cunha[1], K. E. Belk[1,2], S. B. LeValley[1],
N. L. Dalsted[1], J. D. Tatum[1], and G. C. Smith[1]

Summary

The need for a value-based marketing system in the U. S. lamb industry has been recognized. This study was conducted to evaluate use of the Lamb Vision System, a video imaging device, to predict lamb carcass value. Data from lamb carcasses (N = 246) that were fabricated into primal/subprimal cuts served as the test population data set, from which value-prediction methods were developed. In addition, an additional data set of 642 carcasses, provided by Research Management Systems, Inc. (RMS), Fort Collins, CO was utilized to validate the value-prediction methods developed. Values predicted using data from the Lamb Vision System were able to account for 50-54% of the observed variability in boxed carcass value, with more accuracy compared to the traditional, hot carcass weight-based value assessment method which accounted for 25-33% of the variation in boxed carcass value. The Lamb Vision System presents the U. S. sheep industry with the opportunity to more accurately assess individual lamb carcass value.

Key words: Lamb, Carcass Value, Value-Based Pricing

Introduction

Lamb producers/feeders are price takers. With a decreasing number of packers, lamb producers and feeders retain little bargaining power in determining live lamb or carcass prices. Currently, the price signal being sent to producers and feeders is to produce heavier lambs, as the current pricing method is primarily based on weight class. High carcass weight has been found to be associated with increased fatness and thus, this method of pricing only encourages the production of over-fat carcasses, as has been reported in the literature (Van Stavern et al., 1996; Wishmeyer et al., 1996; Snowder et al., 1994; Berg et al., 1994; Garrett et al., 1992; Tatum et al., 1989; Field et al., 1967; Kinsman, 1967). In addition, the seasonal demand of the lamb market encourages prolonged feeding of lambs, resulting in excess fatness (Ward, 1995).

The U.S. lamb industry must change economic signals sent to producers. Stanford et al. (1997) reported that the first step to reward the production of lean, heavy muscled carcasses would be to change carcass evaluation to a more objective system. Furthermore, Berg et al. (1998) suggested that a lamb marketing system based on objective assessment of cutability could enhance the ability of the U.S. sheep industry to not only compete with imported lamb, but also with other red meat products in the retail case.

Objective, accurate measurement of carcass characteristics on which monetary reward can be premised could lead to value-based marketing. Brady et al. (2003) determined that the Lamb Vision System was more accurate than expert USDA graders in the prediction of saleable meat yield. This study was conducted to determine if the LVS saleable meat yield prediction could be used to predict carcass value with accuracy and precision.

Materials and Methods

Test Population

Data from 246 carcasses (Brady et al., 2003) that were used to determine the ability of the Lamb Vision System to predict red meat yield in a previous study served as the test population data-set. Weights of all cuts, lean trim, fat, and bone from both the boneless and bone-in fabrication styles were used. Regression equations were developed for the prediction of red meat yield and weights of subprimal cuts, using LVS output and hot carcass weight as independent variables. These prediction equations were then used to predict individual lamb carcass value. In addition, this study utilized the Lamb Vision System output and hot carcass weight data from the 246 carcasses to develop additional value-prediction methods. An additional data-set of 642 carcasses, provided by Research Management Systems USA, Inc. (RMS), Fort Collins, CO, was utilized in an attempt to validate the value-prediction methods.

Actual Boxed Carcass Value Determination

Before developing value-prediction methods, an actual boxed carcass value was calculated for each of the 246 carcasses. Two actual values were calculated for each carcass: (1) an actual boxed carcass value based on a bone-in cutting regimen, (2) an actual boxed carcass value based on a boneless cutting regimen. The underlying reason for choosing these three actual boxed carcass value calculations will follow.

1 Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523-1171.

2 Correspondence: phone: 970-491-5826; fax: 970-491-0278; Email: keith.belk@colostate.edu.

The actual boxed carcass value for a bone-in cutting style is likely the dollar figure that is of most interest to lamb producers/packers, as the majority of lamb carcasses in the U. S. are fabricated to a bone-in subprimal/primal cut endpoint. Prices for the subprimal/primal-boxed cuts were obtained from USDA Market News Service, Des Moines, IA. The initial goal of this study was to report an average value for the cuts over several years, to account for seasonal and annual differences. However, with recent changes in available price data resulting from implementation of Mandatory Price Reporting, it was deemed best to use prices from the last week of January 2002, in this study. Future lamb cut prices will continue to be reported in this manner. It was recognized that the actual dollar value will vary from season to season and across years, but all actual cut and carcass prices in this study were obtained for the same time period, and price differences among value-prediction methods should be similar in future value prediction calculations.

Each cut value obtained from the USDA Market News Service was multiplied by the actual weight of the bone-in cut fabricated in the initial study (Brady et al., 2003). The weight of the fat, lean trim and thin cuts, and bone generated in the bone-in cutting style were all assigned a standardized value of $0.05/lb, $1.18/lb, and $0.05/lb, respectively. The value of each cut or fabrication product was then multiplied by two, in order to represent both sides of the carcass. The cut values were summed, and the sum was divided by hot carcass weight, converting the value to a per-pound basis. The per-pound value was then multiplied by one hundred, and was thus, converted to a price per hundred-weight basis. Fabrication costs, obtained from USDA Market News Service, of $29.66/cwt were then subtracted from this hundred-weight value, to obtain the actual boxed carcass value, for prices associated with the bone-in fabrication style.

Actual values for carcasses fabricated via a completely boneless cutting regimen was more challenging to obtain, as very few lamb breakers generate boneless cuts evaluated in the initial study (Brady et al., 2003) on a commercial basis. USDA Market News Service reports only those values for cuts that are traded in large volume; thus, boneless cuts are rarely fabricated and are not typically reported on the USDA Market News Service list. As an alternative approach, five major lamb slaughterers/breakers were contacted to obtain price quotes for the boneless cuts, as well as an estimated cost of fabrication for a carcass manufactured for solely boneless cuts. This estimated cost of fabrication was a challenge for the packers to determine, as this practice of fabricating solely boneless cuts is rare. As with the bone-in actual boxed carcass value, it was recognized that the boneless actual boxed carcass values may vary across seasons and years, but the relative differences between the actual boxed carcass value and the values obtained using the value-prediction methods should be similar in future value-prediction calculations.

In a manner similar to that used to calculate the bone-in actual boxed carcass value, the weight of each boneless cut was multiplied by the average value quoted by the five major packers. The fat, lean trim and thin cuts, and bone generated from the production of boneless cuts were standardized in value, as they were in the bone-in actual boxed carcass value calculation, at values of $0.05/lb, $1.18/lb, and $0.05/lb, respectively. Each cut or fabrication product value was then multiplied by two in order to represent both sides of the carcass. The cut values were summed, and divided by hot carcass weight, which converted the dollar value to a per-pound basis. The per-pound value was then multiplied by one hundred, and the boneless actual boxed carcass value was converted to a price per hundred-weight basis.

Value-Prediction Methods

Each carcass was assigned four predicted values for each fabrication style, in addition to the actual boxed carcass values described above. The four values were predicted using: (1) current or "traditional" prices, as reported by USDA Market News Service, (2) use of LVS predicted saleable meat yield to predict actual boxed carcass value, (3) use of LVS output and hot carcass weight to directly predict actual boxed carcass value, and (4) use of LVS predicted cut weights to predict actual boxed carcass value.

The current lamb carcass pricing system is based primarily on hot carcass weight, with Yield Grade 5 carcasses receiving the only notable discount. USDA Market News Service, carcass prices information for the last week of January 2002 was used to assign a value to each carcass. As was the case for cut prices, the initial intent was to use an average of carcass prices across seasons and years, but the changes implemented with Mandatory Price Reporting prevented the calculation of an average price over time. The traditional value assigned to each carcass was the USDA Market News Service reported price (hundred-weight basis) for that time period (last week of January 2002). The traditional value of each carcass was then regressed on the actual boxed carcass value for each fabrication style: bone-in, and boneless to determine the accuracy and precision of traditional pricing methods.

For each carcass in the study, the predicted LVS saleable meat yield (bone-in or boneless) was the sole independent variable and was regressed on its respective actual boxed carcass value (bone-in or boneless).

Thus two equations were developed to predict carcass value with LVS output and hot carcass weight as independent variables to directly predict the actual boxed bone-in or boneless carcass values. These value-prediction equations were generated using methodology developed by Brady et al. (2003). Stepwise, forward, and backward selection regression procedures were used to determine the common independent variables that were to be included in each equation in order to maximize R^2 values and minimize root mean square error values. All statistical procedures were performed using SAS.

A third value-prediction method using LVS to predict weights of bone-in shoulder, bone-in rack, bone-in loin, bone-in leg, boneless shoulder, boneless rack, boneless loin, boneless leg, fat, lean trim/thin cuts, and bone (from carcasses fabricated to yield bone-in vs. boneless cuts) from LVS output.

For the bone-in boxed carcass value prediction, each predicted cut weight was multiplied by its respective USDA Market News Service value that was utilized in determining the bone-in actual boxed carcass value, and then multiplied by two (to convert from side to carcass). The cut values were summed, divided by hot carcass weight, multiplied by one hundred, and $29.66 was subtracted. This predicted bone-in boxed carcass value was regressed on the bone-in actual boxed carcass value, to determine accuracy and precision.

To predict boneless monetary boxed carcass value, each predicted cut and fabrication product weight was multiplied by its respective value (based on the survey of five major packers), and then by two (to convert from side to carcass). The cut values were summed, divided by the hot carcass weight, multiplied by one hundred, and the fabrication cost was subtracted. The predicted boxed carcass value was then regressed on its respective actual boxed carcass value to determine accuracy and precision. All statistical procedures were performed using SAS (SAS Inst. Inc., Cary, NC).

Results and Discussion

Summary statistics, R^2 values, and root mean square error values for all value-prediction methods are presented in Table 1, according to fabrication style. Differences in mean prices between the traditional pricing method, and the other three value-prediction methods were particularly noteworthy. This increase in mean price was expected, as each carcass was priced according to the amount of red meat available for retail with the LVS prediction methods, in comparison to assignment of value based on hot carcass weight and regardless of composition. Ward (1998) recognized that the current pricing system (including use of premiums and/or discounts) does not represent the true value of lamb carcasses. However, traditional pricing methods now differ somewhat due to implementation of Mandatory Price Reporting; Yield Grade 5 carcasses now receive a significant discount. The design of the study that served to determine the ability of LVS to predict red meat yield required that carcasses of each Yield Grade be equally represented. The price-discount applied to the approximately one-fifth of carcasses that were Yield Grade 5 skewed the distribution of traditional carcass values, contributed to the large standard deviation, and resulted in a lower mean carcass value. An increase in mean carcass value, through use of the LVS prediction methods, could be beneficial to those who produce compositionally superior lambs and sell them on a carcass basis. In addition, producers with compositionally inferior lambs could be penalized in a value-based marketing system. Berg et al. (1997) and Blackburn et al. (1991) reported that the assignment of value to lamb carcasses based on lean meat yield would help to discourage the marketing of over-fat lambs.

Values predicted by each of the methods were regressed on the actual boxed carcass value to determine the accuracy and precision of the value assessment methods (Table 1). Corresponding to the large differences in mean carcass value among various methods for predicting cutout price, the traditional pricing method accounted for only 33%, and 25% (Table 1) of the observed variability in bone-in actual boxed carcass value, and boneless actual boxed carcass value, respectively. These reductions in R^2 values for the accuracy of the traditional method to predict boneless low and boneless high actual boxed carcass value (Table 1), compared to that for the traditional method for predicting bone-in actual boxed carcass value, could be attributed to the higher prices assigned to the boneless cuts and to the traditional pricing method being predicated on bone-in cuts.

Use of the other three value-prediction methods - - LVSSMYPE, LVS output plus HCW, and LVSCLbsPE - - to predict actual boxed carcass value, resulted in R^2 values of .50 to .54 across the two prediction methods (Table 1), an increase in carcass value predictability of 21 to 29 percentage points as compared to the traditional method.

The accuracy of each value prediction method is demonstrated in Figures 1, 2, and 3, using frequency distributions of error (from the actual boxed carcass value) for bone-in, and boneless fabrication styles, respectively. The large number of carcasses that were incorrectly valued by more than $25/hd using the traditional method of pricing was particularly noteworthy. The two LVS value prediction methods were able to value all carcasses within $25/hd, and most within $15/hd of the actual carcass value.

In an attempt to validate the previously described value-prediction methods, each value-prediction method was applied to an additional data set of 642 carcasses (provided by RMS, Fort Collins, CO) (Table 2). Cut weights were not available to calculate an actual price; thus, it was not possible to determine the accuracy of each prediction method. Nevertheless, it was noteworthy that results of comparisons of predicted values to values determined using traditional methods of pricing produced results comparable to those reported from the 246 carcass data-set. All two value-prediction methods (within each proposed fabrication style) resulted in an increased value compared to the value derived from use of the traditional method of pricing. Additionally, among the methods, very similar values were predicted for each carcass. Validation analyses suggested that the LVS value prediction methods are useful for predicting true-boxed carcass value.

Conclusions

The Texas A&M Market Research Center Report (1991) stated that, without a lamb market that will monetarily reward carcasses that are superior in red meat yield, producers have no incentive to alter their genetic base, feeders have no reason to alter feeding regime, packers have no motivation to not sell excess fat to breakers, and retailers have no motive to change the way they purchase lamb. The U.S. lamb industry must find a more objective manner to assign true carcass value.

All value-prediction equations developed with the Lamb Vision System more closely predicted actual boxed carcass value than traditional methods of pricing. The mean value generated by each LVS-based prediction method also was higher than traditional. As Steiner et al. (2000) reported, use of video image analysis instrumentation would not only benefit the producer of high yielding carcasses, but packing plants also would benefit, as fabrication styles could be more closely managed, and an enhanced knowledge of incoming inventories could be obtained.

Each value-prediction method developed with LVS exceeded the prediction accuracy of the traditional method. The LVS provides lamb producers and packers with several opportunities to assess, more objectively, lamb carcass value. The LVS could be used as a commercial tool to revolutionize the price discovery method in the U.S. lamb industry.

Literature Cited

Berg, E. P., J. C. Forrest, D. L. Thomas, N. Nussbaum, and R.G. Kauffman. 1994. Electromagnetic scanning to predict lamb carcass composition. J. Anim. Sci. 72:1728-1736.

Berg, E. P., M. K. Neary, J. C. Forrest, D. L. Thomas, and R. G. Kauffman. 1997. Evaluation of electromagnetic technology to assess lamb composition. J. Anim. Sci. 75:2433-2444.

Berg, E. P., M. K. Neary, and J. C. Forrest. 1998. Methodology for identification of lamb carcass composition. Sheep Goat Res. J. 14(1):65-75.

Blackburn, H. D., G. D. Snowder, and H. Glimp. 1991. Simulation of lean lamb production systems. J. Anim. Sci. 69:115-124.

Brady, A. S., K. E. Belk, S. B. LeValley, N. L. Dalsted, J. A. Scanga, J. D. Tatum, and G. C. Smith. 2003. An evaluation of the lamb vision system as a predictor of lamb carcass red meat yield percentage. J. Anim. Sci. 81:1488 - 1498.

Field, R. A., M. L. Riley, and M. P. Botkin. 1967. Effect of sex and ram weight on composition of lambs. Proc. Western Sect. Am. Soc. Anim. Sci. 18:44.

Garrett, R. P., J. W. Savell, H. R. Cross, and H. K. Johnson. 1992. Yield Grade and carcass weight effects on the cutability of lamb carcasses fabricated into innovative style subprimals. J. Anim. Sci. 70:1829-1839.

Kinsman, D. M. 1967. Some growth and carcass characteristics of lambs. J. Anim. Sci. 26:897 (Abstr.).

Snowder, G. D., H. A. Glimp, and R. A. Field. 1994. Carcass characteristics and optimal slaughter weights in four breeds of sheep. J. Anim. Sci. 72:1728-1736.

Stanford, K., S. D. M. Jones, and M. A. Price. 1997. Methods of predicting lamb carcass composition: A review. Small Ruminant Research. 29:241-254.

Steiner, R., A. M. Wyle, D. J. Vote, D. L. Roeber, R. C. Cannell, R. J. Richmond, K. Markey, J. W. Wise, M. E. O'Conner, R. R. Jones, K. E. Belk, J. D. Tatum, and G. C. Smith. 2000. Real time augmentation of USDA Yield Grade application to beef carcasses using state-of-the-art VIA instrumentation. Final Report to National Cattleman's Beef Association, Englewood, CO. Colorado State University, Fort Collins, CO.

TAMRC. 1991. Assessment of marketing strategies to enhance returns to lamb producers. TAMRC Commodity Market Research Report. No. CM-1-91. Texas A&M University, College Station, TX.

Tatum, J. D., J. W. Savell, H. R. Cross, and J. G. Butler. 1989. A national survey of lamb carcass cutability traits. SID Res. J. 5(1):23-31.

Van Stavern, B. D., C. F. Parker, and J. K. Judy. 1996. Interrelationships of certain lamb carcass characteristics. Ohio Agric. Res. and Dev. Res. Summary. 11:19.

Ward, C. E. 1995. Seasonality in budgeting lamb feeding returns. Sheep Goat Res. J. 11:45-50.

Ward, C. E. 1998. Slaughter lamb pricing issues, evidence and future needs. Sheep Goat Res. J. 14(1):35-42.

Wishmeyer, D. L., G. D. Snowder, D. H. Clark, and N. E. Crockett. 1996. Prediction of live lamb chemical composition utilizing electromagnetic scanning (TOBEC). J. Anim. Sci. 74:1864-1872.

Table 1. Comparison of various methods for predicting cutout price ($/cwt) for individual carcasses according to fabrication style

Prediction Method [a]	N	Mean Price [b]	SD	Minimum Price	Maximum Price	R^{2c}	RMSE [d]
Bone-in Fabrication Style:							
Actual Value	246	144.82	6.58	129.70	161.13	N/A	N/A
Traditional	246	113.54	25.54	62.50	143.63	.33	7.43
LVSSMYPE	246	144.82	6.57	126.18	160.28	.52	6.28
LVS output	246	144.81	6.67	124.39	159.64	.54	6.26
LVSCLbPE	246	144.98	6.58	129.70	161.13	.52	6.32
Boneless Fabrication Style							
Actual Value	246	144.50	12.89	110.68	184.10	N/A	N/A
Traditional	246	113.54	25.54	62.50	143.63	.25	11.17
LVSSMYPE	246	144.50	9.12	120.99	165.06	.50	9.14
LVS output	246	144.33	9.34	119.44	167.49	.52	9.02
LVSCLbPE	246	144.51	9.17	124.77	169.63	.50	9.13

[a] Prices presented in this table are based on the following predictors of value: Actual Values are derived from summary statistics of current USDA Market News Service prices, Traditional Values are based on current carcass price/cwt basis as reported by USDA Market News Service, LVSSMYPE are prices derived by use of the LVS prediction equation developed to predict saleable meat yield, LVS output prices are derived by use of LVS output variable plus HCW, and LVSCLbPE prices are derived by use of LVS prediction equations developed to predict wholesale cut weights.
[b]Simple average of the actual or predicted values for all carcasses.
[c]R^2-values for the predicted carcass values, regressed on the actual carcass value ($/cwt)
[d]Root mean square values for the predicted carcass values, regressed on the actual carcass value ($/cwt)

Table 2. Validation of prediction methods, according to fabrication style

Prediction Method[a]	N	Mean Price[b]	SD	Minimum Price	Maximum Price
Bone-in Fabrication Style:					
Traditional	642	121.84	12.46	98.06	285.24
LVSSMYPE	642	145.47	6.56	123.84	166.07
LVS output	642	146.17	5.84	123.01	168.85
LVSCLbPE	642	145.94	6.04	126.69	203.21
Boneless Fabrication Style:					
Traditional	642	121.84	12.46	98.06	285.24
LVSSMYPE	642	143.75	8.54	114.54	171.79
LVS output	642	144.00	9.42	108.76	174.77
LVSCLbPE	642	145.07	8.16	118.43	216.01

[a] Prices presented in this table are based on the following predictors of value: Traditional Values are based on current carcass price/cwt basis as reported by USDA Market News Service, LVSSMYPE are prices derived by use of the LVS prediction equation developed to predict saleable meat yield, LVS output prices are derived by use of LVS output variable plus HCW, and LVSCLbPE prices are derived by use of LVS prediction equations developed to predict wholesale cut weights.
[b]Simple average of the actual or predicted values for all carcasses.

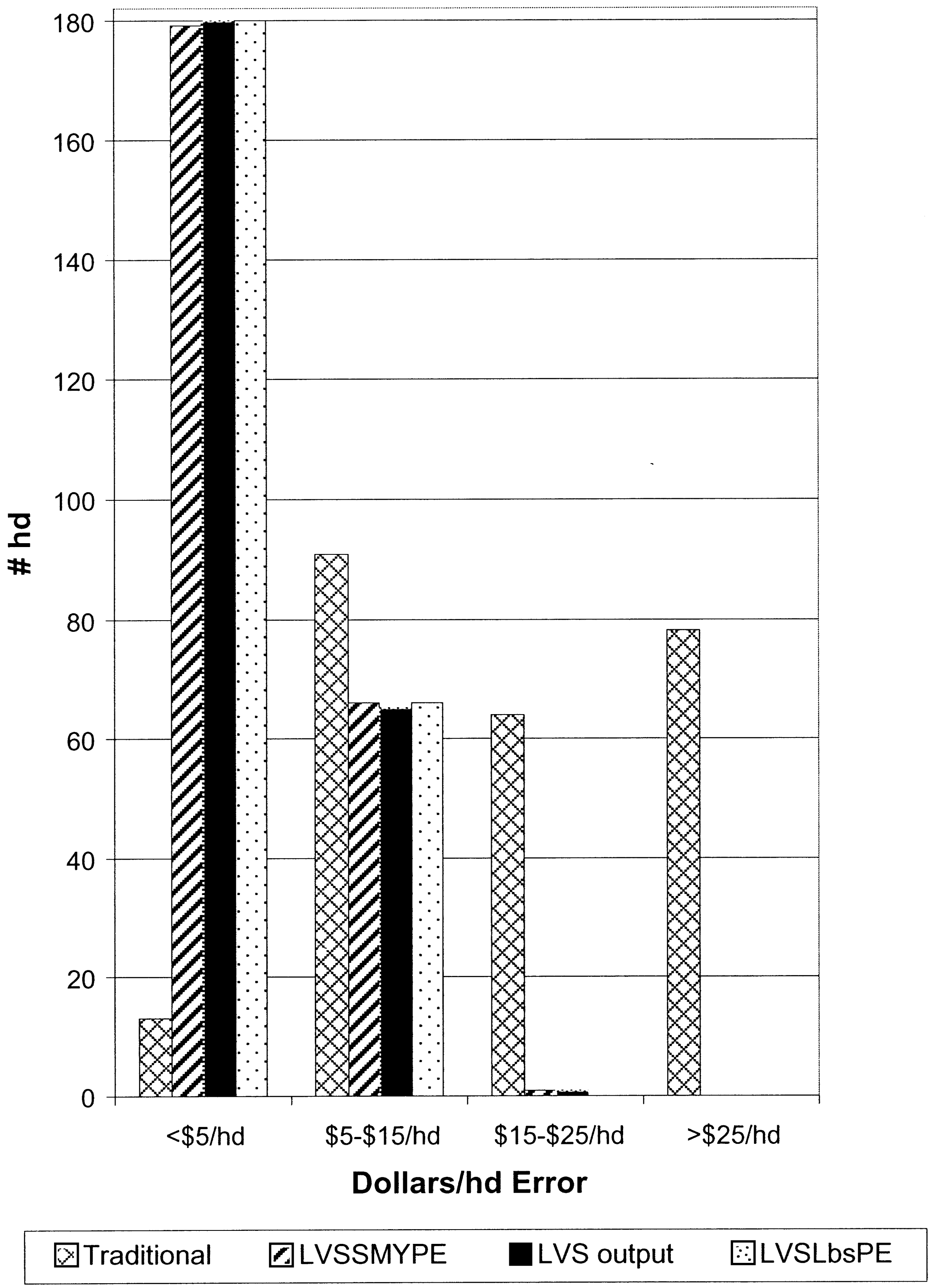

Figure 1. Frequency distribution of error for value prediction methods in a bone-in cutting style

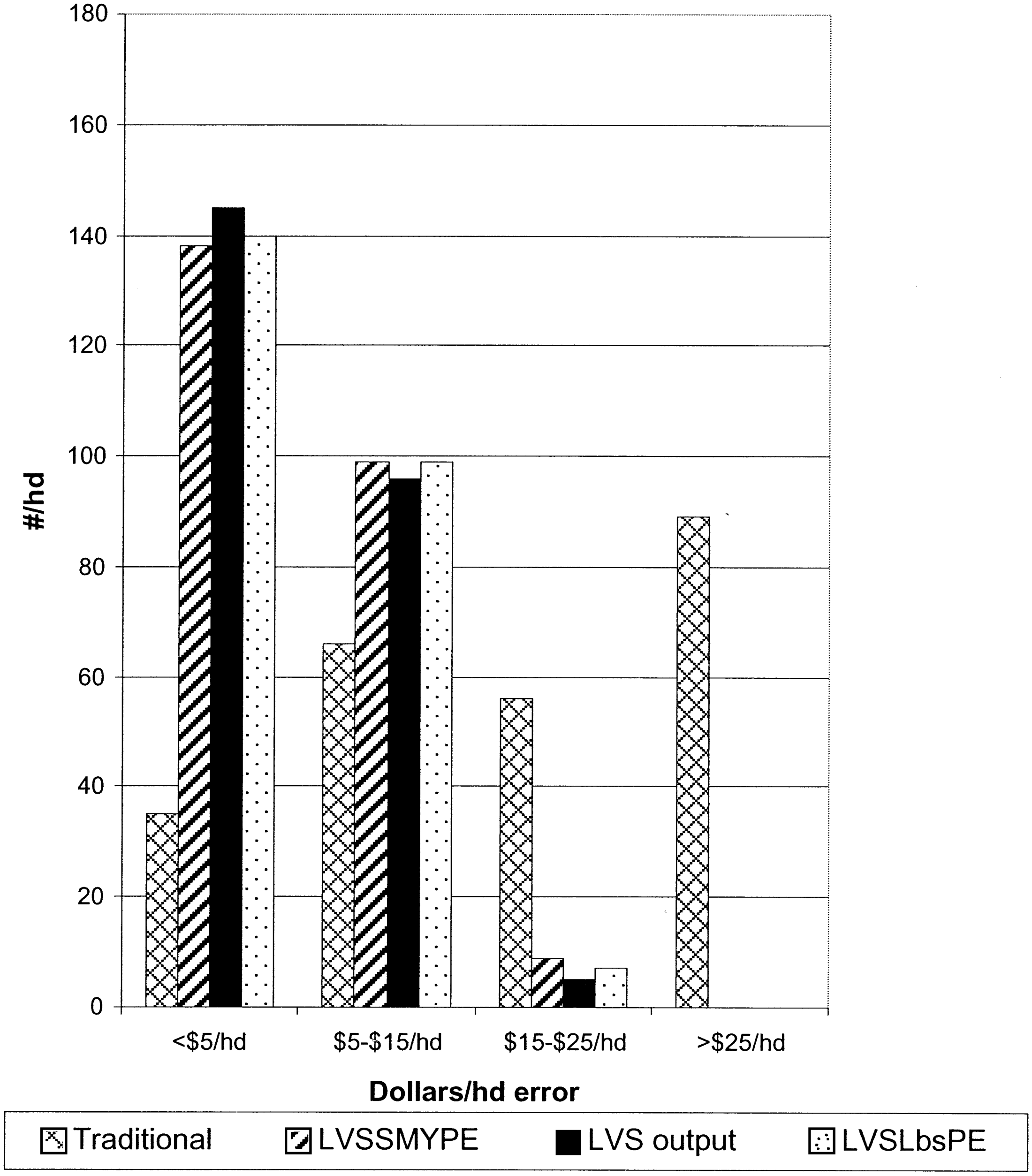

Figure 2. Frequency distribution of error for value prediction methods in a boneless cutting style