"Positioning Lamb Producers to be Competitive in the U.S. Market"

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Lamb Growth Efficiency and Optimum Finished Weight

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Introduction

In the sheep enterprise, lamb sales account for more than 90 percent of gross revenue. Most analyses indicate profitable sheep production is dependent on market prices, pounds of lamb weaned or sold per ewe exposed and the unit cost of production. Producers have little control annually over selling price for their lambs, but they do control production efficiency. Ewe productivity and ewe/lamb feed cost containment are important parameters for all types of flock management systems whether a feeder lamb or finished lamb production emphasis. It is important to excel in each area independent of the type of operation. The feeder lamb operation success is directly linked to economic efficiency in producing pounds of weaned lamb per unit ewe cost. This is also true for the lamb to finish operation but in addition the practice of finishing lambs should be considered an independent enterprise. The economic efficiencies in lamb finishing are measured by the cost to produce a pound of body weight. Essentially producers should evaluate production efficiencies of the ewe and lamb independently and on a flock basis to evaluate these profit centers.

Market Price Trends

Historically finished live lamb price has peaked prior to the Easter holiday with a slow but steady decline through late summer. First and fourth quarter price trends with little or any sharp price shifts. Even though the price was difficult to determine the trend and peak price period was predictable. Producers in the farm flock areas had used this information to design flock management and marketing decisions.

However the dynamics of lamb marketing have changed in the 90's, price trends have moved away from the traditional shape. Peak annual finished lamb prices have occurred post-Easter, in May or June rather than coincide with a structured demand period it is dependent on a short supply. As the supply of "old crop" feedlot lambs decline processors rely on "native" new crop lambs to make up the supply. Reductions in the farm flock ewe base during this decade have created marketing trends with up movement well into the summer months.

Many factors have contributed to the more recent finished lamb market price trends. Adequate feedlot lambs are carried farther into the calendar and at much heavier live weights than in the past. Live lamb market weight continues to increase since 1975 the U.S. live lamb market weight has increased more than 1 pound per year (Table 1). There appears to be little economic opposition to extremely heavy lambs.

Table 1. U.S. Live Lamb Finished Weight

Year	Live Lamb Weight (lb)
1975	104
1985	115
1995	126
1998	132

Farm Flock Profit Centers

Over the past decade producers have needed to look at more than peak lamb price trends to establish a flock marketing management plan. Live lamb price trends have been difficult to predict and packer demands for heavier finished lamb have changed several characteristics in the intensive lamb to finish farm flock. With the sporadic nature of market conditions progressive producers have become more focused on lowering production costs by improving ewe productivity. These management changes include the use of prolific breed genetics in cross breeding, shifting to later lambing dates to improve lambing percent and more recently greater use of forage based resources. Improved ewe efficiencies can reduce input costs to withstand periods of low lamb prices and take advantage of high profit periods.

Heavier lamb market weight is an opportunity to increase the pounds of lamb marketed and gross return per ewe. With ever-increasing finished market weights evaluating flock genetics for optimum lamb economic growth efficiencies becomes a higher priority. Simply adding more pounds into existing flock genetics may be inefficient and fail to increase net return per ewe. Lamb economic growth efficiency is often over looked compared to the effort placed on improving ewe production efficiencies.

Farm Flock Ewe Base

Many different breed combinations can be found in farm flock operations. Wide variation is evident in the mix of ewe flock genetics, ranging from small to medium framed ewes which excel in prolificacy or wool quality to extremely large framed terminal breed based ewes which have superior growth traits as featured assets. Smaller framed ewes have lower annual feed costs compared to the large framed type based on maintenance feed requirements.

Often the question is raised, "What kind of ewe is best for my operation"? Anyone who has given thought to this question would respond with the following: a low maintenance cost, highly productive ewe with superior mothering ability where by she successfully lambs, and rears all lambs born with out any assistance. Interestingly little is mentioned whether the offspring can excel in growth efficiency to the industry average finished weight or higher. Ewe productivity and offspring growth efficiency are linked economic management desires in the farm flock.

Lamb Finished Weight-Body Composition Relationship to Frame Size

The dynamics in the sheep industry continue to trend toward heavier finished lambs. It requires a larger-framed lamb to reach heavier weights with the same or improved growth efficiencies compared smaller framed genetics. Researchers at the University of California-Davis have shown that parental frame size can be used to predict offspring finished weight. As illustrated in Figure 1 Bradford and coworkers at the University of California-Davis developed a model to predict finished lamb body weight based on ewe body weight information from dam and sire breeds. All predicted lamb weights are at constant degree of finish corresponding to a Yield[a] Grade 2 carcass, fat measurement at 0.17 inches (12- 13th rib fat). Using Figure 1, a 116 pound lamb would be expected when the ewe breed is 160 pounds (left column) and the dam of the terminal sire breed is 200 pounds (upper row). The predicted lamb weight is determined using the average weight of the ewes (160lb+200lb/2=180lb) multiplied by 64 percent of mature body size (180lbx0.64=116lb). This research shows that predicting the weight at which a lamb reaches a specific level of fat cover can be estimated based on objective measure for parental frame size. This information can be useful to set goals for a flock market plan and evaluating lamb growth potential in a flock ewe base.

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[a] Yield Grades and Quality Grades for Lamb Carcasses will be discussed in later section.

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Researchers at Colorado State University studied small, medium and large framed lambs to target finished weights. Carcass data was collected to correlate degree of finish with final weight. Large framed lambs were heavier than medium or small framed lambs, medium heavier than small framed lambs when compared at similar degrees of finish. From these data researchers developed a model to predict the finished weight and associated degree of finish (fat depth at 12-13th rib) by frame size. Table 2 shows the prediction model for wether lambs using these data.

Table 2. Projected Target Market Weights

	Fat Thickness		(12-13th rib)
	.15	.25	.35
FRAME SIZE		WETHERS	
Small	92	116	140
Medium	97	126	154
Large	109	140	170

An extrapolation of these data to the Bradford model leads to a classification of ewe frame size based on body weight: 140 pounds or less - small framed, 140 to 170 pounds - medium framed and more than 170 pounds - large framed. Offspring from mating ewes and rams within a frame size would probably be more predictable than matching individuals from the extremes in framesize. Even though these class breaks could be argued the fact remains that a lamb finished weight-body composition relationship is inherent on parental frame-size and furthermore not easily altered by changes in nutritional or other management modification.

Lamb Growth Efficiency

Larger framed lambs are expected to be leaner than smaller framed lambs when compared at equal weight. Animal growth performance, expressed as average daily gain, favors a leaner animal since the conversion of feed to lean weight gain is higher than for fat weight gain. Therefore average daily gain for the larger framed leaner type of lamb would be higher at a constant weight comparison (Figure 2).

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Daily feed intake increases with higher weights although as a percent of body weight intake is nearly constant at 4 percent throughout growth. Feed efficiency, expressed as the pounds of feed to add a pound of body weight, declines with heavier weights and higher levels of body fat.

When feed efficiency declines sufficiently the cost of the feed consumed to add a pound of gain can exceed the value of the next pound gained. At this point the animal has reached the optimum economic market weight for the animal. Using the economic expression for feed efficiency, cost of gain, the optimum economic market weight for lambs can be identified. It is important to understand cost of gain, how to calculate and how to use it. The next section provides a review on cost of gain concepts:

Cost of Gain - An Economic Expression for Feed Efficiency in Finishing Lambs

To express cost of gain (CG) several equations are offered:

Expression 1

= cents/pound of gain

Expression 2

$$= \frac{(\text{feed cost (cents/lb)}) * ((\text{daily feed intake lb}) \times (\text{days on feed}))}{\text{Pounds of gain}}$$

Expression 3

$$= \frac{(\text{feed cost (cents/lb)}) * (\text{daily feed intake, lb})}{\text{Average daily gain (ADG)}}$$

Expression 4

= feed cost (cents/lb)* feed efficiency (pounds of

feed/pound of gain)

The most useful economic management assessment tool in lamb feeding is cost of gain (CG). The average cost of gain, reported as cents/pound of gain, is the most common expression in closeout information for an entire feeding period. However using average CG is historical information and offers little when evaluating feeding practices or determine optimum economic finished weight. Using expression 2 or 3 it becomes clear that altering feed cost, feed intake or growth performance can affect

CG. Does a higher ration cost equate to higher cost of gain, not necessarily so! It depends on intake or performance responses. In contrast, a low cost ration that retards growth performance can result in higher CG. Cost of gain can be determined on a daily basis, weekly, or any other period. Expression 4 is probably the straightest forward, since it is feed efficiency multiplied by the ration cost. When feed efficiency declines, more pounds of feed per pound of gain, the cost of gain increases.

Using Cost of Gain to Explain Growth Efficiencies

Cost of gain trends higher with increasing lamb weight. The lowest cost of gain is usually during early growth when lambs are lightest and leaner. The post-weaned 60 to 90 pound lamb will perform especially well on a cost of gain analysis. Interestingly the lowest cost of gain in the feeding period occurs at or before peak average daily gain. Creep and growing diets must provide adequate nutrients to take full advantage of growth efficiencies. Lamb frame size has less impact on cost of gain up to 90 pounds since body composition is similar.

As animals get heavier it takes more feed to gain a pound of body weight since the gain contains more fat and less muscle than at a lighter less mature status of growth. Since feed intake continues to climb at higher weights and average daily gain falls, cost of gain can rise sharply. Frame size differences become more significant at heavier weights since the cost of gain will rise at a lighter weight in the small framed versus larger framed lambs.

Using Cost of Gain to Determine Optimum Economic Lamb Finished Weight

Figure 3, "Lamb Profit Potential" was developed to help illustrate how cost of gain can be used to maximize lamb return in the finishing period by identifying the optimum economic finished weight. The graph presents comparisons with two costs of gain curves and a live lamb market price line. Plotted is the cost of gain for small and large framed lambs, and the live price for lambs adjusted for a typical weight slide. To interpret these comparisons, at any weight where cost of gain is below the price line the last pound gained was profitable; when cost of gain intersects the price line the last pound gained was a breakeven, above the price line at a loss.

The breakeven for the small framed lamb is set at 120 pounds and 140 pounds for the large framed. The difference between a cost of gain line and market price is the profit at a given weight. It's important to recognize that profit is not determined by the intersect weight for each frame type. Instead it is the additive positive differential between the value and cost of the pounds gained. For example at 100 pounds the live lamb value is $0.80 per pound, the cost of a pound of gain is $0.40 for small framed and $0.25 for large framed. The differential is $.40 ($0.80-0.40) for the small framed and $0.55 ($0.80-0.25) for the large framed. The differential at lighter weights is greater and the respective frame type cost of gain intersects live lamb value where they are equal thus the differential is zero. Average daily gain drives progressively declines at heavier weights until cost of gain more than any other variable including feed cost. Where the cost of gain lines intersect market value the average daily gain was approximately 0.5. The economic advantage for the large framed lamb is two fold, the differential is greater at a given weight and a positive differential can be found at a higher weight.

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Generally during the finishing period when average daily gain falls to 0.5 pounds per day feed efficiency will be at or even exceed 10 pounds of feed per pound of gain. Selecting genetics, which excel in feedlot performance provides the producer an opportunity to reap the benefits when feed costs are low and market prices high since cost of gain would indicate feeding to higher weights at a profit. Most importantly having superior growth efficiency built into the flock offers the producer a competitive advantage when feed prices are high or market prices low since the optimum economic finished weight would be lower.

Over the past twenty years numerous lamb studies have been conducted to evaluate growth efficiency and economic return. Often critical information and data is not available to clearly demonstrate the relationships between frame size and body composition in predicting an optimum economic finished weight. However a study at the University of Idaho by Dahmen illustrated that optimum economic live lamb finished weight is dependent on frame size and body composition.

In this study sixty-four large framed (175 lb crossbred black ewes mated to 300 plus pound Suffolk rams) twin born black-faced cross lambs with an initial weight of 73 pounds were split equally into 4 finishing groups with projected finished weights of 110, 120, 130 and 140 pounds. At the start of the trial age of lamb was 100 days, the length of the trial was 84 days. All lambs were individually penned to record feed intake. A pelleted forage based ration, moderate for energy density, was offered through self-feeders.

Growth performance across the weights was from 0.97 pounds for the 110lb-lamb treatment group to 0.81 pounds for the 140lb-treatment group. The decline was nearly linear from lightest to heaviest treatment groups. The respective carcass fat cover measurements, from 110 through 140-pound groups were 0.13 in. (Yield Grade 1), 0.20 in. (Yield Grade 2), 0.30 in. (Yield Grade 3) and 0.34 in. (nearly a Yield Grade 4). Their income analyses showed the greatest return above cost was for the 110 and 120 weight lambs. These lambs were yield grade 2's or lower. Conclusions included the following statement "changes in feed cost or changing market prices could change optimum economic slaughter weight slightly but because of the decline in feeding efficiency at heavier weight it is not likely that feeding above 120 pounds would be profitable except in unusual circumstances".

Feed efficiency was determined at 2-week intervals over the 84-d feeding trial. Through day 56 the feed efficiency averaged 6 to 8 pounds of feed per pound of gain. In the 70 and 84-d feeding periods the value was over 13 pounds of feed per pound of gain. The sharp decline in feed efficiency after day 56 corresponds to finished weights beyond 120 pounds. The impact of lower feed efficiency, thus higher cost of gain, on net return per lamb slaughter weight group is dramatic as shown in Figure 4.

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The optimum net return occurred near 120 pounds in this study even though at heavier weights the lambs were profitable. Why? Essentially for every pound gained above 120 pounds the cost of gain was more than the value of the gain i.e. the profit accumulated up to 120 pounds was partially used to cover the loss for any additional weight gain. This scenario is similar to that described in the "Lamb Profit Potential" section earlier in this document. Evaluating profitability for these lambs from the beginning weight to 130 or 140 pounds would have masked the finished weight for optimum profit.

Summary

Heavier finish lamb marketing trends provide economic opportunity and have challenged management in the farm flock lamb to finish operation. Simply adding more weight to offspring from an existing genetic ewe frame size base may not necessarily increase optimum economic lamb feeding return, it could be reduced. The model by Bradford shows the impact of ewe frame size on the lamb weight-body composition relationship. Research has shown that optimum returns often coincide when lambs reach a carcass composition at a high yield grade 2 to low yield grade 3, approximately 0.25 inches fat cover. Feed efficiency often declines sharply beyond this degree of finish, mainly due to the reduced average daily gain. When feed efficiency reaches 10 pounds or more per pound of gain the average daily gain will approach 0.5, it can go lower. Using degree of finish or average daily gain benchmarks producers can indirectly determine the optimum economic finished weight. Directly determining cost of gain on a group of lambs during intervals in the feeding period would be ideal. Increasing flock frame size to push the optimum economic lamb finished weight higher must be evaluated with regard to negative impacts on ewe productivity and maintenance costs.

Yield Grades and Quality Grades for Lamb Carcasses

Roger Haugen, Extension Sheep Specialist and Paul Berg, Animal Scientist, NDSU

Lamb carcass grades when applied by a USDA meat grader must consist of a yield grade and a quality grade. Yield grades estimate the percentage of closely trimmed, boneless retail cuts from the leg, loin, rib and shoulder. Quality grades indicate the palatability or eating characteristics of lamb.

Evaluating lamb carcasses for USDA Yield and Quality Grades recognizes carcasses with traits that influence live animal and carcass value, and identifies breeding animals that produce lambs of superior carcass merit.

Yield Grades

Yield grades reflect the "quantity" of retail cuts that can be expected from a lamb carcass. Yield grades are 1, 2, 3, 4 and 5 with yield grade 1 being more desirable than a yield grade 5 in the amount of retail cuts from the leg, loin, rib and shoulder. Adjusted fat thickness of the carcass is the only factor used to determine lamb yield grades. In addition the kidney and pelvic fat must be removed from the carcass, leaving no more than one percent in the carcass.

Yield grades are a numerical representation of % cutability. Cutability is the percentage of carcass weight represented by the boneless and bone--in closely trimmed (0.1 inch) retail cuts from the leg, loin, rib and shoulder. Yield grades and their corresponding % cutability are presented in ***Table 1***.

Table 1. Percentage Cutability and USDA Yield Grade.

YG	% Cutability
1.0	51.0
1.5	50.35
2.0	49.7
2.5	49.05
3.0	48.4
3.5	47.75
4.0	47.1
4.5	46.45
5.0	45.8
5.9	45.15

Adjusted Fat Thickness: Adjusted fat thickness is the most important predictor of cutability and for simplicity in applying the grades is the only yield grade factor. Fat thickness is measured between the 12th and 13th ribs over both ribeyes at the midpoint of the ribeye.

The measurements are then averaged. However, the fat thickness measurement may be adjusted either up or down for unusually heavy or light fat deposits. Fat adjustments of .05 to .10 inch are typical. The amount of fat in the body wall, crotch, cod or udder, sirloin-loin juncture, shoulder and breast is considered in making fat adjustments. The body wall thickness measured from the inside of the rib to the outside fat at 4 inches below the ribeye provides a guideline for adjustments in fat thickness. ***Table 2*** provides typical body wall measurements for each yield grade for a 50 and a 75 pound carcass.

Yield Grade Calculation: Yield grades are calculated by using the following formula:

YG= 0.4 + (10 H adj. fat thickness)

For example, to calculate the yield grade for a carcass that has an adjusted fat thickness of .25 inch would be as follows: YG = 0.4 + (10 H .25) **YG = 2.9**

Table 2. Typical Body Wall Measurements for different Yield Grades.

	Typical Body Wall Measurements	
Yield Grade	55 lbs Hot Carcass Wt	75 lbs Hot Carcass Wt
1	0.75	0.85
2	0.90	1.00
3	1.05	1.15
4	1.20	1.30
5	>1.20	>1.30

Leg Conformation Score

Leg conformation score is not used in yield grading but is an indicator of carcass muscling.

Leg scores are normally coded, such as:

15=Prime +	12=Choice +	9=Good +
14=Average Prime	11=Average Choice	8=Average Good
13=Prime -	10=Choice -	7=Good -

Superior leg scores (higher number codes) are very wide and thick which should indicate a high lean to bone ratio. Narrow, angular legs (lower number codes) will have a lower proportion of edible meat to bone.

Ribeye Area

Although ribeye area is not a yield grade factor, ribeye size is important in evaluating the carcass merit of a lamb. Ribeye area is measured at the 12th rib by using a plastic grid or by tracing the eye on acetate paper and then using a grid or a compensating polar planimeter to determine the area. Only the large major ribeye muscle should be measured - do not count the small muscles adjacent to the ribeye muscle. Both ribeye muscles should be measured and the average reported. **Desirable Ribeye Standards** for various weight ranges can be calculated using the equation **1.4 + (0.02 H Hot Carcass Weight, lbs).**

Quality Grades

Quality grades indicate the expected eating satisfaction of lamb. USDA Lamb Quality Grades are based upon palatability indicating characteristics of the lean and carcass conformation. Conformation has no direct influence upon the eating quality. For quality grading purposes, there are three carcass classes - lamb, yearling mutton and mutton. There are four quality grades within each class. For lamb and yearling mutton the quality grades are Prime, Choice, Good and Utility.

Mutton carcasses are graded Choice, Good, Utility and Cull. The factors used in quality grading lamb carcasses are: 1) maturity, 2) lean quality and 3) carcass conformation.

Maturity: Maturity in lambs is determined by evaluating lean color and texture, rib bones and break joints. Carcasses are classified as lamb (young lamb or older lamb), yearling mutton and mutton. Lamb maturity carcasses have break joints on both shanks, slightly wide and moderately flat rib bones and a light red, fine textured lean. Yearling mutton carcasses may have either 2 break joints, 1 break joint and 1 spool joint or 2 spool joints, moderately wide rib bones that tend to be flat and a slightly dark red, slightly coarse textured lean. Mutton carcasses always have spool joints on both shanks, tend to have wide, flat rib bones and a dark red, coarse textured lean.

Lean Quality: Lean quality is best evaluated by direct observation of texture, firmness and marbling in a cut surface. In lamb grading, direct observation is not possible. Lean quality in lamb carcasses is evaluated indirectly by the quantity of fat streakings within and upon the inside flank muscles. In addition, Prime carcasses must have minimum lean firmness score of "moderately firm" and Choice carcasses must have at least "slightly firm" lean.

Conformation: The conformation of a carcass is evaluated by considering all carcass components but giving particular attention to the more desirable cuts. Superior conformation carcasses are very wide and thick in relation to their length and should produce a higher proportion of edible product. Poor conformation lamb carcasses are thinly muscled and have a less desirable lean to bone ratio.

Balancing Grade Factors: Lamb skeletal and lean maturity is combined with the amount of flank fat streakings to arrive at a quality grade. As maturity increases, there is an increasing requirement in the amount of fat flank streakings. For example, to be eligible for the Choice grade the minimum fat flank streaking requirement for lamb (young lamb) maturity carcasses is "Traces". However, for yearling mutton, the minimum fat flank streaking requirement for the Choice grade is "Small" and for mutton carcasses the minimum requirement is "Modest".

The lamb grading standards give minimum carcass conformation scores for each quality grade. However, superior quality can compensate on an equal basis for inferior conformation. A carcass that has average Prime lean quality and average Choice conformation would still qualify for the Prime grade. Also, in the Choice and Good grades, superior conformation can compensate for inferior quality by 1/3 of a grade. For example, a carcass with Good + lean quality can qualify for the Choice grade with average Choice conformation. Regardless of the extent that conformation exceeds minimum requirements, a carcass must have minimum Prime lean quality to qualify for USDA Prime. To be eligible for Choice and Prime grades, carcasses must have at least a thin covering of fat over the back (muscles no more than plainly visible).

Adapted from University of Nebraska Publication G83-675-A

Dakota Lean Lamb

Three traits will be the basis for Dakota Lean Lamb: fat cover, conformation score, and flank color. Fat cover is the most important predictor of cutability and is measured between the 12th and 13th ribs. Conformation score is an indicator of carcass muscling. Superior conformation scores (higher number codes) are very wide and thick which should indicate a high muscle mass. Narrow, angular conformation (lower number codes) will have a lower proportion of edible meat. Flank color is an indicator of youthfulness with soft reddish pink being the most desirable.

*Image not available. Please contact the Hettinger Research Extension Center for a Printed Copy

Dakota Lean Lamb carcasses are very youthful in appearance; wide and thick in their outline; and carrying very little fat cover which in turn should produce a higher proportion of edible product for the consumer.

<u>To qualify as a Dakota Lean Lamb, the following must be met:</u>

Carcass weight: 55 - 75 lbs.

Fat thickness at 12-13th rib: 0.10-0.30 in

Conformation score of 13-15

Flank color: soft reddish pink

Proposal prepared by Roger G. Haugen, Extension Sheep Specialist and reviewed by Dr. Paul Berg, NDSU Meat Specialist