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CLASSIFICATION AND GRADING OF BEEF AND LAMB IN THE UNITED STATES OF AMERICA

R. A. BARTON

Massey University, Palmerston North

SUMMARY

The grading and classification of beef and lamb carcasses under the federal grading service of the United States Department of Agriculture are described and discussed. The procedure of yield grading both beef and lamb carcasses is considered and data are presented to demonstrate its value. Reference is made to the physical description of live slaughter animals in relation to their probable carcass grades and yield or cutability groups. The importance of these descriptions as aids to live animal appraisal and the judging of carcasses is mentioned. It is concluded that the present American grade standards closely meet the requirements of all segments of the beef and lamb industries.

QUALITY GRADING of carcasses in the U.S.A. attempts to indicate to the customer possible differences in eating values of the meat and is thus grading in the accepted sense of the term since it attempts to collate and assess the various palatability-indicating attributes of the carcass. Quality grades do not, however, indicate the volume of the salable product in the carcass; this is the function of yield grading which can be regarded as carcass classification. Individual beef carcasses in America, however, may be graded or classified for both quality and yield.

The development of beef carcass grading in America has been recorded by Kiehl and Rhodes (1960), Rhodes (1960) and Williams and Stout (1964). The current standards for quality and yield grading of beef carcasses were published by Anon. (1965) and for lamb carcasses by Anon. (1969).

The official grading by the United States Department of Agriculture of carcasses is not compulsory except in wartime, or for government procurement or for shipments into certain cities. Nevertheless, according to Harrington (1969), in 1966 nearly all of the three top grades of beef carcasses were graded for quality by the federal service (Prime 99%, Choice 96%, Good 48%) whereas only a small proportion of the lower quality beef carcasses were so graded (Standard 9%, Commercial and Utility 8%, Cutter and Canner 2%). Yield grading was rather slowly accepted but, by October 1968, 24% of the quality graded

beef carcasses were also yield graded. Harrington (1969) states that this means that some 40% of the Choice grade carcasses were, in fact, appraised for yield grade; again, packers do not wish the poorer grades to be rolled (marked) on the carcasses in most cases.

BEEF CARCASS GRADING AND CLASSIFICATION

The grade of a beef carcass is based on separate evaluations of:

- (1) Palatability-indicating characteristics of the lean, and conformation. These two items form the basis of the quality grade.
- (2) The indicated percentage of trimmed, boneless, major retail cuts (round, loin, rib, and chuck) to be derived from the carcass. This is referred to as the "cutability" or yield grade of the carcass.

Prior to June 1965, conformation was not included as a characteristic indicating quality. Its inclusion in the current standards ". . . is not intended to imply that variations in conformation are either directly or indirectly related to differences in palatability" (Anon., 1965).

GRADING BEEF CARCASSES FOR QUALITY

There are eight quality designations — Prime, Choice, Good, Standard, Commercial, Utility, Cutter and Canner. All these designations are applicable to steer, heifer and cow carcasses, except that cow carcasses are not eligible for the Prime grade. Bull and stag carcasses are not eligible for either the Prime or Standard grades.

The standards provide for the grading and stamping of beef from steers, heifers, and cows according to the characteristics as specified for the grade, irrespective of the sex of the animal from which it was derived. Bull and stag carcasses are graded according to their sex characteristics and are identified also for class as "Bull" or "Stag" beef as the case may be.

Graders in America evaluate conformation by assessing the shape or development of the various parts of the carcass or primal cut. They consider ". . . not only the proportion that each part is of the carcass or primal cut weight but also the general value of each part as compared with the other parts. Thus, although the chuck and round are nearly the same percentage of the carcass weight, the round is considered the more valuable cut.

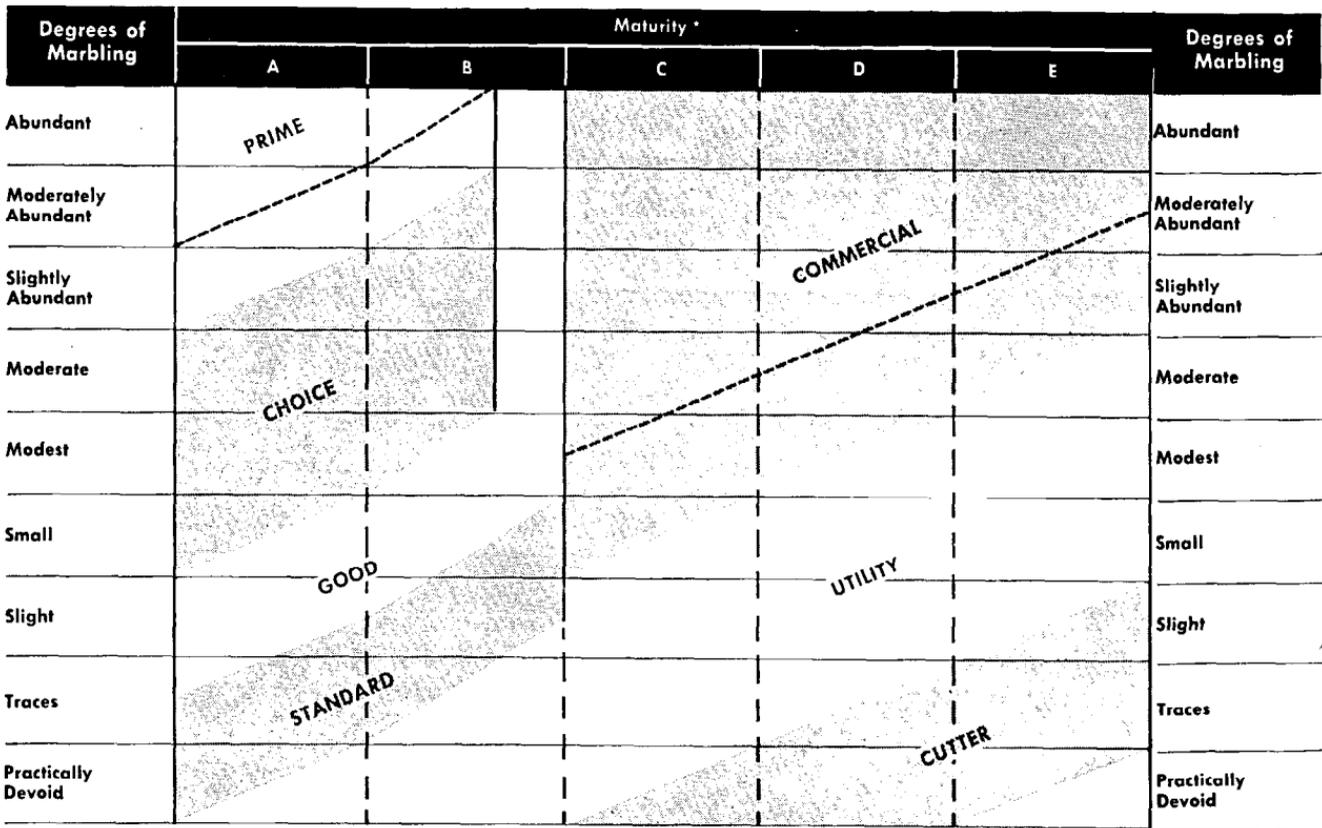


FIG. 1: Relationship between marbling, maturity, and quality.

Note: (a) Maturity increases from left to right (A to E).

(b) Dotted lines represent midpoint of Prime and Commercial grades.

Therefore, in evaluating the overall conformation of a carcass, the development of the round is given more consideration than the development of the chuck. Similarly, since the loin is both a greater percentage of the carcass weight and also generally a more valuable cut than the rib, its conformation receives much more consideration than the conformation of the rib. Superior conformation implies a high proportion of meat to bone and a high proportion of the weight of the carcass or cut in the more valuable parts. It is reflected in carcasses and cuts which are very thickly muscled, very full and thick in relation to their length and which have a very plump, full, and well-rounded appearance. Inferior conformation implies a low proportion of meat to bone and a low proportion of the weight of the carcass or cut in the more valuable parts. It is reflected in carcasses and cuts which are very thinly muscled, very narrow and thin in relation to their length and which have a very angular, thin, sunken appearance."

"Quality of the lean is evaluated by considering its marbling [intramuscular fat content] and firmness as observed in a cut surface in relation to the apparent maturity of the animal from which the carcass was produced."

"The maturity of the carcass is determined by evaluating the size, shape, and ossification of the bones and cartilages — especially the split chine bones — and the colour and texture of the lean flesh. . . . Within any specified grade, the requirement for marbling and firmness increase progressively with evidence of advancing maturity. To facilitate the application of this principle, the standards recognize nine different degrees of marbling and five different maturity groupings as shown in Fig. 1."

"From Fig. 1 it can be seen, for instance, that the minimum marbling requirement for Choice varies from a minimum small amount for the very youngest carcasses classified as beef to a maximum modest amount for carcasses having the maximum maturity permitted in the Choice grade."

"The marbling and other lean flesh characteristics specified for the various grades are based on their appearance in the ribeye muscle of properly chilled carcasses that are ribbed between the 12th and 13th ribs."

"The final quality grade of a carcass or primal cut is based on a composite evaluation of its conformation and quality. Since relatively few carcasses or cuts have an identical development of conformation and quality, it is obvious that each grade will include various combinations

of development of these two characteristics. . . . In each of the grades a superior development of quality is permitted to compensate for a deficient development of conformation, without limit, through the upper limit of quality. The rate of compensation in all grades is on an equal basis — a given degree of superior quality compensates for the same degree of deficient conformation. The reverse type of compensation — a superior development of conformation for an inferior development of quality — is not permitted in the Prime, Choice, and Commercial grades. In all other grades this type of compensation is permitted but only to the extent of one-third of a grade of deficient quality. The rate of compensation is also on an equal basis — a given degree of superior conformation compensates for the same degree of deficient quality."

CLASSIFYING BEEF CARCASSES FOR CUTABILITY

"The cutability group of a beef carcass is determined by considering four characteristics: (1) The amount of external fat, (2) the amount of kidney, pelvic and heart fat*, (3) the area of the ribeye muscle, and (4) the carcass weight."

"The amount of external fat on a carcass is evaluated in terms of the thickness of this fat over the ribeye muscle measured perpendicular to the outside surface of a point three-fourths of the length of the ribeye from its chine bone end. This measurement may be adjusted, as necessary, to reflect unusual amounts of fat on other parts of the carcass. . . ."

"The amount of kidney, pelvic, and heart fat considered in determining the cutability group includes the kidney knob (kidney and surrounding fat), the lumbar and pelvic fat in the loin and round, and the heart fat in the chuck and brisket area which are removed in making closely trimmed retail cuts. The amount of these fats is evaluated subjectively and expressed as a percent of the carcass weight."

"The area of the ribeye is determined where this muscle is exposed by ribbing. This area usually is estimated subjectively; however, it may be measured . . . by means of a grid calibrated in tenths of a square inch or by other devices designated by the Consumer and Marketing Service."

"Hot carcass weight (or chilled carcass weight \times 102%) is used in determining the cutability group."

*Pericardial and mediastinal fatty tissue and other fat deposits in the thoracic cavity.

TABLE 1: THE EFFECT OF A CHANGE IN ONE FACTOR IN THE PREDICTION EQUATION ON THE CUTABILITY GROUP OF A BEEF CARCASS (ANON., 1969)

<i>Factor</i>	<i>Effect of Increase on Cutability Group</i>	<i>Approx. Change in Each Factor Required to Make a Full Cutability Group Change*</i>
Thickness of fat over ribeye	Decreases	4/10 in.
Percent of kidney, pelvic, and heart fat	Decreases	5%
Carcass weight	Decreases	260 lb
Area of ribeye	Increases	3 sq. in.

*This assumes no change in the other factors.

"The standards include a mathematical equation for determining the cutability group. This group is expressed as a whole number; any fractional part of a designation is always dropped."

"The cutability group of a beef carcass is determined on the basis of the following equation:

$$\text{Cutability group} = 2.50 + (2.50 \times \text{adjusted fat thickness, inches}) + (0.20 \times \% \text{ kidney, pelvic, and heart fat}) + 0.0038 \times \text{hot carcass weight, lb} - (0.32 \times \text{area ribeye, square inches})."$$

The approximate effect on beef cutability grade of a change in one of the four factors incorporated in the above equation is given in Table 1.

Table 2 presents figures for the percentages of carcass weight in boneless, closely trimmed (trimmed to $\frac{3}{8}$ in. external fat cover), retail cuts from the round, loin, rib, and chuck for each of the five cutability groups.

TABLE 2: CUTABILITY GROUP (YIELD GRADE) AND RANGE OF PERCENTAGES FOR THE MAJOR RETAIL CUTS (ROUND, LOIN, RIB, AND CHUCK) IN THE BEEF CARCASS

<i>Cutability Group</i>	<i>Major Retail Cuts (%)</i>
1	52.3 or more
2	49.9-52.2
3	49.8-47.7
4	47.6-45.4
5	45.3 or less

TABLE 3: THE QUANTITY OF BEEF REQUIRED TO GIVE A RETAILER 30,000 LB OF RETAIL CUTS AND THE PERCENTAGES OF FAT, BONE AND SHRINKAGE, AND TRIMMED CUTS FOR EACH OF THE FIVE USDA CUTABILITY GROUPS (ANON., 1968)

Cutability Group	No. Carcasses Required	Total Carcass Weight (lb)	Fat Trim (%)	Bone and Trimmed	
				Shrinkage (%)	Cuts (%)
1	61	36,585	7.5	10.5	82.0
2	65	38,760	12.6	10.0	77.4
3	69	41,210	17.7	9.5	72.8
4	73	43,990	22.8	9.0	68.2
5	78	47,170	27.9	8.5	63.6

TABLE 4: SUMMARY OF CUTTING TESTS ON 164,211 LB OF CARCASS BEEF (U.S. ARMY SUBSISTENCE CENTER, 1963)

Yield Grade	Amount Beef Processed (lb)	Yield of Usable Meat (%)		Raw Fat (%)
		Estimated	Actual	
2	35,027	70.8	70.2	11.0
3	56,532	68.0	67.6	13.9
4	29,665	65.2	65.7	16.0
5	27,399	62.3	61.9	21.7
6	15,588	60.1	59.4	23.1

Note: Beef of Yield Grade 1 was not analysed because of its scarcity. The trim standard was $\frac{1}{2}$ in. surface fat.

TABLE 5: ACTUAL YIELD OF BONELESS, CLOSELY TRIMMED RETAIL CUTS FROM THE ROUND, LOIN, RIB, AND CHUCK BY CUTABILITY GROUPS (ANON., 1963)

Cutability Group	Cutability Group Range (%)	Test A (University Illinois)		Test B (USDA)	
		No. Carcasses	Actual Yield (%)	No. Carcasses	Actual Yield (%)
1	53.1 and over	14	53.2	24	54.1
2	50.8-53.0	97	51.3	25	51.9
3	48.5-50.7	161	49.0	38	49.8
4	46.2-48.4	43	46.5	32	47.5
5	46.1 and under	29	44.4	26	45.2

DESCRIPTION OF EXTREME CUTABILITY GROUPS

"A carcass in Cutability Group 1 usually has only a thin layer of external fat over the ribs, loins, rumps, and clods and slight deposits of fat in the flanks and cod or udder. There is usually a very thin layer of fat over the outside of the rounds and over the tops of the shoulders and neck. Muscles are usually visible through the fat in many areas of the carcass."

"A 500 lb carcass of this group which is near the borderline of Cutability Groups 1 and 2 might have $\frac{3}{10}$ inch of fat over the ribeye, 11.5 square inches of ribeye, and 2.5 percent of its weight in kidney, pelvic, and heart fat."

"A carcass in Cutability Group 4 usually is completely covered with fat. The only muscles usually visible are those on the shanks and over the outside of the plates and flanks. There usually is a moderately thick layer of fat over the loins, ribs and inside rounds and the fat over the rumps, hips, and clods usually is thick. There usually are large deposits of fat in the flanks and cod or udder."

"A 500 lb carcass of this group which is near the borderline of Cutability Groups 4 and 5 might have one inch of fat over the ribeye, 9.0 square inches of ribeye, and 4.5 percent of its carcass weight in kidney, pelvic, and heart fat."

"A carcass in Cutability Group 5 usually has more fat on all of the various parts, a smaller area of ribeye, and more kidney, pelvic, and heart fat than a carcass in Cutability Group 4."

The value to the retailer of buying carcasses classified according to yield is illustrated in Table 3. The example given shows how a retailer might obtain his requirement of 30,000 lb of boned and trimmed retail cuts by buying Choice grade 600 lb beef carcasses of different cutability groups.

Tests have been conducted to determine the performance of carcasses in lots of different cutability grades as normally traded; results from some tests are shown in Tables 4 and 5.

At the time these results were obtained six yield grades were operative (Barton, 1964) whereas currently there are only five yield grades.

The results presented in Tables 4 and 5 indicate good agreement between predicted yield and actual yield of beef from carcasses of different yield grades. A higher degree of precision than that illustrated is unlikely since the

percentages of carcasses that will yield within the indicated limits of a grade will depend on two considerations: (1) The position of the carcasses within the grade, and (2) The width or spread of the grade. Carcasses close to the limits of a grade will yield outside that grade more frequently than will carcasses in the middle of the grade. Similarly, it is also obvious that, the narrower the grade, the greater will be the number of carcasses that fall outside their predicted grade. Because of these considerations, the percentage of carcasses that fall within the prescribed limits of their grade is not a valid basis for determining the usefulness of yield grading in the marketing of beef.

To assist cattle producers and traders, the Consumer and Marketing Service, U.S.D.A. has published official standards for slaughter cattle for both quality grades and cutability groups (Anon., 1966). These standards describe the appearance of live cattle whose carcasses would qualify for the various grades and are thus of value to the industry and have lately influenced cattle judging (Barton, 1965, 1967, 1968a, 1969a). The characteristics taken into account in the yield grading of beef carcasses in America are also incorporated in the New Zealand National Beef Cuts Judging Standard (Barton, 1968b).

Harrington (1969) has questioned the requirement in the American beef grade standards of a high level of marbling, particularly in the Choice grade. Many traders and meat scientists maintain that this amount of marbling fat is not necessary for reliable and desirable eating qualities of the beef. He also criticized the standards for the quality grades as they now involve an appraisal of conformation as well as an assessment of the probable eating quality of the meat. According to Harrington (1969) the inclusion of conformation in the grade standards effective from June 1, 1965 was largely due to the powerful lobby of breeders of pedigree beef cattle who did not wish to reduce the competitive position of their cattle compared with the Holstein-Friesian even though cattle of this breed grow faster in the feedlots than those of the beef breeds. In grading for quality, emphasis on conformation, however, is slight as has already been indicated.

LAMB CARCASS GRADING AND CLASSIFICATION

The principles involved in the grading of lamb in America are essentially the same as those used in beef grading.

There are five quality grades — Prime, Choice, Good, Utility, and Cull — applicable to lamb, yearling mutton,

and mutton carcasses, except that mutton carcasses are not eligible for the Prime grade. These grades take into account the quality or the palatability-indicating characteristics of the lean and the conformation of the carcass (Anon., 1969).

GRADING LAMB CARCASSES FOR QUALITY

"The quality of the lean flesh is evaluated by considering its texture, firmness, and marbling, as observed in a cut surface, in relation to the apparent maturity of the animal from which the carcass was produced. However, in grading carcasses direct observation of these characteristics is not possible. Therefore, the quality of the lean is evaluated indirectly by giving equal consideration to: The quality of fat intermingled within the lean between the ribs called 'feathering', and streaking of fat within and upon the inside flank muscles, and the firmness of the fat and lean — all in relation to the apparent evidence of maturity" (Anon., 1969).

"The quality standards apply to all ovine carcasses without regard to the apparent sex condition of the animal at time of slaughter. However, carcasses from males which have thick, heavy necks and shoulders typical of uncastrated males are discounted in quality grade in accord with the extent to which these characteristics are developed."

The chemical and physical characteristics of New Zealand lamb, when graded according to American grade standards, have been reported by Kemp and Barton (1969). These same parameters for the New Zealand export grades were presented earlier (Clarke and McMeekan, 1952; Barton, 1960; Kemp and Barton, 1966).

CLASSIFYING LAMB CARCASSES FOR YIELD

"The yield grade of an ovine carcass is determined by considering three characteristics: The amount of external fat, the amount of kidney and pelvic fat, and the conformation grade of the legs."

"The amount of external fat for carcasses with a normal distribution of this fat is evaluated in terms of its actual thickness over the centre of the ribeye muscle and is measured perpendicular to the outside surface between the 12th and 13th ribs. On intact carcasses fat thickness is measured by probing. This measurement may be adjusted, as necessary, to reflect unusual amounts of fat on other parts of the carcass."

"The amount of kidney and pelvic fat considered in determining the yield grade includes the kidney knob and the lumbar and pelvic fat in the loin and leg which are removed in making closely trimmed retail cuts. The amount of these fats is evaluated subjectively and expressed as a percent of the carcass weight."

"The conformation grade code of the legs . . . is in terms of thirds of grades and coded using 15 for high Prime and 1 for low Cull." (Conformation has been defined in these standards as ". . . the manner of formation of the carcass with particular reference to the relative development of the muscular and skeletal systems, although it is influenced to some extent by the quantity and distribution of external finish. . . . External fat in excess of that normally left on retail cuts is not considered in evaluating conformation.")

"The yield grade [cutability group] of an ovine carcass or side is determined on the basis of the following equation:

TABLE 6: YIELD GRADE AND RANGE OF PERCENTAGE BONELESS, CLOSELY TRIMMED, MAJOR RETAIL CUTS FOR THE FIVE YIELD GRADES OF LAMB

<i>Yield Grade</i>	<i>Major Retail Cuts, %</i>
1	47.3 or more
2	45.5-47.2
3	43.7-45.4
4	41.9-43.6
5	41.8 or less

TABLE 7: THE EFFECT OF A CHANGE IN ONE FACTOR IN THE PREDICTION EQUATION ON THE YIELD GRADE OF A LAMB CARCASS (ANON., 1969)

<i>Factor</i>	<i>Effect of Increase on Yield Grade</i>	<i>Approx. Change in Each Factor Required to Make a Full Yield Grade Change*</i>
Thickness of fat over ribeye	Decreases	0.15 in.
Percent of kidney and pelvic fat	Decreases	4%
Leg conformation	Increases	—†

*This assumes no change in the other factors.

†A change in leg conformation score from minimum to maximum score will produce only 0.70 of a change in grade.

Yield grade = $1.66 - (0.05 \times \text{leg conformation grade code}) + (0.25 \times \text{percent kidney and pelvic fat}) + (6.66 \times \text{adjusted fat thickness over the ribeye in inches}).$ "

Table 6 presents figures for the estimated yields of boneless, closely trimmed ($\frac{1}{4}$ in. fat trim) major retail cuts from each of the five yield grades for lamb.

The approximate effect on lamb yield grade of a change in one of the four factors incorporated in the above equation is given in Table 7.

DESCRIPTION OF EXTREME YIELD GRADES OF LAMB

"A carcass in Yield Grade 1 usually has only a thin layer of external fat over the back and loin and slight deposits of fat in the flanks and cod or udder. There is usually a very thin layer of fat over the top of the shoulders and the outside of the legs. Muscles are usually plainly visible on most areas of the carcass."

"A carcass of this yield grade which is near the borderline of Yield Grade 1 and Yield Grade 2 might have 0.1 inch of fat over the ribeye, 1.5 percent of weight in kidney and pelvic fat, and an average Prime leg conformation grade. Such a carcass with normal fat distribution would also have a body wall thickness of 0.5 inch."

As a contrast to the description for a Yield Grade 1 carcass is the description for a Yield Grade 4 carcass.

"A carcass in Yield Grade 4 usually is completely covered with fat. There usually is a moderately thick covering of fat over the back and a slightly thick covering over the shoulder and legs. There usually are large deposits of fat in the flanks and cod or udder."

"A carcass in this yield grade which is near the borderline of Yield Grade 4 and Yield Grade 5 might have 0.4 inch of fat over the ribeye, 4.5 percent of its weight in kidney and pelvic fat, and an average Choice leg conformation grade. Such a carcass with normal fat distribution would also have a body wall thickness of 1.1 inches."

The standards for Yield Grade 5 merely state that a carcass in this grade "... usually has more external and kidney and pelvic fat and a lower conformation grade of leg than a carcass in Yield Grade 4."

The official descriptions for slaughter lambs, yearlings and sheep (Anon., 1969) are of assistance to producers and traders as they define the physical appearance of sheep in relation to the predicted grade of their carcasses for either quality or yield. This relationship has been dis-

cussed and emphasized by Barton (1969b) in connection with the New Zealand National Lamb Cuts Judging Standard in which measurements to indicate the yield of cuts and a measurement of leg length are made so that points for leg shape or conformation can be given (Barton, 1968c).

GENERAL

Attention in the United States is paid to assessing the maturity of the carcass. Freeman (1962) has stated that maturity is the most important grade-determining factor in beef. Maturity of beef carcasses is subjectively determined on the appearance of cartilages, bones and the flesh. In the case of sheep carcasses, their classification into age groups is based on the "break joint" at the zone of bone growth — *i.e.*, the junction of the epiphysis and diaphysis. Carcasses whose metacarpal bones break at this junction are classed as lamb even though they may be from sheep which are as old as 14 months at the time of slaughter.

Although the standards for yield grades are based largely on measurements, in practice the grading is done subjectively by trained personnel who decide on the yield grade of a particular carcass following a rapid subjective appraisal of it. The yield grade standards are detailed in the specifications so that training of graders can be on a sound basis. The written standards also facilitate understanding of the product, which in turn should minimize trade controversies and difficulties.

Consumers in an affluent society demand a better product and this, in the case of meat, is most easily achieved if grading and classification of carcasses is meaningful in terms of the requirements of the market. Targets for breeding and feeding are likely to be more pertinent if trade standards are realistic and emphasize the important things. Marketing and price reporting also benefit from a grading and classification procedure which is reliable, repeatable and universally acceptable. These benefits are being enjoyed increasingly in the United States because of the new beef and lamb grading and classification standards that are now widely appreciated and accepted by each segment of the meat industry.

REFERENCES

- Anon., 1963: AMS — Livestock Div. USDA pamphlet Dec. 20, 1963 (mimeographed).
———, 1965: *Official U.S. Standards for Grades of Carcass Beef*. SRA-C & MS 99, USDA.

- , 1966: *Official U.S. Standards for Grades of Slaughter Cattle*. C & MS-SRA 112, USDA.
- , 1968: USDA C & MS Marketing Bull. No. 45.
- , 1969: *Official U.S. Standards for Grades of Lamb, Yearling Mutton, and Mutton Carcasses; Slaughter Lambs, Yearlings, and Sheep*. Federal Register, Title 7, Chapt. 1, Pt 53, Subpart B — Standards, Jan. 8, 1969.
- Barton, R. A., 1960: *Proc. 15th Ann. Reciprocal Meat Conf.* Chicago, p. 145 (mimeographed).
- , 1964: *Proc. N.Z. Soc. Anim. Prod.*, 24: 1.
- , 1965: *Sheepfmg A.*: 93.
- , 1967: *Anim. Breed. Abstr.*, 35: 1.
- , 1968a: *Spur*, 2 (7): 22.
- , 1968b: *Inst. Meat Bull. No. 61*: 10.
- , 1968c: *Inst. Meat Bull. No. 60*: 2.
- , 1969a: *Sheepfmg A.*: 79.
- , 1969b: *Proc. Sydney Lamb Symp.* Roy. Agric. Soc., N.S.W. p. 2 (mimeographed).
- Clarke, E. A.; McMeekan, C. P., 1952: *N.Z. Jl Sci. Technol.*, A33: 1, 24.
- Freeman, O. L., 1962: *Congressional Record*, p. 8050. (Cited by Naumann, H. D. (1965) in: *Food Quality: Effects of Production Practices and Processing*, Publ. 77, Amer. Assn. Adv. Sci., 1965, p. 239).
- Harrington, G., 1969: *Inst. Meat Bull. No. 64*: 2.
- Kemp, James D.; Barton, R. A., 1966: *N.Z. Jl agric. Res.*, 9: 590.
- Kemp, James D.; Barton, R. A., 1969: *J. Anim. Sci.*, 28: 324.
- Kiehl, E. R.; Rhodes, V. J., 1960: *Res. Bull. No. 728*, Mo. Agric. Expt Stn.
- Rhodes, V. J., 1960: *J. Farm Econ.*, 42 (1): 133.
- Williams, W. F.; Stout, T. T., 1964: *Economics of the Livestock-Meat Industry*. Macmillan Co., N.Y.
- U.S. Army Subsistence Center, 1963: *Evaluation of Graded Beef Carcass*. U.S. Army Subsistence Center, Chicago (mimeographed).