CLASSIFICATION AND GRADING OF BEEF AND VEAL CARCASSES

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SUMMARY

Data derived from nearly 1,200 cattle processed in two successive years were used to illustrate the operation and efficiency of the export beef carcass classification and grading system used in New Zealand.

Marked differences in grading results between years were ascribed to changes in application of specifications, reflecting the subjective nature of the system.

Heifers in all grades had a slightly higher proportion of high-priced cuts than steers. The difference in meat yield between steers and heifers reflected the greater weight of internal (kidney/channel) fat in heifers. As the producer is now paid on the basis of carcass weight excluding internal fat, continuation of a lower price per 100 lb carcass weight for heifers compared with steers appears unjustified.

The present grades within sexes were differentiated by carcass weight and fatness; with no appreciable differences in meat yield or in the proportion of high-priced cuts.

Improvements in classification and grading, by prediction of the meat content of individual carcasses using carcass weight (excluding internal fat) and an objective simple measurement of fatness, are discussed.

THE number and variety of classification and grading schemes for beef and veal carcasses in use throughout the world illustrate the complexity, lack of agreement and state of flux of the position.

Standards in use today in New Zealand were established when wholesale handling of beef was exclusively in the carcass form. During the past decade, particularly, adoption of modern processing techniques (Everitt, 1961a, b, c; Barton, 1966) results in nearly all export beef being sold as boneless, fat-trimmed meat, packed in boxes (Anon., 1969b). The conformation or shape of beef carcasses, deemed a vital quality factor by pedigree breeders and in carcass grading (Smith-Pilling, 1954, 1959; Anon., 1969a) is today rendered obsolete (reviewed Everitt, 1966). Meat traders are now far more deeply concerned with the weight of salable beef which can be derived, for their product cannot be disguised in the disreputable mantles of fat and bone as in earlier days.

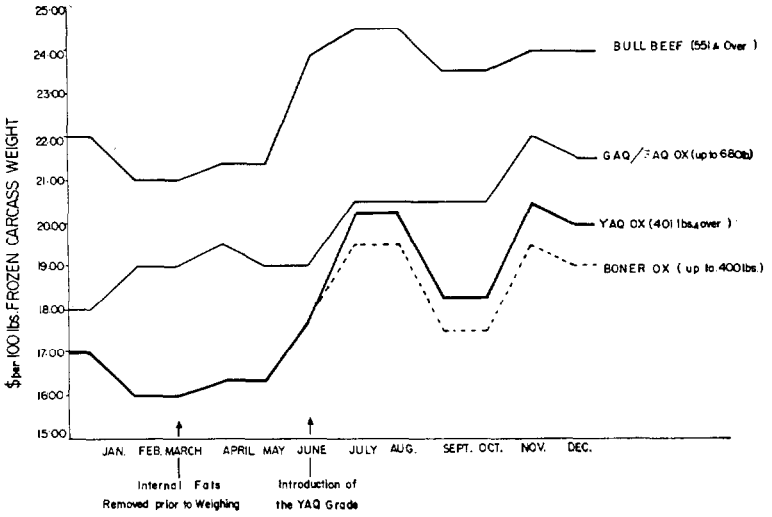

FIG. 1: *Schedule prices ($ per 100 lb carcass weight) for selected classes and grades of beef for export operating in 1969.*

Much of the mysticism of beef "quality", purported present in carcass form, has thus been eliminated by these processing and marketing changes. Unfortunately, the content and operation of existing classification and grading schemes have not been subject to concomitant needed revision, despite authoritative urgings (Anon., 1965b, Anon., 1969c). It is important that specifications and methods of payment should be constantly under review, for both the producer and processor are affected financially by differential prices between classes and grades, as shown in Fig. 1.

Two classification and grading schemes are used for beef and veal in New Zealand. Specifications for beef and veal intended for export are dictated and supervised by the N.Z. Meat Producers' Board (Smith-Pilling, 1954, 1959; Anon., 1969a). Beef intended for local consumption in New Zealand is classified and graded according to specifications of the N.Z. Standards Association, implemented and supervised by graders of the Meat Division of the Department of Agriculture. Neither the specifications for each system, nor reasons for the need of two sets of standards, are well known. A Supervising Meat Grader of the N.Z. Meat Producers' Board commented some years ago, "Local consumption [grading] standards bear litle, if any, relation to export standards . . ." (Smith-Pilling, 1959).

Why is it necessary to classify and grade beef; and, if required, what are the main essentials of a practical system? Smith-Pilling (1959) states that, "The main purpose of grading is to make possible a determination of values . . . [and] to distribute the various types and qualities of meat to suit market preferences". Kirton (1966) advances the view that the purpose of grading is to provide a reliable system of classification for the benefit of the purchaser, and that it should allow for differences in quality between grades. A superior grade, Kirton contends, should contain carcasses with a higher proportion of high-priced cuts, a higher red meat content, and meat of superior eating quality. Wardrop (1964) defined grading as ". . . a process which attempts to divide a heterogeneous group of material into sub-groups, within each of which the material has similar charcteristics", which paraphrased, might read — to place like with like. In a recent review, Harrington (1969) points out that carcass classification is nothing more nor less than a common language of communication between meat traders. One problem is to define a workable system which will classify the expected *quantity* of salable beef in a carcass from classification of the expected *quality* of that meat. A definition of "quality" applicable to all conditions has, however, yet to be established.

This paper uses information derived from cattle trials in progress to illustrate the operation of the present export grading system and to examine two pertinent questions. Do the existing export classes and grades for steers and heifers distinguish between carcasses in the amount of salable beef; and, as a measure of "quality", do the grades applied contain carcasses differing in the proportion of high-priced meat cuts?

MATERIALS AND METHODS

Organization of Trials

The organization of the co-operative farm trials conducted in the Auckland region has been described previously (Everitt *et al.*, 1969).

In the autumn of 1968, 494 steers and heifers (mean age, 620 days), comprising 5 breeds and crosses taken from 18 widely distributed grazing farms, were killed, graded and processed at Horotiu freezing works. A further 680 cattle of 7 breeds and crosses of similar age to those killed in 1968 were taken from 22 grazing farms, and processed in the autumn of 1969.

Information Recorded

(1) *Carcass Weight*

The carcass weight used in these analyses refers to the export (frozen) weight, including the kidney and channel or perirenal (*internal*) fat. In 1968 the producer was paid on this weight, but the basis of payment was changed in 1969 by removing the kidney fat before weighing. The weight of internal fat recorded in this work exceeds the values recorded commercially as it includes channel fat, and is also determined with greater accuracy.

(2) *Export Carcass Grades*

In both years, hot carcasses were classified by industry graders into steers and heifers, and then into one of three appropriate grades — Good Average Quality (G.A.Q.), Fair Average Quality (F.A.Q.) or Boner. Specifications for the grades appeared to follow those provided by Smith-Pilling (1954, 1959) and Anon. (1969a).

(3) *Measurement of Fat Cover*

In 1969 only, on the day following slaughter, three measurements of the depth of subcutaneous fat over the rib were taken from the left side of each chilled carcass, and a mean value computed (Anon., 1965a).

(4) *Carcass Composition*

Each carcass was boned out and primal meat cuts trimmed of excess fat (Everitt, 1961b) to standard specifications of the U.S.A. market. Individual meat cuts, fat trimmings and bone were weighed for each carcass.

Primal cuts have been collated into relatively high-priced and low-priced groups (Everitt *et al.*, 1969).

Biometrical Procedures

Effects due to breed and sex, and their interaction, were estimated by variance/covariance analyses allowing for unequal sub-class numbers. Sex effects were consistent within breeds. Values for steers and heifers have been presented separately in some cases but in others, where more appropriate, least square values are given, together with estimates of variability and significance.

TABLE 1: BREED AND SEX COMPOSITION OF CATTLE KILLED

	1968 Kill						1969 Kill					
	Steers		Heifers		Total		Steers		Heifers		Total	
Breed/Cross	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
F × J	70	22.1	37	20.9	107	21.7	98	23.5	35	13.3	133	19.6
H × J	72	22.7	62	35.0	134	27.1	68	16.3	72	27.4	140	20.6
C × J	50	15.8	43	24.3	93	18.8	85	20.4	104	39.5	189	27.8
F × F	32	10.1	—	—	32	6.5	47	11.2	—	—	47	6.8
C × F	—	—	—	—	—	—	4	1.0	7	2.7	11	1.6
H × F	—	—	—	—	—	—	8	1.9	8	3.0	16	2.4
Subtotal	224	70.7	142	80.2	366	74.1	310	74.3	226	85.9	536	78.8
A × A	93	29.3	35	19.8	128	25.9	107	25.7	37	14.1	144	21.2
Total	317	100.0	177	100.0	494	100.0	417	100.0	263	100.0	680	100.0

Note:

In this and in subsequent tables the following abbreviations are used:

(1) F × J = Friesian × Jersey; H × J = Hereford × Jersey; C × J = Charolais × Jersey; F × F = Friesian × Friesian; C × F = Charolais × Friesian; H × E = Hereford × Friesian; A × A = Angus × Angus.

(2) S.D. = Standard deviation within sex and grade sub-groups.
S.E. = Standard error of difference.
* = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

Apart from indicating the breed/cross composition of the samples, values for individual breeds have not, in general, been presented. It has been assumed that carcass grading authorities do not know the breeds and crosses of animals presented for grading.

RESULTS

Composition of the Samples

The breed and sex composition of cattle killed in each of the two years is recorded in Table 1. Steers represented 64% and 61% of the cattle killed in 1968 and 1969, respectively. The samples were biased towards animals of dairy origin, with approximately 20% of A × A cattle in each year.

Grading Attainments

Distributions of carcass grades of the different breeds and crosses of cattle killed in 1968 and 1969 are presented in Table 2.

TABLE 2: DISTRIBUTION OF EXPORT CARCASS GRADES ACCORDING TO BREED AND SEX

	Percentage							
	G.A.Q.		*F.A.Q.*		*G.A.Q./F.A.Q.*		*Boner*	
Sex/breed	*1968*	*1969*	*1968*	*1969*	*1968*	*1969*	*1968*	*1969*
Steers:								
F × J	20	5	44	22	64	27	36	73
H × J	51	32	33	35	84	67	16	33
C × J	48	9	26	26	74	35	26	65
F × F	13	—	50	17	63	17	37	83
H × F		—		75	—	75	—	25
C × F		—		—	—	—	—	100
Subtotal	35	11	38	25	73	36	27	64
A × A	89	79	7	15	96	94	4	6
Total	51	29	28	23	79	52	21	48
Heifers:								
F × J	30	17	38	29	68	46	32	54
H × J	63	54	31	31	94	85	6	15
C × J	49	31	28	29	77	60	23	40
F × F	—	—	—	—	—	—	—	—
H × F	—	—	—	71	—	71	—	29
C × F	—	—	—	25	—	25	—	75
Subtotal	50	34	32	31	82	65	18	35
A × A	77	65	17	22	94	87	6	13
Total	55	38	29	29	84	67	16	33

TABLE 3: MEAN CARCASS WEIGHTS (lb) AND PROPORTIONS OF CARCASS COMPONENTS CLASSIFIED ACCORDING TO GRADE

Grade	*Carcass Wt.*	*% of Carcass Weight*			*% High-priced Cuts*
		Meat	*Bone*	*Excess Fat*	
Cattle killed 1968:					
G.A.Q.	414.7	63.9	22.8	13.3	40.5
F.A.Q.	365.8	64.0	24.6	11.4	41.1
Boner	316.0	63.1	26.9	10.0	41.6
S.D.	60.3	2.6	1.6	2.7	1.6
Cattle killed 1969:					
G.A.Q.	430.8	62.7	22.0	15.3	41.9
F.A.Q.	386.3	64.0	23.6	12.4	41.6
Boner	345.5	64.9	24.9	10.2	41.8
S.D.	60.5	2.1	1.6	2.4	1.3

Note: High-priced meat cuts as % of total meat.

Grading of steers and heifers did not differ significantly in 1968 but did do so ($P < 0.001$) in 1969.

The proportions of cattle grading Boner differed markedly in the two years. In 1969, approximately twice the proportion of steers graded Boner as in 1968. All breeds and crosses were affected and steers rather more than heifers.

In 1968, 35% of steers of dairy origin graded G.A.Q. compared with only 11% in 1969. The difference between the two years in the proportion of F.A.Q. steers of dairy origin was not so marked as with G.A.Q. steers. The relative proportions of G.A.Q. and F.A.Q. Angus steers in each year was not altered so markedly.

When the G.A.Q. and F.A.Q. grades are combined, as no financial distinction existed between them in either year, Table 2 shows that 52% of steers and 67% of heifers "graded" in 1969 compared with 79% and 84% in 1968, respectively.

Either the standards for grading of each sex classification, or the application of specifications, or the carcass composition of cattle presented, varied appreciably between the two seasons.

CARCASS WEIGHT AND COMPOSITION

Table 3 summarizes least square estimates of the carcass weights and composition by grades of cattle killed in the two years.

(1) *Carcass Weight*

The mean carcass weights of the three grades reduced progressively from G.A.Q. to F.A.Q. to Boner in each year. On the average, the G.A.Q. grade cattle were 49 lb heavier than F.A.Q. in 1968, and 45 lb heavier in 1969. Cattle graded F.A.Q. in 1968 were 50 lb heavier than those graded Boner, and 40 lb heavier in 1969.

Cattle killed in 1969 had heavier carcasses (overall, and by individual grades) than those killed in 1968. The mean weights of G.A.Q., F.A.Q. and Boner grades in 1969 were 16 lb, 20 lb and 30 lb heavier, respectively, than cattle in the same grades killed in 1968.

(2) *Carcass Composition*

The proportion of meat in the carcasses of the three grades did not differ significantly in 1968, but, in 1969, Boner and F.A.Q. grade cattle yielded significantly ($P < 0.01$) more meat than G.A.Q. grade cattle.

Cattle processed in 1969 had heavier carcasses, as noted earlier, and Table 3 shows that they carried more excess fat than cattle killed in 1968. Each grade of cattle in 1969 was heavier and fatter than the comparable grade in 1968.

The leaner, lighter cattle killed in 1968 carried proportionately a little more bone than cattle killed in 1969.

It may be noted that breeds and crosses differed significantly in carcass weight and composition in both years. Significant ($P < 0.001$) breed effects in both years remained after adjustment, by covariance, for differences in carcass weight (internal fats included) or carcass weight (internal fats excluded).

Table 3 shows that the proportion of high-priced cuts of beef did not differ significantly between grades within years, or between years. Neither did breeds and crosses differ significantly in this character except that Charolais × Jersey cattle had up to 1% more meat in this region than any other breed or cross examined.

Fat Cover

The mean depth of fat over the loin of cattle killed in 1969, together with the distribution of measurements recorded, is shown for steers and heifers by grades in Fig. 2.

A minimum depth of 3 mm of fat over the loin is regarded as one requirement for animals to be graded G.A.Q. or F.A.Q. Figure 2 shows, however, that a high proportion of G.A.Q. grade cattle, and an even higher proportion of

TABLE 4: SEX EFFECTS ON CARCASS WEIGHT (including internal fats) AND PROPORTIONS OF COMPONENTS CLASSIFIED ACCORDING TO GRADE

Grade	*Carcass Wt.*	*% Meat*	*Steers — Heifers ± S.E.* *% Bone*	*% Fat*	*% High-priced Cuts*
Cattle killed 1968:					
G.A.Q.	36.4*** ± 7.52	1.8*** ± 0.25	0.8 ± 0.58	— 2.6*** ± 0.31	— 0.7*** ± 0.18
F.A.Q.	41.2*** ± 9.73	0.8** ± 0.29	0.8** ± 0.25	— 1.6** ± 0.33	— 0.9*** ± 0.21
Boner	46.3*** ± 13.51	1.3** ± 0.43	0.9* ± 0.47	— 2.3*** ± 0.42	— 1.2*** ± 0.32
Cattle killed 1969:					
G.A.Q.	47.4*** ± 7.71	1.2** ± 0.42	0.7*** ± 0.21	— 1.9*** ± 0.56	— 0.8*** ± 0.21
F.A.Q.	64.3*** ± 7.65	0.9** ± 0.36	0.3 ± 0.24	— 1.2*** ± 0.30	— 0.6** ± 0.24
Boner	32.4*** ± 8.34	1.3*** ± 0.32	0.9*** ± 0.21	— 2.2*** ± 0.31	— 0.4* ± 0.20

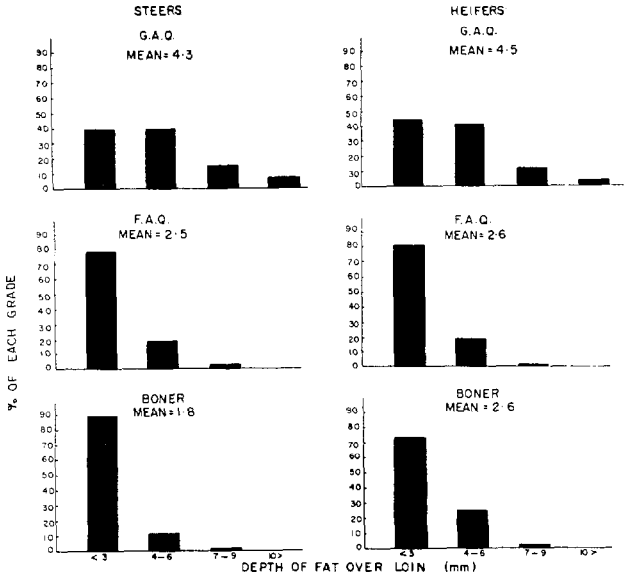

FIG. 2: *The distribution of measurements (mm) of the depth of fat over the loin classified by steers and heifers, and grades.*

F.A.Q., carried less than the stated minimum. A wide range in the depth of fat cover within grades can be seen, especially for G.A.Q.

Boner grade animals carried less external fat than F.A.Q. and the latter less than G.A.Q. Heifers were slightly fatter than steers in this measurement, with a greater proportion of G.A.Q. grade heifers carrying more than 3 mm of external fat over the loin.

SEX EFFECTS ON CARCASS WEIGHT AND COMPOSITION

Table 4 records the differences between steers and heifers in carcass weight (including internal fats) and composition for each grade of each year.

Steers were significantly heavier, with proportionately more meat and less excess fat, than heifers of the same grade in both years. Heifers had slightly, but significantly, more meat in the high-priced cuts grouping than steers in all grades of both years.

DISTRIBUTION OF EXCESS FAT

The distribution of excess fat is classified according to grade in Table 5; sex effects are summarized in Table 6.

TABLE 5: DISTRIBUTION OF EXCESS FATS CLASSIFIED ACCORDING TO GRADE

Grade	*% of Carcass Weight* *External Fat*	*Internal Fat*	*Internal Fat as % of Total Excess Fat*
Cattle killed 1968:			
G.A.Q.	8.2	5.7	40.2
F.A.Q.	7.1	4.7	39.5
Boner	6.0	4.3	40.7
S.D.	1.6	1.6	5.6
Cattle killed 1969:			
G.A.Q.	8.6	7.2	45.3
F.A.Q.	7.2	5.6	43.5
Boner	5.5	5.0	47.1
S.D.	1.3	1.3	4.9

TABLE 6: SEX EFFECTS ON DISTRIBUTION OF EXCESS FAT CLASSIFIED ACCORDING TO GRADE

	Steers — Heifers ± S.E. *% of Carcass Weight* *External Fat*	*Internal Fat*	*Internal Fat as % of Total Excess Fat*
Cattle killed 1968:			
G.A.Q.	— 1.0*** ± 0.2	— 1.7*** ± 0.2	— 4.4*** ± 0.6
F.A.Q.	— 0.6*** ± 0.2	— 1.0*** ± 0.1	— 3.1*** ± 0.7
Boner	— 0.9*** ± 0.3	— 1.5*** ± 0.3	— 4.3** ± 1.4
Cattle killed 1969:			
G.A.Q.	— 0.6* ± 0.3	— 1.5*** ± 0.2	— 3.7*** ± 0.7
F.A.Q.	— 0.2 ± 0.2	— 1.0*** ± 0.2	— 3.4*** ± 0.9
Boner	— 0.8*** ± 0.2	— 1.5*** ± 0.2	— 3.8*** ± 0.7

G.A.Q. grade carcasses in both years carried more external and internal fat, as proportions of carcass weight, than F.A.Q. carcasses, and the latter proportionately more than those in the Boner grade.

Internal fat, as a proportion of total excess fat, was greater in the heavier, fatter cattle killed in 1969 than those killed in 1968, with irregular differences between grades within each year.

Table 6 shows that the greater proportion of fat carried by heifers was fairly evenly distributed between external and internal fat depots when expressed as a percentage of carcass weight, with no appreciable differences between grades within years or between years. Internal fat as a proportion of total fat, however, was 3 to 4% greater in heifers than steers.

Prediction of Salable Meat

Regressions relating the weight of salable meat to carcass weight, including and excluding internal fat, are summarized in Table 7. Breeds and crosses differed significantly in these relations.

Carcass weight is clearly a major determinant of the weight of salable meat. With the internal fat as a component of carcass weight — the basis of producer payment in 1968 — separate regressions for steers and heifers within years, and between years, were needed to describe the relations.

When, however, carcass weight excluded internal fat — the basis of producer payment in 1969 — steers and heifers did not differ significantly in the prediction of the weight of meat within years, but did do so between years. The lack of a sex difference in this relationship remained after adjustment for the effects of breeds and crosses.

In 1968, carcass weight, excluding internal fat, accounted for 96% of the variation in the weight of salable meat, and for 92% in 1969 with rather fatter animals (Table 3). Removal of the internal fat before weighing of carcasses improved the precision of prediction as measured by the residual standard deviation.

Inclusion of the measurement of fat cover over the loin for cattle killed in 1969, using multiple regression, gave some improvement in the prediction of salable meat from

Table 7: Prediction of Salable Meat

y = wt (lb) of meat
x_1 = wt (lb) of carcass including internal fat
x_2 = wt (lb) of carcass excluding internal fat

Year	*Sex*	*Equation*	*r.s.d.*	*r*
1968	Heifers	$y = 0.66\ (\pm\ 0.007)\ x_1 - 2.97$	10.61	0.97***
	Steers	$y = 0.66\ (\pm\ 0.007)\ x_1 + 1.48$		
1969	Heifers	$y = 0.62\ (\pm\ 0.008)\ x_1 + 10.90$	13.97	0.95***
	Steers	$y = 0.62\ (\pm\ 0.008)\ x_1 + 15.51$		
1968	Heifers and Steers	$y = 0.72\ (\pm\ 0.006)\ x_2 - 10.13$	8.99	0.98**
1969	Heifers and Steers	$y = 0.69\ (\pm\ 0.007)\ x_2 + 1.34$	12.00	0.96***

carcass weight (internal fat removed) alone. Separate regressions for steers and heifers were needed:

Heifers: -0.21

$$y = 0.72\ (\pm\ 0.008)\ X_2 - 1.77\ (\pm\ 0.22)\ c$$

Steers: -2.40

Where c = depth (mm) of fat over the loin. This equation reduced the residual standard deviation to 11.49 lb, with a correlation coefficient of 0.96 ($P < 0.001$). At a constant carcass weight, over the range encompassed by this sample of cattle, the weight of salable meat decreased by 1.8 lb for every mm increase in the depth of fat over the loin. The small average depth of external fat cover in these cattle has been noted previously (Fig. 2).

DISCUSSION

These analyses clearly indicate that the grading of beef carcasses for the New Zealand export trade is no exception to the variability inherent in subjective assessments. Nor is there much room for confidence in the existing system as a reliable indicator of trade merit and as an effective means of communication between the processor and producer.

Cattle killed in 1969 were heavier and fatter than those killed in 1968. Despite these facts, a much higher proportion of cattle processed in 1969 were graded Boner. Two plausible explanations can be offered. First, and on the assumption that the grading specifications remained unaltered, the application of the standards may have been lax in 1968, but with more rigid adherence to standards in 1969. Or secondly, if the 1968 standards used accurately reflected specifications, then the marked changes between the two successive years must be ascribed to over-zealous application in 1969.

In either event, the obvious differences between years represent more than purely academic observation. The producer gains or loses financially owing to price differentials between grades (Fig. 1). Moreover, the farmer becomes atuned to recognizing the degree of fatness in live animals necessary to achieve a prescribed carcass grade. An alteration in grading standards, or in their application, without due prior publicity creates grave confusion for the producer.

Kirton (1966) pointed out that there is an implied superiority in the name *Good* Average Quality over *Fair* Average Quality. These results do not bear out such an implication. The grading system failed to place higher meat yielding cattle, with a high proportion of "quality" cuts, in the G.A.Q. grade. Apart from the higher yield of Boner cattle in 1969, the grades did not differ appreciably either in meat yield or the proportion of high-priced cuts. Carcass weight and fatness appeared as the main determinants of grades; heavier, fatter cattle achieving higher grades and a greater price per lb (Fig. 1) despite lower yields.

These anomalies are not confined to New Zealand. Vial and Kelly (1963), in Ireland, established a tendency to give a premium to fatter carcasses with reduced lean portions. Their conclusion applies equally to New Zealand export beef grading as it does in Ireland, namely, "There is little sense in a grading system which penalises the farmer producing lean carcasses, and at the same time forces butchers to charge higher prices than are necessary to allow for trimming of superfluous fat."

In the U.S.A., beef carcasses of the same weight and visual quality grade showed differences of up to 17% in yields of trimmed, boneless retail cuts, with a correspondingly wide difference in value. Differences in the Choice grade, for example, of more than $15 U.S. existed (Anon., 1965c). Pierce (1960) quotes examples of differences in value between individual beef carcasses of over $10 U.S. per 100 lb carcass weight or over $60 per carcass. Bray (1963), also in the U.S.A., drew attention to the meaningless nature of visual grades in beef, while grading authorities (Anon., 1965c) there stated, "The inability under the present Federal [*visual*] beef grade system to more precisely identify the yield of meat has forced many retailers to develop individual purchase specifications. Since each specification is slightly different the full force of competition cannot be directed against the total beef supply".

The problem has been recognized in New Zealand for some time. Barton (1965) found variation of nearly $1.50 per 100 lb carcass weight in Angus steers of the same age and carcass grade. An investigational committee set up to advise the N.Z. Meat Producers' Board (Anon., 1965b) concluded that, "Emphasis on cutability as the main criterion in beef grading should secure the most rapid improvement in the quality of beef"; while the Distribution Committee reporting to the recent National Development Conference (Anon., 1969c) comments, "Classification

according to yield as well as quality and age of meat appears to be desirable".

Commendable progress has been made in the South Island of New Zealand in application of yield grading (Cushen, 1967) or, as claimed by some authorities, yield buying. In this system, carcasses with a high yield of red meat are paid a premium and over-fatness is discriminated against, with payment of differential prices according to estimated meat yield. The present system suffers, however, from being restricted to G.A.Q. grade carcasses, *subjectively* assessed, and upon a further *subjective* appraisal of yield.

Development of the proposals advanced in this paper for prediction of the weight of meat in each carcass, using carcass weight (excluding internal fat) and a measurement of fat cover, is fully warranted. Further work on fatter cattle than those in the present sample is needed to confirm the usefulness of including a fat cover measurement. A simple table of computed values, or a slide rule, suitable for industry use can be readily devised. This would permit payment to the producer for the meat of each beast — a most desirable requirement (Everitt, 1966) — as well as ensuring that the processor was paying for the goods he must eventually sell. Such a system needs assessing not solely on whether it is absolute in prediction for individual carcasses, but whether it is more precise, informative and reliable than the existing scheme.

Use of carcass weight and a fat thickness measurement, both easily measured characters in industry practice, were found to account for over 70% of the variation in separable lean by Cole *et al.* (1962); and one fat measurement gave a better indication than an average of three. Fat thickness over the loin was negatively associated with meat yield in this work, in agreement with other reports (reviewed Butterfield, 1965; Everitt, 1966; Hedrick *et al.*, 1969). Barton (1967) used this knowledge to suggest that beef cattle selection for the total amount of muscle in the carcass can be achieved in part by reducing the quantity of fat.

Charles (1964), in Australia, has proposed a combination of yield grading with classification by specifications. A system of classifying and marketing beef by specification of age, sex, weight and approximate carcass composition as indicated by fat cover, is suggested. As Charles (1964) comments, ". . . this system would encourage the production of better quality meat no matter what the definition of quality in a particular market. Demand for

certain specifications would eventually result in higher prices being paid for the most suitable meat for current markets". The results of the present analyses lend strong support to Charles' (1964) proposals.

Finally, the establishment of a common relationship in meat yield for steers and heifers, irrespective of breeds, is of particular importance. Heifers were discounted by approximately $1 per 100 lb carcass weight (excluding internal fat) during 1969 as compared with steers (Fig. 1). No justification for this differential could be found in the present sample of cattle. Indeed, heifers yielded slightly more meat in the high-priced cuts region than steers. It seems unlikely that the difference in producer price for steer and heifer beef reflects a difference in meat market realization values accruing to the processor.

The difference in meat yields between steers and heifers based on carcass weight including internal fat reflected the greater weight of the latter in heifers. Some discrimination in price on this basis might have been acceptable but not to the degree operating earlier in export price schedules. Exclusion of the internal fat from the basis of producer reward effectively removes the need for classification and price discrimination on the basis of sex. Further work on fatter cattle is needed to confirm this finding. On growth principles, it would be expected that heifers would contain more intermuscular and subcutaneous fat than steers.

This apparent anomaly, however, in the imposition of a classification and grading scheme illustrates the *ad hoc* approach to the subject. The decision applied in 1969 to remove the internal fat before weighing, whilst commendable in many respects, appears to have been proposed, accepted and applied by grading authorities without full consideration of all the implications. It raises the distinct possibility of the existence of other anomalies. Do the differences in meat yields and market realizations between YAQ and Boner steers of comparable carcass weight, or between different weight ranges warrant the present price differentials between these grades, for example? To what extent do the schedule values reflect meat yields and product realizations? These, and other like questions can be answered only by sustained collection and analysis of industry information upon which rational decisions on classification and grading can be based.

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